KARACHI WATER AND SEWERAGE BOARD
GOVERNMENT OF SINDH

DESIGN, FINANCE, BUILD, REHABILITATE, OPERATE, MAINTAIN AND TRANSFER OF KARACHI HUB WATER CANAL UNDER PUBLIC-PRIVATE PARTNERSHIP MODE

THIS DOCUMENT INCLUDES:	
VOLUME I	BIDDING PROCEDURE
VOLUME II	TECHNICAL SPECIFICATIONS
VOLUME III	CONCESSION AGREEMENT
VOLUME IV	EQUITY FUNDING & UTILIZATION AGREEMENT

FOR BID PREPARATION/ SUBMISSION

CLICK HERE TO DOWNLOAD
BID FORM F3 – FINANCIAL FORMS
(MICROSOFT EXCEL FILE)

29TH AUGUST 2022

Address: Room No. 26, 1st Floor, Block B, Karachi Water and Sewerage Board, 9th Mile, Karsaz, Karachi, Pakistan.
Phone: +92 21 9924 5130 – 9922 2193 **Fax:** +92 21 9924 5154 – 5
E-mail: kwsc@ifc.org & karachihubwatercanalproject@gmail.com

KARACHI WATER AND SEWERAGE BOARD

REQUEST FOR PROPOSALS
FOR
AWARD OF CONCESSION
IN RESPECT OF THE
KARACHI HUB WATER CANAL

29TH AUGUST 2022

LETTER OF INVITATION

Karachi Water and Sewerage Board ("**KW&SB**") intends to engage a private party on PPP mode to design, finance, build, rehabilitate, operate, maintain and transfer the infrastructure of Karachi Hub Water Canal and associated facilities to ensure long term water supply of 454,609 m^3/Day to the city of Karachi while minimizing water losses and maintaining quality of water supply. The Project is expected to have a major development impact as the first competitively procured water supply project in Pakistan. For details on Project background, scope of work and specifications, please refer to Volume II (*Technical Specifications*) of the Request for Proposals ("**RFP**").

Capitalized terms used herein and not otherwise defined shall have the meaning given to them in Volume I (Bidding Procedure) of the RFP.

For the purposes of the Project, KW&SB invited Prequalification Applications from interested developers pursuant to the Prequalification Document to determine and evaluate their capabilities, competence and resources to execute the Project.

KW&SB hereby invites the Prequalified Applicants to participate in the Bidding Process and to submit their Bids for the Project in accordance with the requirements of the Applicable Evaluation Documents.

Bidders are required to submit only one (1) Bid, comprising of one (1) original Technical Proposal and one (1) original Financial Proposal, and four (4) hard copies of each, with one (1) soft copy of each (on CDs/ DVDs/ USBs) and other supporting documents (as applicable), as identified in the RFP, no later than **12:00 hours PST** by the Bid Submission Date at the submission address, as indicated in the Data Sheet.

The Technical Proposals will be opened on the Bid Submission Date at **13:00 hours PST** in the presence of the representatives of the Bidders who may wish to attend. After completion of evaluation of the Technical Proposals, Bidders who have submitted responsive Technical Proposals in terms of the Applicable Evaluation Documents shall be invited to attend the opening of the Financial Proposals. The date, time, and location of the opening of Financial Proposals shall be advised in writing to all technically qualified Bidders by KW&SB.

All Bidders are required to furnish, as part of their Financial Proposals (in a separately sealed envelope) a Bid Security, equivalent to one percent (1%) of the Bid Price. The Bid Security shall be an irrevocable, unconditional and on-demand bank guarantee in the form attached as Bidding Form F2 (*Form of Bid Security*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, issued in accordance with the requirements set out in the Instructions to Bidders.

It is mandatory for the Bids to be prepared using the standard formats for Technical Proposals and Financial Proposals, as provided in the RFP. Bids that are not prepared on the prescribed formats may not be considered by TFEC. If any information required in the prescribed forms is found missing, or written elsewhere, no credit will be given during evaluation and may lead to rejection of the Bid.

KW&SB may amend the RFP by issuing an addendum or a corrigendum (as the case may be) as per the requirements specified in the RFP, at any time prior to the Bid Submission Date.

Subject to the provisions of the Applicable Evaluation Documents, KW&SB reserves the right to cancel the Bidding Process at any time.

The RFP shall be: (a) uploaded on the websites of KW&SB, SPPRA and PPP Unit (provided below); (b)

issued to the Prequalified Applicants via email, on the email addresses provided by the Prequalified Applicants in their Prequalification Applications; and (c) issued to the Prequalified Applicants via registered post on the addresses provided by the Prequalified Applicants.

Designation: Project Director - Karachi Hub Water Canal Project.
Address: Room No. 26, First Floor, Block B, Office of The Karachi Water & Sewerage Board, 9th Mile, Karsaz, Karachi, Pakistan.
Phone No.: 0092 21 9924 5130
0092 21 9922 2193
Email: kwsc@ifc.org & karachihubwatercanalproject@gmail.com
Websites: **KW&SB –** https://www.kwsb.gos.pk
SPPRA – https://ppms.pprasindh.gov.pk/PPMS/
PPP Unit – https://www.pppunitsindh.gov.pk/

Sincerely,

PROJECT DIRECTOR
KARACHI HUB WATER CANAL PROJECT
KARACHI WATER AND SEWERAGE BOARD

IMPORTANT NOTICE

The RFP, together with all volumes, attachments, forms, annexures and appendices, attached thereto, is issued by KW&SB and is provided to the recipients solely for use in preparing and submitting the Bids.

Bids submitted in response to the RFP by the Bidders shall be upon full understanding and agreement of all terms of the RFP and such submission shall be deemed as an acceptance to all the terms and conditions stated in the RFP.

No GoS Party makes any representations (express or implied) or warranties as to the accuracy or completeness of the information contained in the RFP, or in any other document or information made available to a person in connection with the Project (including the Bidding Process); and the same shall have no liability for the RFP or for any other written or oral communication transmitted to the recipient in the course of the recipient's evaluation of the Project. No GoS Party shall be liable to reimburse or compensate any recipient for any costs, fees, damages or expenses incurred by the recipient in evaluating or acting upon the RFP or otherwise in connection with the Project.

The RFP shall neither constitute a solicitation to invest, or otherwise participate, in the Project (including the Bidding Process), nor shall it constitute a guarantee or commitment of any manner on the part of any GoS Party that the Project will be awarded or otherwise proceed. KW&SB (including GoS) reserves the right, in its full discretion, to modify the RFP and/or the Project requirements at any time to the fullest extent permitted by applicable Laws and shall not be liable to reimburse or compensate the recipient for any costs, taxes, expenses or damages incurred by the recipient in such an event.

KW&SB may amend the RFP by issuing an addendum or a corrigendum (as the case may be) as per the requirements specified in the RFP, at any time prior to the Bid Submission Date.

Subject to the provisions of the Applicable Evaluation Documents, KW&SB reserves the right to cancel the Bidding Process at any time.

Capitalized terms used herein and not otherwise defined shall have the meaning given to them in Volume I (Bidding Procedure) of the RFP.

TABLE OF CONTENTS OF THE RFP

- **VOLUME I – BIDDING PROCEDURE**
- **VOLUME II – TECHNICAL SPECIFICATIONS**
- **VOLUME III – CONCESSION AGREEMENT AND APPENDICES**
- **VOLUME IV – EFU AGREEMENT**

VOLUME I:
BIDDING PROCEDURE

TABLE OF CONTENTS (VOLUME I)

GLOSSARY **9**

1. GENERAL **17**

2. ELIGIBLE BIDDERS **19**

3. RFP DOCUMENT **23**

4. PREPARATION OF BIDS **26**

5. SUBMISSION AND OPENING OF BIDS **36**

6. CLARIFICATION AND EVALUATION OF BIDS **40**

7. AWARD OF CONCESSION **44**

8. OTHER CONSIDERATIONS **45**

9. DATA SHEET **48**

ANNEXURE A – ELIGIBILITY CRITERIA FOR PROPOSED CONTRACTORS **110**

ANNEXURE B – EVALUATION CRITERIA **112**

ANNEXURE C – FORM OF C&O PERFORMANCE SECURITY **123**

PART 1
INSTRUCTIONS TO BIDDERS

GLOSSARY

Unless otherwise specified / defined, all capitalized terms used herein shall bear the meanings set out below. References to any law, rule or regulation shall include any amendments, modifications or any re-enactment thereof.

The headings in the Instructions to Bidders, including the table of contents, are for convenience of reference only and not for purposes of construction or interpretation of the Instructions to Bidders.

TERM	DEFINITION
Acceptable Bank	Has the meaning given to it the Concession Agreement.
Acceptance of Notification of Award	Has the meaning given to it in Sub-Section 7.3.3 of the Instructions to Bidders.
Affiliate	With respect to a person (being the Bidder or, where the Bidder is a Consortium, each Consortium Member), means: (a) any company or entity that directly or indirectly Controls or is Controlled by, or is under common Control with such person; (b) any director, senior executive or manager either of such person or of any company or entity referred to in paragraph (a) above; (c) any consultant, agent or representative supporting such person in connection with the Project (including the Prequalification Process and / or Bidding Process for the Project); and / or (d) any other person with an aggregate ultimate beneficial interest in at least five percent (5%) of the share capital or ownership interest in such person (howsoever held).
Applicable Evaluation Documents	Collectively: (a) the Sindh PPP Act; (b) the SPPRA Act; (c) the SPPRA Rules; (d) the SPPRA Guidelines; (e) any applicable order, instruction, guideline, regulations or instrument issued under the Sindh PPP Act, the SPPRA Act and / or the SPPRA Rules; and (f) the RFP.
Approved Contractor	The Approved EPC Contractor and / or the Approved O&M Contractor.
Approved EPC Contractor	The contractor selected from the qualified Proposed EPC Contractors, approved in terms of Sub-Section 6.5 (*Evaluation Criteria*) of the Instructions to Bidders, to undertake the Mobilisation Activities and the C&O Activities.
Approved O&M Contractor	The contractor selected from the qualified Proposed O&M Contractors and approved in terms of Sub-Section 6.5 (*Evaluation Criteria*) of the Instructions to Bidders, to undertake the C&O Activities and the O&M Activities.
Availability Payment	Has the meaning given to it in the Concession Agreement.

Best Evaluated Bid	A Bid which is determined to be the '*best evaluated bid*' for the award of Concession in terms of the requirements of the Applicable Evaluation Documents.
Bid	The proposal (constituting the Technical Proposal and Financial Proposal) submitted by a Bidder in response to the RFP, which is prepared and submitted in accordance with this RFP.
Bidder	The Prequalified Applicant that has submitted a Bid in response to the RFP.
Bidding Forms	The forms provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, that are required to be submitted with the Technical Proposals and the Financial Proposals.
Bidding Process	The international competitive bidding process being conducted pursuant to the Applicable Evaluation Documents, for the selection of the Successful Bidder for the award of the Concession for the Project.
Bid Price	The price quoted by a Bidder in its Financial Proposal, calculated as per the formula set out in Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP.
Bid Security	Has the meaning given to it in Sub-Section 4.7.1 of the Instructions to Bidders.
Bid Submission Date	The last date for submission of Bids as specified in the Data Sheet, as may be extended by KW&SB in accordance with the requirements of the Applicable Evaluation Documents.
Bid Validity Period	The period of one hundred twenty (120) days starting from the Bid Submission Date, as may be extended in accordance with the requirements of the Applicable Evaluation Documents.
Business Day	Any day that is not declared a public holiday in Karachi, Pakistan, during which banks are generally open for business in Karachi, Pakistan.
C&O Activities	Has the meaning given to it in the Concession Agreement.
C&O Performance Security	The irrevocable, unconditional and on-demand bank guarantee, in favour of GoS, in an amount equal to Pakistani Rupees One Billion only (PKR 1,000,000,000/-) issued by an Acceptable Bank as per the requirements of the RFP and in the form set out in Annexure C (*Form of the C&O Performance Security*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP.
C&O Performance Security Expiry Date	Has the meaning given to it in the Concession Agreement.

Class B Equity Subscription Account	Has the meaning given to it in the EFU Agreement.
Commencement Conditions Precedent	Has the meaning given to it in the Concession Agreement.
Commencement Date	Has the meaning given to it in the Concession Agreement.
Company	The SPV to be established and incorporated under the laws of Pakistan by the Successful Bidder, for the purposes of undertaking the Project.
Concession	Has the meaning given to it in the Concession Agreement.
Concession Agreement	The agreement titled "Concession Agreement" attached in Volume III (*Concession Agreement and Appendices*) of the RFP, including all appendices thereto.
Concession Documents	Collectively: (a) the Concession Agreement; (b) the License Agreement; (c) the EFU Agreement; and (d) such other instrument executed in relation to the Project, which has been designated by KW&SB / GoS as a Concession Document.
Concession Period	Has the meaning given to it in the Concession Agreement.
Consortium	A Bidder comprised of two (2) or more Consortium Members, formed to submit the Bid, in accordance with the requirements of the Applicable Evaluation Documents.
Consortium Authorized Representative	The Lead Investor or the Lead Developer, appointed as the authorized representative of a Consortium in terms of the requirements of the Prequalification Document and the RFP.
Consortium Members	Each member of a Consortium, including the Lead Developer and the Lead Investor.
Consortium Undertaking	Has the meaning given to it in Sub-Section 2.1.2 of the Instructions to Bidders.
Control	The: (a) ownership or control (whether directly or otherwise) of more than 50% of the equity share capital, voting capital, or the like, of the controlled entity; or (b) ownership of equity share capital, voting capital, or the like, by contract or otherwise, conferring control of or power to: (i) control the composition of, or power to appoint more than fifty percent (50%) of the members of the board of directors, board of management, or other equivalent or analogous body of the controlled entity; or (ii) appoint the key managers of such entity,

	and **"Controls" "Controlling"** or **"Controlled"** shall be construed accordingly.
Data Sheet	The data sheet provided in Section 9 (*Data Sheet*) of the Instructions to Bidders.
EFU Agreement	The agreement titled "Equity Funding and Utilization Agreement" attached in Volume IV (*EFU Agreement*) of the RFP, including all appendices thereto.
Eligible Country	All countries of the world with whom Islamic Republic of Pakistan has commercial/trade relations and those which are not Sanctioned Countries.
Equity IRR	The Equity IRR (USD) and the Equity IRR (PKR), as applicable, as set out in Bidding Form F3-G (*Termination Payments*) of Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP.
Final Expiry Date	Has the meaning given to it in the Concession Agreement.
Financial Proposal	The financial proposal (including all forms, documents and information required in terms of the RFP and submitted therewith), submitted by a Bidder as part of its Bid pursuant to the RFP.
Foreign Sponsor	Has the meaning given to it Sub-Section 8.5 (*Requirements with respect to Foreign Exchange Indexation*) of the Instructions to Bidders.
GoS	The Local Government & Housing Town Planning Department, Government of Sindh.
GoS Account One	Has the meaning given to it in the Concession Agreement.
GoS Equity Amount	The amount requested by the Bidder in its Financial Proposal from the GoS, not exceeding PKR 2,500,000,000/- (Pakistani Rupees Two Billion Five Hundred Million only), and which amount shall in no circumstances be more than forty-nine (49%) percent of the paid-up share capital of the Company, to be funded in terms of the EFU Agreement.
GoS Funding Amount	Has the meaning given to it in the EFU Agreement.
GoS Party(ies)	Collectively, the KW&SB, the Government of Sindh and the TFEC, including their consultants, advisors, employees, personnel or agents and in the case of the Government of Sindh, also includes GoS, all ministries, department, attached department, autonomous body of Government of Sindh, local government or any organization or corporation owned or controlled by the Government of Sindh.
GoS Payment Account	Has the meaning given to it in the Concession Agreement.

GoS Payment Account Required Balance	Has the meaning given to it in the Concession Agreement.
GoS Termination SBLC	Has the meaning given to it in the Concession Agreement.
Head Regulator	The bifurcation point, at the end of the WAPDA canal from where water is distributed into the KWC and the Lasbela canal, as more specifically described in Volume II *(Technical Specifications)* of the RFP.
IDA	International Development Association, the World Bank Group.
IFC	International Finance Corporation, the World Bank Group.
IFC Advisory Fee	The fee of an amount equal to USD 500,000/- (United States Dollars Five Hundred Thousand Only) or an amount (in USD) equivalent to one point five percent (1.5%) of the Total Project Cost indicated by the Successful Bidder, whichever is higher, accrued as a result of IFC's services rendered to KW&SB and the GoS in respect of the Project, to be paid by the Successful Bidder to IFC. ***Note:*** *Exchange rate for USD equivalent amount of the Total Project Cost shall be based on the rate published by Reuters on https://www.reuters.com/markets/currencies at close of business UK time, on the date of Notification of Award.*
Independent Appointees	Has the meaning given to it in the Concession Agreement.
Instructions to Bidders	The Instructions to Bidders set out in Part 1 (*Instructions to Bidders*) of Volume I (*Bidding Procedure*) of the RFP.
Integrity Pact	Has the meaning given to it in Sub-Section 8.3 (*Integrity Pact*) of the Instructions to Bidders.
Karachi Hub Water Canal or **KWC**	Has the meaning given to the terms "*Karachi Water Canal System*" or "*KWC*" in the Concession Agreement.
KW&SB	Karachi Water and Sewerage Board, established under the KW&SB Act.
KW&SB Act	The Karachi Water and Sewerage Board Act, 1996.
Laws	Has the meaning given to it in the Concession Agreement.
Lead Developer	The lead developer, fulfilling the relevant requirements applicable to a Lead Developer, set out in the Prequalification Document, and as identified in the Prequalification Application.
Lead Investor	The lead investor, fulfilling the relevant requirements applicable to a Lead Investor, set out in the Prequalification Document, and as identified in the Prequalification Application.

License Agreement	Has the meaning given to it in the Concession Agreement.
m^3	Cubic meters.
MIGA	Multilateral Investment Guarantee Agency, the World Bank Group.
Mobilisation Activities	Has the meaning given to it in the Concession Agreement.
Notification of Award	The notification of award to be issued by KW&SB to the Successful Bidder as per Sub-Section 7.3.1 of the Instructions to Bidders.
NPV of Service Payments	The net present value of Service Payments, quoted by a Bidder in its Financial Proposal, calculated as per the methodology set out in Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP.
O&M Activities	Has the meaning given to it in the Concession Agreement.
Output Payment	Has the meaning given to it in the Concession Agreement.
PKR	Pakistani Rupees, the lawful currency of the Islamic Republic of Pakistan.
PPP	Public Private Partnership.
PPP Unit	The PPP Unit established under Section 6 (*Public-Private Partnership Unit*) of the Sindh PPP Act.
Pre-Bid Meeting	The meeting / conference relating to the queries raised and clarifications sought by the prospective Bidders held on the date specified in the Data Sheet.
Prequalification Application	The prequalification application, including all documents and information, submitted by an applicant in response to the Prequalification Document (including all documents and information submitted by the applicant in response to the clarifications sought by KW&SB during evaluation of Prequalification Process).
Prequalification Document	The prequalification document issued by KW&SB on September 15, 2021 for the prequalification of developers for the Project, and includes any amendments and / or modifications thereto.
Prequalification Process	The prequalification process conducted by KW&SB for the purposes of the Project, in terms of the Prequalification Document.
Prequalified Applicant	An applicant who has been prequalified by KW&SB during the Prequalification Process, as per the requirements of the Prequalification Document.
Project	Has the meaning given to it in the Concession Agreement.

Project Activities	Has the meaning given to it in the Concession Agreement.
Project Commercial Operations Date	Has the meaning given to it in the Concession Agreement.
Proposed Contractors	The Proposed EPC Contractors and / or the Proposed O&M Contractors.
Proposed EPC Contractors	The contractors proposed by a Bidder (not exceeding three (3)) in terms of Sub-Section 2.1.10 of the Instructions to Bidders, which will be evaluated by TFEC under this RFP; and may include a Bidder itself in case the Bidder intends to undertake the construction works for the Project.
Proposed O&M Contractors	The contractors proposed by a Bidder (not exceeding three (3)) in terms of Sub-Section 2.1.10 of the Instructions to Bidders, which will be evaluated by TFEC under this RFP; and may include a Bidder itself in case the Bidder intends to undertake the operations works for the Project.
PST	Pakistan Standard Time.
RFP	The Request for Proposals document issued by KW&SB in relation to the Project, containing the documents specified in Sub-Section 3.1.1 of the Instructions to Bidders, and includes any amendments and / or modifications thereto.
Sanctioned Country(ies)	Has the meaning given to it in the Concession Agreement.
SBP	The State Bank of Pakistan.
SBP Debit Authority	Has the meaning given to it in the Concession Agreement.
Service Payments	Has the meaning given to it in the Concession Agreement.
Sindh PPP Act	The Sindh Public Private Partnership Act, 2010.
SOE	Has the meaning given to it in Sub-Section 2.1.6.
Solar Plant	Has the meaning given to it in the Concession Agreement.
Sovereign	Has the meaning given to it in Sub-Section 2.1.6.
SPPRA	The Sindh Public Procurement Regulatory Authority, established under the SPPRA Act.
SPPRA Act	The Sindh Public Procurement Act, 2009.
SPPRA Rules	The Sindh Public Procurement Rules, 2010.
SPV	Special purpose vehicle, being a company incorporated under the

	applicable Laws.
Successful Bidder	The Bidder whose Bid has been determined to be the Best Evaluated Bid.
Technical Proposal	The technical proposal (including all forms, documents and information required in terms of the RFP and submitted therewith), submitted by a Bidder as part of its Bid pursuant to the RFP.
TFEC	The technical and financial evaluation committee formed in accordance with the applicable Laws for the purposes of the Project.
Total Project Cost	The cost specified by a Bidder in Bidding Form F1 (*Letter of Financial Proposal*) submitted as part of the Financial Proposal.
USD	United States Dollars, the lawful currency of the United States of America.
WAPDA	The Pakistan Water and Power Development Authority.

1. GENERAL

1.1 INTRODUCTION

KW&SB intends to engage a private party on PPP mode, to undertake the Project to ensure long term water supply of 454,609 m^3/day to the city of Karachi while minimizing water losses and maintaining quality supply. The Project is expected to have a major development impact, as the first competitively procured water supply project in Pakistan.

For details in relation to Project background and scope of work, please refer to **VOLUME II (*TECHNICAL SPECIFICATIONS*)** of the RFP.

The Concession Agreement establishes the rights and obligations of KW&SB, the GoS and the Company (as the concessionaire) and will be executed among KW&SB, the GoS and the Company in accordance with the requirements of the RFP. The Company will be required to execute Mobilisation Activities as a condition to the commencement of the Concession Period. The Concession Period shall commence on the Commencement Date (i.e., the date on which it is certified that the Commencement Conditions Precedent have been satisfied, deferred or waived in accordance with the Concession Agreement) and end on the Final Expiry Date (i.e., fifteen (15) years from the Project Commercial Operations Date, unless terminated earlier, in accordance with the Concession Agreement).

The Successful Bidder / Company shall be responsible for developing and implementing the financing structure for the Project, including the financing and commercial arrangements in accordance with the requirements of this RFP. Supports available to the Successful Bidder / Company from GoS for the Project have been specified in the Concession Documents.

Subject to the requirements of the applicable Concession Documents, the GoS shall:

(a) establish the GoS Equity Account and fund the same with the GoS Funding Amount, in accordance with the mechanism specified in the EFU Agreement;

(b) establish the GoS Payment Account and pre-fund the same with the GoS Payment Account Required Balance, in accordance with the mechanism specified in the Concession Agreement; and

(c) issue the SBP Debit Authority, authorising the SBP to debit the GoS Account One; and shall have the option of replacing the GoS Account One with the GoS Termination SBLC, each for the purposes and as per the mechanism specified in the Concession Agreement.

The GoS Equity Amount shall not exceed PKR 2,500,000,000/- (Pakistani Rupees Two Billion Five Hundred Million only) and shall be funded by the GoS, in accordance with the EFU Agreement. The injection of GoS Equity Amount as specified by the Successful Bidder in Biding Form F1 (*Letter of Financial Proposal*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP should not result in in the GoS holding more than forty-nine percent (49%) of the paid-up share capital of the Company.

Successful Bidder / Company shall be required to comply with the shareholding requirements, including share transfer restrictions, as set out in the EFU Agreement.

The Service Payments to be paid to the Company shall comprise: (a) following the Commencement Date, the Output Payment; and (b) following the Project Commercial Operations

Date: (i) the Availability Payment; and (ii) the Output Payment, in each case payable in accordance with the Concession Agreement. Determination of Service Payment including applicable indexation and deduction are detailed in appendix 8 of the Concession Agreement.

The Company will be responsible for handing over the KWC to KW&SB in a good working condition, as determined by the Independent Appointees, at the end of the Concession Period, as specified in the Concession Agreement, without any further compensation, to the Company at the time of such transfer. The transfer of KWC shall be subject to an inspection and correction process in order to ensure that KWC is handed over in accordance with the terms and conditions set out in the Concession Agreement.

All risks and obligations of KW&SB, the GoS and the Successful Bidder / Company shall be in accordance with the RFP (including the Concession Documents) and the Bidders shall be deemed to have full and complete understanding of the risks relating to the Project and their allocation, as set out in the RFP (including the Concession Documents).

By submitting the Bid, the Bidder acknowledges the acceptance of all tax-related obligations. The Service Payments are inclusive of all taxes. For the sake of clarity, the Company shall be required to pay all the taxes, duties, levies, stamp duties, rents, and other charges payable to any local government, provincial or federal government (as applicable) without any grossing-up obligation or liability on part of the GoS/KW&SB.

Before submitting the Bids, the Bidders should carefully examine all the information provided in the RFP (including the Concession Documents).

1.2 OVERVIEW OF THE BIDDING PROCESS

1.2.1 The bidding process in relation to the Project is being conducted pursuant to the Applicable Evaluation Documents and comprises the following:

- ***Stage 1 – Prequalification***

  For the purposes of the Project, KW&SB invited Prequalification Applications from interested developers pursuant to the Prequalification Document to determine and evaluate their capabilities, competence and resources to develop and implement the Project.

- ***Stage 2 – Competitive Bidding***

  After the completion of the Prequalification Process, KW&SB has issued the RFP for conducting the Bidding Process for the selection of a Successful Bidder for the award of the Concession, in accordance with the requirements of the Applicable Evaluation Documents.

  In terms of the Applicable Evaluation Documents, the "*single stage two envelope*" bidding procedure has been adopted. A Bidder whose Bid is determined to be the Best Evaluated Bid, shall be awarded the Concession.

  The Successful Bidder shall be required to incorporate the Company which shall be the concessionaire for the purposes of the Project.

Note that IFC's advisory team has been engaged by KW&SB for the purposes of the structuring

and tendering of the Project, including the Prequalification Process and the Bidding Process in relation to the Project.

1.3 INDICATIVE SCHEDULE

The indicative timelines in relation to the Bidding Process for the Project (as may be amended by KW&SB in its discretion) are as follows:

Activity	Date (*Tentative*)
Issuance of RFP	29 August 2022
Pre-Bid Meeting	20 September 2022
Bid Submission Date & Opening of Technical Proposals	29 November 2022
Opening of Financial Proposals	10 January 2023
Announcement of Bid Evaluation Results	31 January 2023
Issuance of Notification of Award to Successful Bidder	15 February 2023
Signing of the Concession Agreement & EFU Agreement	28 February 2023

* In the event of any public holiday occurring on the above-mentioned dates, the immediately succeeding Business Day will be considered as the day on which the respective milestone shall take place.

2. ELIGIBLE BIDDERS

2.1 GENERAL REQUIREMENTS

2.1.1 The Bidding Process is open only to the Prequalified Applicants. Applicants who were conditionally prequalified during the Prequalification Process shall only be eligible to submit their Bids in response to the RFP, once they have complied with the requirements specified in the conditional prequalification acceptance letters issued by KW&SB, to the satisfaction of KW&SB.

2.1.2 In case a Bidder is a Consortium, such Bidder shall submit an undertaking as part of its Technical Proposal, in the form and substance attached as Bidding Form T5 (*Form of Consortium Undertaking*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP (the "**Consortium Undertaking**") to be executed by each Consortium Member through its authorized representative.

2.1.3 Each Consortium Member shall authorize the Consortium Authorized Representative (appointed during the Prequalification Process, as per the requirements of the Prequalification Document) to represent and irrevocably bind the Consortium Members in all matters in connection with the Bidding Process, and in case the Consortium is awarded the Project, finalize the Concession Documents. Such authority shall be in the form of a power of attorney in favour of the Consortium Authorized Representative in the form attached as Part B (*Power of Attorney to authorize the Consortium Authorized Representative*) of the Bidding Form – T3 (*Form of Power of Attorney*)

of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP.

The Power of Attorney for the appointment of the Consortium Authorized Representative, is to be executed by the authorized representative of each Consortium Member (appointed pursuant to the power of attorney in Part A (*Power of Attorney to Authorize a Person to Sign the Documents*) of Bidding Form – T3 (*Form of Power of Attorney*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP). The Consortium Authorized Representative shall be the same entity (i.e., Lead Investor or the Lead Developer), appointed to represent the Consortium during the Prequalification Process. Subject to the approval of KW&SB / TFEC, a different Consortium Authorized Representative (i.e., different from the representative appointed during the Prequalification Process) may be appointed pursuant to the Power of Attorney, provided that such Consortium Authorized Representative is the Lead Investor or the Lead Developer; and the approval for such change is sought one (1) month prior to the Bid Submission Date.

2.1.4 In case a Prequalified Applicant is a Consortium, such Prequalified Applicant shall notify KW&SB of all changes in the proposed shareholding of the Consortium Members in the Company, including the addition of new shareholders, no later than forty-five (45) calendar days prior to the Bid Submission Date. Such changes may be approved by KW&SB / TFEC in its sole discretion, provided that:

(i) the same are carried out in conformity with the requirements of the Applicable Evaluation Documents;

(ii) the Prequalified Applicant continues to fulfil the requirements (including the evaluation and qualification criteria) set out in the Prequalification Document; and

(iii) the new shareholder complies with the requirements of the Prequalification Document and submits the relevant information / documentation as required in terms thereof, within the time period as may be specified by KW&SB / TFEC.

KW&SB / TFEC may require such Prequalified Applicant (including the approved shareholder) to submit such further documents / information as may be specified by KW&SB / TFEC. In no event shall a Prequalified Applicant be permitted to change the Lead Investor or the Lead Developer, and their respective shareholdings shall not fall below the minimum shareholdings of the Lead Investor and the Lead Developer in the Company as provided in the Prequalification Document.

In case a Prequalified Applicant is a single entity, such Prequalified Applicant may be allowed to form a consortium with new entities and submit its Bid as a consortium, provided that the Prequalified Applicant has notified KW&SB of its intention to form a consortium with a new entity, no later than forty-five (45) calendar days prior to the Bid Submission Date. Such addition may be approved by KW&SB / TFEC in its sole discretion, provided that:

(i) the same is carried out in conformity with the requirements of the Applicable Evaluation Documents;

(ii) the Prequalified Applicant (after it has formed a consortium with a new entity) continues to fulfil the requirements (including the evaluation and qualification criteria) set out in the Prequalification Document; and

(iii) the new shareholder complies with the requirements of the Prequalification Document and submits the relevant information / documentation as required in terms thereof,

within the time period as may be specified by KW&SB / TFEC.

KW&SB / TFEC may require such Prequalified Applicant (including the approved shareholder) to submit such further documents / information as may be specified by KW&SB / TFEC. If the Prequalified Applicant is a single entity, it shall continue to be the Lead Investor and the Lead Developer and the new entity shall be added as a Consortium Member. The Prequalified Applicant shall ensure that, as a result of formation of a consortium with a new entity, it continues to maintain the minimum shareholding as the Lead Investor and the Lead Developer in the Company, as provided in the Prequalification Document.

2.1.5 In case the Successful Bidder is a Consortium, such Successful Bidder shall be required to comply with the requirements regarding shareholding matters including share transfer restrictions set out in the EFU Agreement.

2.1.6 A Bidder (including a Consortium Member) shall not have a conflict of interest as per the requirements of the Prequalification Document. All Bidders (including any Consortium Members) found to have a conflict of interest shall be disqualified. KW&SB will take appropriate actions to manage such conflicts of interest which may include rejecting the Bid if it determines that a conflict of interest may affect the integrity of the Bidding Process.

A Bidder (including a Consortium Member) may be considered to be in a conflict of interest with one or more Bidders, if such Bidder / Consortium Member, including its subsidiaries, participates in more than one (1) Bid, either individually or as a Consortium Member. This will result in the disqualification of all Bids in which the Bidder (including a Consortium Member) is involved.

A Bidder (including a Consortium Member) shall not be considered to be in a conflict of interest with another Bidder, if such Bidders (including Consortium Members) are the subsidiaries of a common parent company or one Bidder (including a Consortium Member) is the parent company of the other Bidder (including a Consortium Member), provided that the following conditions are satisfied:

(i) such parent company is a sovereign state ("**Sovereign**") or a sovereign state-owned enterprise ("**SOE**");

(ii) the Sovereign, SOE and the relevant subsidiaries of the Sovereign and / or SOE participating in the Bidding Process conduct their business operations on an independent basis, are independent legal persons, have independent management and boards and are free from each other's financial obligations including independent auditing and accounting; and

(iii) such Bidder (including a Consortium Member) has provided a legal opinion duly issued by a reputable, qualified legal counsel in its jurisdiction of incorporation confirming (i) and (ii) above.

The circumstances provided above which may constitute a conflict of interest are not exhaustive, and the TFEC shall be the sole determinant of when a conflict of interest shall arise.

2.1.7 A Bidder (or a Consortium Member) which has been declared ineligible or has been blacklisted by any of its employers, any Federal or Provincial governmental or non-governmental department / agency in Pakistan, or any other provincial government / governments of any foreign countries or their governmental bodies and / or international organizations (e.g. World Bank, Asian Development Bank, United Nations, International Monetary Fund etc.) at the Bid Submission

Date, shall not be considered.

2.1.8 In order to demonstrate their continued compliance with the requirements set out in the Prequalification Document and for participation in the Bidding Process, all Bidders (including each Consortium Member) shall submit an undertaking in the form and substance attached as Bidding Form T4 (*Form of Undertaking*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP.

2.1.9 Each Bidder (including a Consortium Member) shall indemnify the GoS Parties fully in respect of any damage, cost, penalty or expense of any kind incurred by such person arising from a Bidder's or its representative's (including a Consortium Member's or its representative's) breach of its obligations under the RFP.

2.1.10 A Bidder may undertake the works and / or services for the Project as contemplated in the RFP (including the Concession Documents), either itself or may sub-contract the same in accordance with the requirements set out in the RFP (including the Concession Documents). For any part of the scope of works and / or services for the Project, which the Bidder intends to sub-contract, the Bidder shall give details of the name and nationality of the Proposed Contractors, including the entities which are part of the Proposed Contractors. Proposed Contractors can be single entities or may comprise a consortium comprising of Proposed EPC Contractors and Proposed O&M Contractors. In addition, the Bidder shall include in its Bid, information establishing compliance of the Proposed Contractors (in case of a consortium, the consortium members) with the requirements specified in Annexure A (*Eligibility Criteria for Proposed Contractors*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP. Bidders are allowed to list at least one (1) and up to three (3) Proposed Contractors for each item of the works and / or services to whom the relevant Project Activities are proposed to be sub-contracted.

2.1.11 The Bidder shall be responsible for ensuring that any Proposed Contractor (including its representative(s)) complies with the requirements of the RFP (including the applicable Concession Documents) and the Laws. The engagement of Approved Contractors for the Project shall not absolve a Bidder (including the Company) from its obligations under the RFP (including the applicable Concession Documents) and the Laws.

2.1.12 The Bidders shall ensure that if a Proposed EPC Contractor is a consortium, such consortium shall enter into or has entered into a single turnkey EPC arrangement with the Bidder for undertaking the relevant construction works for the Project. Similarly, if a Proposed O&M Contractor is a consortium, such consortium shall enter into or has entered into a single operations and maintenance arrangement with the Bidder for undertaking the relevant operations and maintenance services for the Project.

2.1.13 In case the Proposed Contractors have formed a consortium, the relevant Bidder shall be required to identify the lead member of such consortium, and the Bidder shall ensure that the lead member of the Consortium formed by the Proposed Contractors shall be liable to the Bidder with respect to its obligations in respect of the activities proposed to be undertaken by the Proposed Contractor in respect of the Project.

3. RFP DOCUMENT

3.1 CONTENTS OF THE RFP

3.1.1 The RFP comprises the documents stated below and should be read in conjunction with any addendum and / or corrigendum issued in accordance with Sub-Section 3.4 (*Amendment of RFP*) of the Instructions to Bidders.

(A) VOLUME I – BIDDING PROCEDURE

(a) Part 1 – Instructions to Bidders.

(b) Part 2 – Bidding Forms.

(c) Part 3 – Bidding Documentary Requirements.

(d) Part 4 – Annexures

(i) Eligibility Criteria for Proposed Contractors (Annexure A).

(ii) Evaluation Criteria (Annexure B).

(iii) Form of C&O Performance Security (Annexure C).

(B) VOLUME II – TECHNICAL SPECIFICATIONS

(C) VOLUME III – CONCESSION AGREEMENT AND APPENDICES

(D) VOLUME IV – EFU AGREEMENT

3.1.2 The Bidding Forms comprise the forms stated below and should be read in conjunction with any addendum (or corrigendum) to the RFP issued in accordance with Sub-Section 3.4 (*Amendment of RFP*) of the Instructions to Bidders:

(A) For the Technical Proposal:

(a) Bidding Form T1 – Letter of Technical Proposal;

(b) Bidding Form T2 – Form of Integrity Pact;

(c) Bidding Form T3 – Form of Power of Attorney;

(d) Bidding Form T4 – Form of Undertaking;

(e) Bidding Form T5 – Form of Consortium Undertaking;

(f) Bidding Form T6 – Form of Affidavit by Proposed Contractor;

(g) Bidding Form T7 – Technical Project Methodology / Approach;

(h) Bidding Form T8 – Operation & Maintenance Plan and Procedures;

(i) Bidding Form T9 – Implementation Schedule;

(j) Bidding Form T10 – List of Manufacturers of Main Equipment;

(k) Bidding Form T11 – Schedule of Equipment & Technology Suppliers;

(l) Bidding Form T12 – Organization & Staffing;

(m) Bidding Form T13 – Quality Control Practices & Procedures;

(n) Bidding Form T14 – Health & Safety Plan and Procedures;

(o) Bidding Form T15 – Methodology/Approach for the Environmental & Social Management Plan and Procedures;

(p) Bidding Form T16 – Other Technical Data Submission;

(q) Bidding Form T17 – Project References of Proposed EPC Contractor;

(r) Bidding Form T18 – Project References of Proposed O&M Contractor; and

(s) Bidding Form T19 – Net Worth Requirements of Proposed Contractors.

(B) For the Financial Proposal

(a) Bidding Form F1 – Letter of Financial Proposal;

(b) Bidding Form F2 – Form of Bid Security; and

(c) Bidding Form F3 – Financial Forms.

3.2 COMPLETENESS OF RFP

3.2.1 No GoS Party shall be responsible for the completeness of the documents comprising the RFP and its addenda / corrigenda, if a Bidder has not obtained the same directly from the source(s) stated by KW&SB in the Letter of Invitation.

3.2.2 Bidders are expected to carefully examine all instructions, forms and terms in the RFP and to furnish all information or documentation required pursuant to the RFP. Failure to comply with the requirements of Bid submission set out in the RFP will be at the Bidders' own risk and may result in the rejection of the Bid. Pursuant to Sub-Section 6.4 (*Determination of Responsiveness of Bids*) of the Instructions to Bidders, Bids which are not responsive to the requirements of the RFP shall be rejected.

3.3 CLARIFICATIONS OF RFP

3.3.1 A Bidder requiring any clarification pertaining to the RFP shall contact KW&SB in writing, at address or through email provided in the Data Sheet or raise its enquiries during the Pre-Bid Meeting. KW&SB will respond in writing to any request for clarification provided that such request is received no later than five (05) calendar days prior to the Bid Submission Date. The response shall be uploaded on the websites of KW&SB, PPP Unit and SPPRA including a description of the inquiry but without identifying its source. Should KW&SB deem it necessary to amend the RFP as a result of a request for clarification, it shall do so following the procedure under Sub-Section 3.4 (*Amendment of RFP*) of the Instructions to Bidders. No markup of the RFP (including the Concession Documents and / or other documents / instruments attached to the

RFP) shall be accepted. Bidders may submit comments or seek clarifications on the RFP, which may be considered by KW&SB / TFEC.

3.3.2 The Bidder's designated representative(s) shall be invited to attend the Pre-Bid Meeting at the date, time and venue indicated in Data Sheet. The Pre-Bid Meeting may be conducted virtually via the web link provided by KW&SB to all Bidders. The purpose of the Pre-Bid Meeting will be to clarify issues and to answer questions of the Bidders on any matter relating to the RFP. Queries to be discussed during the Pre-Bid Meeting should be submitted seven (7) calendar days prior to the date of Pre-Bid Meeting. In addition to the queries discussed during the Pre-Bid meeting, Bidders may submit additional queries to KW&SB within the time period as specified in Sub-Section 3.3.1 of the Instructions to Bidders and KW&SB shall respond to such queries in writing as specified in Sub-Section 3.3.1 of the Instructions to Bidders. Non-attendance at the Pre-Bid Meeting will not be a cause for disqualification of a Bidder. In addition to the Pre-Bid Meeting, on a written request of any Bidder, provided that the same are submitted twenty (20) calendar days prior to Bid Submission Date, KW&SB may hold discussions on the RFP separately with such Bidder on such questions and clarifications submitted in writing to KW&SB. Any proposed changes or responses to such clarifications and questions shall be provided to all Bidders.

3.3.3 No later than twenty (20) calendar days prior to the Bid Submission Date, Prequalified Applicants may visit and examine the site(s), where the works and services in relation to the Project are to be performed and undertaken, and its surroundings, and obtain for themselves at their own expense and responsibility all information that may be necessary for preparing the Bid and entering into the Concession Documents and other relevant instruments as per the RFP. The costs and permission(s) (if any) for the purposes of visiting such site(s) shall be at the Bidder's own expense and liability. Bidders shall be required to seek prior written permission of KW&SB for visiting such site(s), provided that such permission is sought one (1) week from the planned visit date.

In addition to the site visits by the respective Prequalified Applicants, KW&SB shall invite all Prequalified Applicants for a site visit to be conducted by KW&SB at a date and time as may be communicated to all Prequalified Applicants.

Site visit(s) shall be conducted only upon the express condition that the Prequalified Applicant, its personnel and agents will release and indemnify the GoS Parties (including KW&SB) from and against all liabilities in respect thereof, and will be responsible for injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of such visit.

3.3.4 A Bidder or any of its representatives, personnel or agent may enter the site(s) where the works and services in relation to the Project are to be performed and undertaken, only upon the express condition that the Bidder, its representatives, personnel and agents, will release and indemnify KW&SB and its representatives, personnel and agents from and against all liability in respect thereof, and the Bidder will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

3.4 AMENDMENT OF RFP

3.4.1 At any time prior to the Bid Submission Date, KW&SB may amend the RFP by issuing an addendum / corrigendum.

3.4.2 Any addendum / corrigendum issued shall be considered part of the RFP. Such addendum /

corrigendum shall be communicated to the potential Bidders and shall be published on the respective websites of KW&SB, PPP Unit and the SPPRA.

3.4.3 KW&SB may, at its discretion, extend the Bid Submission Date in accordance with Sub-Section 5.2.4 of the Instructions to Bidders, if it considers that as a result of issuance of any addendum / corrigendum, additional time will be required by the Bidders for preparation of their Bids.

4. PREPARATION OF BIDS

4.1 COSTS FOR BIDS

Bidders shall bear all costs associated with the preparation and submission of their Bids, including, without limitation, all costs and expenses relating to preparation of responses to any clarifications sought by KW&SB in accordance with Sub-Section 6.1.1 of the Instructions to Bidders. KW&SB shall in no case be responsible or liable for such costs, regardless of the conduct or outcome of the Bidding Process.

4.2 LANGUAGE OF THE BIDS

The Bid, and all correspondence and documents related to the Bid and the Bidding Process between the Bidder and KW&SB shall be written in the English language. In case any document / information furnished by the Bidder is in a language other than English, it will need to be accompanied by an English translation (duly notarized by Notary Public and attested by Pakistan Embassy / Consulate and Ministry of Foreign Affairs, Pakistan) of its pertinent passages for the purposes of interpretation of the Bid. In case of any discrepancy, the English translation shall prevail.

4.3 DOCUMENTS COMPRISING THE BID

4.3.1 The Bid shall comprise a Technical Proposal, containing the documents listed in Sub-Section 4.4 (*Technical Proposal*) of the Instructions to Bidders, and a Financial Proposal, containing the documents listed in Sub-Section 4.5 (*Financial Proposal*) of the Instructions to Bidders, each submitted simultaneously in separately sealed envelopes clearly marked "TECHNICAL PROPOSAL" and "FINANCIAL PROPOSAL" respectively, in accordance with manner provided herein.

4.3.2 Bidders are expected to carefully examine the RFP when preparing their Bids and use only the Bidding Forms specified in Sub-Section 3.1.2 of the Instructions to Bidders. Bidding Forms must be completed without any alterations to the text, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested. Any material deviations / omissions / reservations from the formats provided in the RFP shall not be accepted and may form basis for the rejection of the Bid. Material deficiencies, in the sole opinion of TFEC, in providing the information requested may result in rejection of a Bid.

4.3.3 In case a document required to be submitted as part of the Technical Proposal, is submitted with the Financial Proposal; or a document required to be submitted with the Financial Proposal, is submitted with the Technical Proposal, it shall not be considered for evaluation and such document shall be considered as not submitted by the Bidder.

4.4 TECHNICAL PROPOSAL

4.4.1 The Technical Proposal shall demonstrate the Bidder's unconditional acceptance of the complete

scope of works and services under the RFP. Any material omission, reservation, deviation or condition attached in the Technical Proposal may cause the Bid to be rejected by TFEC as non-responsive. Under no circumstances will KW&SB / TFEC consider / accept a conditional Technical Proposal.

4.4.2 The Technical Proposal submitted by the Bidder shall include the following information:

(a) signed and filled out 'Letter of Technical Proposal', as set out in Bidding Form T1 (*Letter of Technical Proposal)* of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP;

(b) Integrity Pact, as set out in Bidding Form T2 (*Form of Integrity Pact*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP, in accordance with Sub-Section 8.3 (*Integrity Pact*) of the Instructions to Bidders;

(c) authorization in the form of a power of attorney on behalf of the Bidder, and in case of a Consortium, each Consortium Member, authorizing its representative to sign the relevant documents as per the requirements of the RFP, on its behalf, in the format attached as Part A (*Power of Attorney to Authorize A Person to Sign the Documents*) of Bidding Form T3 (*Form of Power of Attorney*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP;

(d) in case the Bidder is a Consortium, a power of attorney, to be executed by the authorized representatives of the Consortium Members, in favour of the Consortium Authorized Representative, to authorize it to represent and bind all Consortium Members, as set out in the form attached as Part B (*Power of Attorney to authorize the Consortium Authorized Representative*) of Bidding Form T3 (*Form of Power of Attorney*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP. Note that the Consortium Authorized Representative shall be the same Consortium Member (as the Lead Developer or the Lead Investor, as the case may be) who was authorized to the represent and bind the Consortium Members during the Prequalification Process. Subject to the prior approval of KW&SB / TFEC, a different Consortium Authorized Representative (*i.e.*, different from the representative appointed during the Prequalification Process) may be appointed pursuant to the Power of Attorney, provided that such Consortium Authorized Representative is the Lead Investor or the Lead Developer;

(e) Consortium Undertaking, to be issued by the authorized representatives of the Consortium Members, in the form and substance as set out in Bidding Form T5 (*Form of Consortium Undertaking*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP;

(f) an undertaking from the Bidder (in case of Consortium, each Consortium Member), in the form and substance as set out in Bidding Form T4 *(Form of Undertaking)* of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP;

(g) list of Proposed Contractors in accordance with Sub-Section 2.1.10 of the Instructions to Bidders, along with the following documents / information evidencing compliance with the eligibility criteria for Proposed Contractors set out in Annexure A (*Eligibility Criteria for Proposed Contractors*) and the criteria set out in Section I (*Technical Evaluation Criteria*) of Annexure B (*Evaluation Criteria*), each of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP:

(I) For Proposed EPC Contractors (or a Bidder (including a Consortium Member), in case the Bidder (or the relevant Consortium Member) intends to undertake the relevant engineering, procurement and construction works for the Project itself):

(i) completion certificates, or relevant evidence issued by an employer or a relevant third-party which engaged the Proposed EPC Contractor (or a Bidder (including a Consortium Member), as applicable) for the relevant works / project, indicating that the relevant works / project undertaken by the Proposed EPC Contractor (or a Bidder (including a Consortium Member), as applicable) have been completed, and with respect to each of the completed works / projects in the last fifteen (15) years, the information in the format provided in Bidding Form T17 (*Project References of Proposed EPC Contractor*) set out in Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP, clearly indicating the name of the Proposed EPC Contractor (or a Bidder (including a Consortium Member), as applicable), scope of engineering, procurement and construction works undertaken by such Proposed EPC Contractor (or a Bidder (including a Consortium Member) as applicable), in each case evidencing compliance with Section I (*Technical Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP; and

(ii) in respect of a Proposed EPC Contractor: (A) audited financial statements, duly certified by an independent certified public accountant or auditor, for the three (3) most recent full financial years for which audited financial statements are available as at the Bid Submission Date; or (B) if: (aa) the relevant Proposed EPC Contractor is incorporated in a jurisdiction which does not require the auditing of financial statements; and / or (bb) such Proposed EPC Contractor has not in fact had its financial statements audited, on such Proposed EPC Contractor's non-audited consolidated financial statements, accompanied by a written opinion issued by an independent certified public accountant or auditor certifying the relevant Proposed EPC Contractor's net worth for the three (3) most recent full financial years for which such financial statements are available as at the Bid Submission Date. Provided that the non-audited financial statements submitted by an entity, which by applicable law is required to prepare audited financial statements, shall not be accepted for the purposes of evaluation,

(II) For Proposed O&M Contractors (or a Bidder (including a Consortium Member), in case the Bidder (or the relevant Consortium Member) intends to undertake the relevant operation and maintenance works for the Project itself):

(i) most recent performance certificate/report, or relevant evidence issued by an employer or a third-party which engaged the Proposed O&M Contractor (or a Bidder (including a Consortium Member), as applicable) for the relevant works / project, indicating the relevant works / project, undertaken by the Proposed O&M Contractor (or a Bidder (including a Consortium Member), as applicable) in the last fifteen (15) years, and with respect to each of the works / projects, the information in the format provided in Bidding Form T18 (*Project References of Proposed O&M*

Contractor) set out in Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP, clearly indicating the name of the Proposed O&M Contractor (or a Bidder (including a Consortium Member), as applicable), scope of operations and maintenance works undertaken by such Proposed O&M Contractor (or a Bidder (including a Consortium Member), as applicable), in each case evidencing compliance with Section I (*Technical Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP; and

(ii) in respect of the Proposed O&M Contractor: (A) audited financial statements, duly certified by an independent certified public accountant or auditor, for the three (3) most recent full financial years for which audited financial statements are available as at the Bid Submission Date; or (B) if: (aa) the relevant Proposed O&M Contractor is incorporated in a jurisdiction which does not require the auditing of financial statements; and / or (bb) such Proposed O&M Contractor has not in fact had its financial statements audited, on such Proposed O&M Contractor's non-audited consolidated financial statements, accompanied by a written opinion issued by an independent certified public accountant or auditor certifying the relevant Proposed O&M Contractor's net worth for the three (3) most recent full financial years for which such financial statements are available as at the Bid Submission Date. Provided that the non-audited financial statements submitted by an entity, which by applicable law is required to prepare audited financial statements, shall not be accepted for the purposes of evaluation,

(III) A detailed description of the Proposed Contractors containing:

(i) legal name;

(ii) complete head office contact information, including mailing address, telephone and fax numbers, and an e-mail address;

(iii) incorporation details, including corporate charter and articles of incorporation. If the Proposed Contractor is an unincorporated legal entity, then the proof of that legal entity's existence must be provided,

(IV) the Proposed Contractor shall be required to provide:

(i) for the Proposed Contractor, other than to whom Sub-Section (g)(I)(ii)(A) and (g)(II)(ii)(A) above, apply, audited consolidated financial statements, including a consolidated balance sheet, income statement, statement of cash flows and accompanying notes, for the three (3) most recent full financial years for which such statements are available as at the Bid Submission Date, duly certified by a certified public accountant or auditor; or

(ii) for the Proposed Contractor to whom Sub-Section (g)(I)(ii)(B) and (g)(II)(ii)(B) above, apply, non-audited consolidated financial statements, including a consolidated balance sheet, income statement,

statement of cash flows and accompanying notes, for the three (3) most recent full financial years for which such statements are available as at the Bid Submission Date, accompanied by a written opinion issued by an independent certified public accountant or auditor, certifying the relevant entity's Net Worth for the three (3) most recent full financial years for which such financial statements are available as at the Bid Submission date; and

(iii) information as per as per Bidding Form T19 (*Net Worth Requirements of Proposed Contractors*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, specifying the net worth of the Proposed Contractor,

(h) an affidavit from the Proposed Contractors in the form and substance attached as Bidding Form T6 (*Form of Affidavit by Proposed Contractor*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP;

(i) in case the Proposed Contractors have formed a consortium, details of the consortium arrangements, along with any consortium agreements;

(j) copies of the contractual arrangements executed between Bidders and the Proposed Contractors, setting out: (i) the intention of the Bidder and the Proposed Contractors to undertake the Project as per the requirements of the RFP, in case of award; (ii) authorization in favour of the Bidder to submit the Proposed Contractor's information and documentation required in terms of the RFP as part of its Bid.

Bidders shall ensure that persons signing the documents for an on behalf of the Proposed Contractors as required in terms of the RFP, have valid authorizations from the relevant Proposed Contractors and the said documents are issued by such persons as per the requirements of the applicable Laws. KW&SB shall not be held liable, in the event it is determined by any forum or entity, that a document of the Proposed Contractor submitted by the Bidder as part of its Bid, is without valid legal authority and such document shall not be accepted for evaluation;

(k) following Bidding Forms, specified in Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP, each prepared as per the requirements specified therein:

(i) Bidding Form T7 (*Technical Project Methodology / Approach*);

(ii) Bidding Form T8 (*Operation & Maintenance Plan and Procedures*);

(iii) Bidding Form T9 (*Implementation Schedule*);

(iv) Bidding Form T10 (*List of Manufacturers of Main Equipment*);

(v) Bidding Form T11 (*Schedule of Equipment & Technology Suppliers*);

(vi) Bidding Form T12 (*Organization & Staffing*);

(vii) Bidding Form T13 (*Quality Control Practices & Procedures*);

(viii) Bidding Form T14 (*Health & Safety Plan and Procedures*);

(ix) Bidding Form T15 (*Methodology/Approach for the Environmental & Social Management Plan and Procedures*);

(x) Bidding Form T16 (*Other Technical Data Submission*);

(xi) Bidding Form T17 (*Project References of Proposed EPC Contractor*);

(xii) Bidding Form T18 (*Project References of Proposed O&M Contractor*); and

(xiii) Bidding Form T19 (*Net Worth Requirements of Proposed Contractors*);

(l) any other documents required under the RFP.

4.5 FINANCIAL PROPOSAL

4.5.1 In preparing the Financial Proposals, Bidders are expected to fully understand the requirements and conditions set out in the RFP, including all contractual obligations of KW&SB, the Company, the Successful Bidder and the GoS under the Concession Documents (as applicable) and the scope of works and services to be performed by the Company (as the concessionaire) in relation to the Project.

4.5.2 Any material omission, reservation, deviation or any condition included in the Financial Proposal to the contrary shall cause the Bid to be rejected by TFEC as non-responsive as per the Applicable Evaluation Documents. Under no circumstances shall TFEC consider / accept a conditional Financial Proposal.

4.5.3 The Financial Proposal submitted by the Bidder shall comprise the following:

(a) signed and filled out Letter of Financial Proposal, as set out in Bidding Form F1 (*Letter of Financial Proposal*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP;

(b) Bid Security, as set out in Bidding Form F2 (*Form of Bid Security*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, in accordance with Section 4.7 (*Bid Security*) of the Instructions to Bidders;

(c) information as required in the relevant forms as set out in Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP. Relevant forms in Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP can be downloaded from any of the websites of KW&SB, PPP Unit or SPPRA. Bidders are required to use and fill in the forms available at the aforementioned websites in Microsoft Excel file;

(d) following information / documentation evidencing the Bidder's ability to finance one hundred percent (100%) of the Project costs, excluding the GoS Equity Amount through a combination of debt and equity, subject to a gearing cap of no more than a debt to equity ratio of 80:20, after accounting for GoS Equity Amount:

(i) in the case of Bidders intending to enter into financing arrangements with financial institutions in respect of the Project, a financing term-sheet issued and signed by the financial institution in the format attached as Bidding Form F3-H (*Financing Term Sheet*) of Bidding Form F3 (*Financial Forms*) of Part 2

(Bidding Forms) of Volume I (*Bidding Procedure*) of the RFP, prepared in accordance with the requirements of the RFP and the Concession Documents; or

(ii) in the case of Bidders intending to finance the Project through their own funds, a copy of a board resolution authorizing the Bidders to finance the Project through their own funds, together with either:

(A) evidence of sufficient cash and cash equivalent assets (receivables, real estate holdings, stocks and inventory will not be accounted for in computation of liquid investments / cash and cash equivalent) on the Bidders' balance sheet by way of either: (I) the audited financial statements of the last fiscal year; or (II) an auditor's certificate confirming the cash and cash equivalent assets figure on the Bidders' balance sheet; or

(B) evidence of a sufficient and valid credit line from one or more financial institutions;

(e) Bidders are required to provide a letter from a financial model advisor, setting out the entire scope of the Project and the advisor's findings with respect thereto, and ensuring the following:

(i) structural integrity, formulae, accuracy of the workings and outputs from the Bidder's model, consistency of the technical and costing information with the Technical Proposal and the reasonableness of the financial assumptions used in a Bidder's model;

(ii) consistency of the Bidder's model with the information submitted by the Bidders as Bidding Form F3 (*Financial Forms*) set out in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, including the assumptions specified in Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP;

(iii) accuracy of the Equity IRR and debt calculations and its alignment with the figures provided in Bidding Form F3 (*Financial Forms*) set out in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, confirming that the Equity IRR has been calculated: (I) at the Company's level; (II) based on the distributions on the cash flows available for distribution from the Service Payments; (III) on an annual basis during the C&O Period and the Operating Period; (IV) on a nominal basis; and (V) on the basis that the rate shall not be modified to reflect a reinvestment rate;

(iv) compliance with the maximum debt to equity ratio of 80:20;

(v) findings / confirmation of inclusion of the applicable federal, provincial and local taxes, duties, levies and other charges as per the Income Tax Ordinance, 2001 (as may be amended, modified, supplemented or re-enacted from time to time). As a documentary requirement, Bidders are required to submit tax report from tax advisor, along with a confirmation from the financial model advisor that all the taxes in such report are aligned with the financial model provided by the Bidder with its Financial Proposal;

(vi) the Cost Recovery Charges (see Bidding Form F3-B (*Cost Recovery Charges*) of Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP), i.e., aggregate of Foreign Debt Principal Recovery Charge (FD_P_RC), Foreign Debt Interest Recovery Charge (FD_I_RC), Local Debt Principal Recovery Charge (LD_P_RC), Local Debt Interest Recovery Charge (LD_I_RC), Foreign Equity Recovery Charge (FE_RC), Local Equity Recovery Charge (LE_RC), should be same during the entire Concession Period, without accounting for any indexation as per the applicable Concession Documents;

(vii) the determination by the Bidder of Fixed O&M Cost Recovery Charge/FOMRW is structured in such manner that the net present value of the escalated fixed operation and maintenance payment revenue stream over the Operating Period equals the net present value of the escalated fixed operation and maintenance cost stream over the Concession Period, in each case applying a discount rate as mentioned in Section 1.3 (*Determination of the NPV of Service Payment*) of Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP, taking into account the proposed figures for Projected Available Net Water Output, as per Bidding Form F3-A (*Projected Available NWO*) of Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP;

(viii) the determination by the Bidder of Variable O&M Cost Recovery Charge / VOMRW is structured in such manner that the net present value of the escalated variable operation and maintenance payment revenue stream over the Concession Period equals the net present value of the escalated variable operation and maintenance cost stream over the Concession Period, in each case applying a discount rate as per in Section 1.3 (*Determination of the NPV of Service Payment*) of Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP, taking into account the proposed figures for Net Water Output, as per Bidding Form F3-E (*Output Payment*) of Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP; and

(ix) compliance with section 8.5 of the Instructions to Bidders.

The Bidders shall ensure that the financial model advisor issuing the aforesaid letter is: (i) in case an audit firm operating in Pakistan, it is an auditor listed on SBP list Category A; or (ii) in case not an audit firm operating in Pakistan, it is a reputable and recognized financial or transaction advisory firm in Pakistan; or (iii) a reputable and recognized international audit firm or financial or transaction advisory firm. Bidders should provide confirmation that the firm selected as financial model advisor has experience of developing / auditing financial model in at least two (2) project financed infrastructure projects or public private partnership projects that have achieved financial close in the last five (5) years;

(f) a financial model in Microsoft Excel spreadsheet form, consistent with the Technical Proposal, setting out all the amounts in PKR and includes all the information required in terms of the Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP; and

(g) any other document required in the RFP.

4.6 CURRENCIES OF BID AND PAYMENT

4.6.1 All Bids and other supporting documents shall state all monetary amounts in Pakistan Rupees (PKR).

4.7 BID SECURITY

4.7.1 The Bidder shall furnish, as part of the Financial Proposal, in a separately sealed envelope, a Bid Security equivalent to one percent (1%) of the Bid Price (the "**Bid Security**").

4.7.2 The Bid Security shall be an irrevocable, unconditional and on-demand bank guarantee in the form attached as Bidding Form F2 (*Form of Bid Security*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP.

4.7.3 The Bid Security shall be issued and maintained in PKR by an Acceptable Bank, approved by KW&SB).

4.7.4 The Bid Security shall be valid until twenty-eight (28) days following the Bid Validity Period, as may be extended in accordance with Sub-Section 4.8.2 of the Instructions to Bidders. If the C&O Performance Security has not been issued by the Successful Bidder thirty (30) days prior to the expiry of the Bid Security, then the Successful Bidder shall extend the Bid Security until such date as notified by KW&SB.

4.7.5 Any Bid not accompanied by a compliant Bid Security (as exclusively determined by KW&SB), shall be rejected by TFEC as non-responsive and the Bidder shall not be allowed to submit Bid Security at a later stage. The Bid Security issued by a foreign bank and not counter-guaranteed / confirmed from a local bank in Pakistan shall result in the rejection of the Bid.

4.7.6 Bidders are required to submit with their original Financial Proposals the original Bid Security. TFEC shall reject a Bid if a photocopy of original Bid Security is attached with the original Financial Proposal and such Bid shall not be further evaluated.

4.7.7 The Bid Security of the unsuccessful Bidders shall be returned earlier of: (a) the expiry of the Bid Validity Period; or (b) once the Successful Bidder furnishes the C&O Performance Security pursuant to Sub-Section 7.5 (*Performance Security*) of the Instructions to Bidder.

4.7.8 The Bid Security of the Successful Bidder shall be returned as soon as reasonably possible once the Successful Bidder has furnished the required C&O Performance Security and the Company has signed the Concession Agreement.

4.7.9 The Bid Security shall be forfeited:

(I) if a Bidder:

(a) withdraws its Bid during the Bid Validity Period (except as provided in Sub-Section 5.4.4 of the Instructions to Bidders);

(b) is found to be engaged in any corrupt, fraudulent, collusive, coercive, or obstructive practices;

(c) does not accept the arithmetical corrections of its Bid in accordance with Sub-Section 6.3.4 of the Instructions to Bidders; and / or

(d) fails to fulfil its obligations under the RFP in terms thereof.

(II) if the Successful Bidder or the Company, as applicable:

(a) fails to sign the Concession Agreement and the EFU Agreement, in accordance with Sub-Section 7.6 (*Signing of Concession Agreement and EFU Agreement*) of the Instructions to Bidders;

(b) fails to furnish C&O Performance Security pursuant to Sub-Section 7.5 (*C&O Performance Security*) of the Instructions to Bidders;

(c) fails to pay the IFC Advisory Fee within the timeline set out in the Instructions to Bidders; and / or

(d) fails to comply with the requirements set out in the Notification of Award.

4.7.10 The Bid Security is required to protect KW&SB and the GoS against the risk of Bidder's conduct which would warrant the Bid Security's forfeiture, pursuant to Sub-Section 4.7.9 of the Instructions to Bidders.

4.8 BID VALIDITY

4.8.1 Bids shall remain valid for the Bid Validity Period, as may be extended by KW&SB in accordance with Sub-Section 4.8.2 of the Instructions to Bidders. A Bid valid for a shorter period shall be rejected by TFEC as non-compliant in accordance with the Applicable Evaluation Documents.

4.8.2 In exceptional circumstances, prior to the expiration of the Bid Validity Period, KW&SB may request all Bidders to extend the period of validity of their Bids. Any such request by KW&SB with respect to the extension of the Bid Validity Period and the response by the Bidders, shall be in writing. The Bid Security requested in accordance with Sub-Section 4.7 (*Bid Security*) of the Instructions to Bidders, shall also be extended accordingly for a corresponding further period not exceeding the original Bid Validity Period. Extension of Bid Security may be requested upon the extension of Bid Validity Period. A Bidder may refuse the request, following which such Bidder's Bid will be disqualified and its Bid Security returned without forfeiture. A Bidder accepting the request shall not be required or permitted to modify its Bid.

4.9 MANNER OF SIGNING OF BID

4.9.1 The Bidder shall prepare one (1) original of the Technical Proposal and one (1) original of the Financial Proposal comprising the Bid as described in Sub-Section 4.3 (*Documents Comprising the Bid*) of the Instructions to Bidders, and clearly mark each as "ORIGINAL – TECHNICAL PROPOSAL" and "ORIGINAL – FINANCIAL PROPOSAL", respectively, in addition to the marking stipulated in Sub-Section 4.3 (*Documents Comprising the Bid*) of the Instructions to Bidders. The Bidder shall submit as "COPY" four (4) hard copies, printable softcopies (PDF), and editable softcopies (Microsoft Word, Microsoft Excel etc., as may be relevant). The CDs / DVDs / USBs should be clearly marked "Technical Proposal" and "Financial Proposal" and placed in their respective envelopes containing the Technical Proposal and the Financial Proposal marked as "ELECTRONIC COPY". In the event of any discrepancy between the original and the

copies, the original shall prevail. Note that the Bid Security is required to be submitted in a sealed envelope, separately in the envelope marked as "Financial Proposal".

4.9.2 The original and all copies of the Bid shall be typed or written in indelible ink and shall be signed by a person duly authorised to sign on behalf of the Bidder. This authorization shall consist of a written power of attorney, as set out in Bidding Form T3 (*Form of Power of Attorney*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, as per the requirements set out in the Instructions to Bidders. This authorization must contain the name and position held by each person signing the authorization and name and position of the authorised signatory.

4.9.3 The hard copy of each Bid should be bound in the hard book binding form to avoid the possibility of removal or insertion of page(s). All pages of the original Bid must be signed and stamped by the Bidder's authorized representative. All the pages must be numbered starting from the first page to the last. Any Bid not substantially adhering to these requirements may be rejected by TFEC.

4.9.4 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialled by the authorized representative signing the Bid.

4.9.5 KW&SB / TFEC reserves the right to reject a Bid which does not meet the requirements in Sub-Section 4.9 (*Manner of Signing of Bid*) of the Instructions to Bidders.

5. SUBMISSION AND OPENING OF BIDS

5.1 SEALING, MARKING AND SUBMISSION OF BIDS

5.1.1 In accordance with Sub-Section 4.9.1 of the Instructions to Bidders, each Bid shall be in a separate envelope indicating the Bid as original or copy clearly marked as "ORIGINAL" and "COPY", as appropriate. The Technical Proposal shall be placed in a sealed envelope clearly marked "TECHNICAL PROPOSAL" and the Financial Proposal in the sealed envelope clearly marked "FINANCIAL PROPOSAL". These two envelopes, in turn, shall be sealed in an outer envelope bearing the address for Bid submission indicated in the Data Sheet. The envelope shall be clearly marked: "DO NOT OPEN, EXCEPT IN PRESENCE OF TFEC".

The outer envelope of the Technical Proposal shall bear a warning not to open the envelope before the Bid Submission Date. The outer envelope of the Financial Proposal shall bear a warning not to open the envelope before the Technical Proposal has been evaluated. Any Bidder (including a Consortium Member) who submits or participates in more than one (1) Bid shall be disqualified. The inner and outer envelopes of the Technical Proposal and the Financial Proposal shall bear the name of the Bidder and be addressed to KW&SB and shall the mention the name of the Project i.e., "*Karachi Hub Water Canal Project*".

5.1.2 If all the envelopes are not sealed and marked as required, KW&SB / TFEC shall not assume any responsibility for the misplacement or premature opening of the Bid. In case of such misplacement or premature opening of Bid which results in disclosure of any direct or indirect financial information prior to the scheduled opening of the Financial Proposal, the Bid shall be rejected by TFEC as non-responsive.

5.1.3 All Bidding Forms forming part of the Technical Proposal and the Financial Proposal, as specified in the RFP are to be properly completed and signed. No alteration is to be made in the Letter of Financial Proposal, Letter of Technical Proposal or in the Bidding Forms, except in filling up the blanks as directed. If any alteration is made or if these instructions have not been

fully complied with, the Bid shall be rejected.

5.1.4 Bids shall be submitted by the Bidders: (i) through courier / express mail; or (ii) by hand at the address indicated in the Data Sheet.

5.2 DEADLINE FOR SUBMISSION

5.2.1 Bids must be received by KW&SB at the address provided in the Data Sheet not later than the Bid Submission Date.

5.2.2 No arrangements shall be made by KW&SB with Bidders for collection of the Bids from any delivery point. Bidders shall bear all expenses incurred in the preparation and delivery of Bids. No claims for refund of any expense shall be entertained.

5.2.3 Where delivery of the Bid is by courier / express mail and Bidder wishes to receive an acknowledgment of receipt of such Bid, the Bidder shall make a request for such acknowledgement in a separate letter attached to (but not included in) the sealed Bid.

5.2.4 KW&SB may, at its discretion, extend the Bid Submission Date by issuing an addendum in accordance with Sub-Section 3.4 (*Amendment of RFP*) of the Instructions to Bidders, in which case all rights and obligations of KW&SB and the Bidders previously subject to the earlier Bid Submission Date shall thereafter be subject to the extended Bid Submission Date.

5.2.5 KW&SB shall not consider any Bid that arrives after the Bid Submission Date. Any Bid or any document received by KW&SB after the Bid Submission Date shall be declared late, rejected, and returned unopened to the Bidder.

5.2.6 Delays in the mail, delays of person(s) in transit, or delivery of a Bid to an incorrect location, shall not be accepted as an excuse for failure to deliver a Bid at the proper place and time. It shall be the Bidder's responsibility to determine the manner in which to deliver its Bid in a timely manner.

5.3 MODIFICATION, SUBSTITUTION AND WITHDRAWAL OF BIDS

5.3.1 Any Bidder may modify, substitute, or withdraw its Bid after submission provided that written notice, duly signed by authorised representative, for the modification, substitution or withdrawal is received by KW&SB prior to the Bid Submission Date.

5.3.2 The notice for modification, substitution or withdrawal of any Bid shall be prepared, sealed, marked and delivered in accordance with the provisions applicable to the original Bid with additional marking of "MODIFICATION" or "SUBSTITUTION" on all envelopes in case of modification or substitution, or "WITHDRAWAL" on the envelope containing the notice, in case of withdrawal.

5.3.3 Withdrawal of a Bid during the interval between the Bid Submission Date and the expiration of the Bid Validity Period (or any extension thereof) shall result in forfeiture of the Bid Security pursuant to Sub-Section 4.7.9 of the Instructions to Bidders.

5.3.4 Bids requested to be withdrawn in accordance with Sub-Section 5.3.1 of the Instructions to Bidders shall be returned unopened to the requesting Bidder(s).

5.3.5 After the Bid Submission Date, no changes to the Concession Documents shall be permitted other

than those requested by KW&SB and agreed to by the Bidder, and inclusion of details of the Successful Bidder (to whom the Concession is awarded), and any other information that was incomplete prior to the Bid Submission Date.

5.3.6 Bids submitted in response to the RFP by the Bidders shall be upon full understanding and agreement of all terms of the RFP (including the Concession Documents) and such submission shall be deemed as an acceptance to all the terms and conditions stated in the RFP (including the Concession Documents).

5.4 OPENING OF BIDS

5.4.1 TFEC shall conduct the opening of Technical Proposals on the same day as the Bid Submission Date at **13:00 hours** (PST) at the address provided in the Data Sheet, in the presence of Bidders' designated representatives who choose to attend.

5.4.2 If the Technical Proposal and the Financial Proposal are submitted together in one envelope, other than as specified in the Instructions to Bidders, TFEC may reject the entire Bid. If any document, required to be submitted with Technical Proposal, is submitted with the Financial Proposal, or if any document required to be submitted with the Financial Proposal is submitted with the Technical Proposal, such document shall not be considered for evaluation and may also form the basis of rejection of a Bid.

5.4.3 The Financial Proposals shall remain unopened and will be held in custody of KW&SB until the specified time of their opening, as communicated by KW&SB to the Bidders.

5.4.4 First, envelopes marked "WITHDRAWAL" shall be opened and read out and the inner envelope with the corresponding Bid shall not be opened but returned to the Bidder. No Bid shall be withdrawn unless the corresponding withdrawal notice contains a valid authorization by the Bidder to request the withdrawal and is read out during the Bid opening.

5.4.5 Second, outer envelopes marked "SUBSTITUTION" shall be opened. The inner envelopes containing the substitute Technical Proposal and / or substitute Financial Proposal shall be exchanged for the corresponding envelopes being substituted, which shall be returned to the Bidder unopened. Only the substituted Technical Proposal, if any, shall be opened, read out, and recorded. Substituted Financial Proposal, if any, will remain unopened in accordance with Sub-Section 5.4.3 of the Instructions to Bidders. No Bid shall be substituted unless a valid authorization by the Bidder to request the substitution is submitted and is read out and recorded during the Bid opening.

5.4.6 Next, outer envelopes marked "MODIFICATION" shall be opened. The original Technical Proposal shall be opened, read out, and recorded, followed by the opening, reading out and recording of the modification to the Technical Proposal. Any modification to the Financial Proposal shall remain unopened in accordance with Sub-section 5.4.3 of the Instructions to Bidders. No Bid shall be modified unless a valid authorization by the Bidder to request the modification is submitted and is read out and recorded during the Bid opening.

5.4.7 All other envelopes holding the Technical Proposals shall be opened one at a time, and the following read out and recorded:

(a) the name of the Bidder;

(b) whether there is a modification or substitution; and

(c) any other details as KW&SB / TFEC may consider appropriate.

5.4.8 Only Technical Proposals read out and recorded during the Bid opening shall be considered for evaluation as per the requirements of the RFP. No Bid shall be rejected at the opening of Technical Proposals except for late Bids, in accordance with Sub-Section 5.2.5 of the Instructions to Bidders.

5.4.9 TFEC shall prepare a record of the Bid opening that shall include, as a minimum: the name of the Bidder and whether there is a withdrawal, substitution, or modification. The Bidders' representatives who are present shall be requested to sign the attendance sheet. The omission of a Bidder's signature on the attendance sheet shall not invalidate the contents and effect of the record.

5.4.10 At the end of the evaluation of the Technical Proposals, TFEC shall invite Bidders who have submitted responsive Technical Proposals pursuant to the requirements of the RFP and who have been determined as technically qualified for award of Concession to attend the opening of the Financial Proposals. The date, time, and location of the opening of Financial Proposals shall be advised in writing by KW&SB.

5.4.11 KW&SB shall notify in writing at any time prior to the opening of the Financial Proposals, the Bidders who have been rejected on the grounds of their Technical Proposals not being responsive to the requirements of the RFP. Such Bidders shall be required to collect their Financial Proposals unopened from KW&SB on the date notified by KW&SB.

5.4.12 TFEC shall conduct the opening of Financial Proposals of all Bidders who have technically qualified, in the presence of Bidders' representatives who choose to attend at the address, date and time specified by KW&SB. The Bidders' representatives who are present shall be requested to sign an attendance sheet evidencing their attendance.

5.4.13 Financial Proposals of the Bidders shall be opened one at a time and the following read out and recorded:

(a) the name of the Bidder;

(b) whether there is a modification or substitution;

(c) the presence and value of the Bid Security;

(d) the Bid Price; and

(e) any other details as KW&SB / TFEC may consider appropriate.

5.4.14 Only the Financial Proposals read out and recorded during the opening of Financial Proposals shall be considered for evaluation. No Financial Proposal shall be rejected at the time of opening of Financial Proposals.

5.4.15 TFEC shall prepare a record of the opening of Financial Proposals that shall include, as a minimum: the name of the Bidder, presence or absence and the value of Bid Security and the Bid Price. The Bidders' representatives who are present shall be requested to sign the attendance sheet. The omission of a Bidder's signature on the attendance sheet shall not invalidate the contents and effect of the record. A copy of the attendance sheet shall be distributed to all Bidders.

6. CLARIFICATION AND EVALUATION OF BIDS

6.1 CLARIFICATION OF BIDS

6.1.1 To assist in the examination, evaluation and comparison of the Technical Proposals and / or Financial Proposals, TFEC may, at its discretion, ask the Bidders for any clarification, additional information or supporting documentation in respect of any matter associated with the documentation submitted by the Bidders in their Bids. Any such request and the response shall be in writing. Subject to Sub-Section 6.1.3, no change in the price in the Financial Proposals or substance of the Bid shall be sought, offered or permitted except to confirm the correction of arithmetic errors discovered by TFEC in the evaluation of the Bids, in accordance with Sub-Section 6.3.4 of the Instructions to Bidders.

6.1.2 If a Bidder does not provide clarifications of the information requested by the date and time set in TFEC's request for clarification, its Bid shall be rejected.

6.1.3 As a result of clarification sought from a Bidder, if applicable, the prices / amounts quoted by such Bidder in the Financial Proposal may be reduced downwards but shall not be increased from the prices / amounts quoted in the Financial Proposals.

6.2 EVALUATION OF BIDS

6.2.1 During the evaluation of Bids, the following definitions apply:

(a) *"Deviation"* is a departure from the requirements specified in the RFP;

(b) *"Reservation"* is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the RFP; and

(c) *"Omission"* is the failure to submit part, or all of the information or documentation required in the RFP.

6.3 PRELIMINARY EXAMINATION OF BIDS

6.3.1 Prior to the detailed evaluation of Bids pursuant to Sub-Section 6.4 (*Determination of Responsiveness of Bids*) of the Instructions to Bidders, TFEC shall examine each Bid to determine whether:

(a) the Bid is complete and does not deviate from the scope of works and services to be performed in relation to the Project;

(b) any computational errors have been made;

(c) required sureties (including Bid Security) have been furnished;

(d) documents have been properly signed;

(e) valid authorization(s) is / are present;

(f) the Bid is valid till the Bid Validity Period; and

(g) the Bidder continues to be meet the evaluation and qualification criteria set out in the Prequalification Document.

6.3.2 Prior to conducting detailed evaluation of Bids pursuant to Sub-Section 6.4 (*Determination of Responsiveness of Bids*) of the Instructions to Bidders, TFEC shall examine each Bid as follows, and a Bid may not be considered acceptable if:

(a) it is unsigned; or

(b) its validity is less than the Bid Validity Period.

6.3.3 Prior to the detailed evaluation of Bids pursuant to Sub-Section 6.4 (*Determination of Responsiveness of Bids*) of the Instructions to Bidders, TFEC shall examine each Bid as follows, and a Bid shall not be considered acceptable if:

(a) it is not accompanied by a Bid Security;

(b) it is received after the Bid Submission Date;

(c) it is submitted through fax, email, or any other form of electronic transmission;

(d) the Bidder refuses to accept arithmetic correction(s); or

(e) it materially deviates from the requirements of the RFP.

6.3.4 TFEC shall require arithmetical errors to be rectified. If there is a discrepancy between:

(a) the relevant input amount and the output (i.e., total) amount in any Bidding Form, due to any error in calculation, the relevant input amount shall prevail, and the output (i.e., total) amount shall be corrected;

(b) the words and figures, the amount in words shall prevail.

6.3.5 If the Bidder does not accept the corrected amount of the Bid, its Bid shall be rejected, and its Bid Security shall be forfeited.

6.4 DETERMINATION OF RESPONSIVENESS OF BIDS

6.4.1 TFEC shall determine the responsiveness of each Bid to the RFP. The Technical Proposals that conform to all the terms and conditions of the RFP without material deviations, reservations or omissions shall be declared responsive. A material deviation, reservation or omission is one that:

(a) if accepted, would:

(i) affect in any substantial way the scope, quality, or performance of the works and services in relation to the Project as specified in the RFP; or

(ii) limit in any substantial way KW&SB's or GoS's rights or the Bidder's or the Company's obligations under the RFP; or

(b) if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Technical Proposals.

6.4.2 TFEC's determination of a Bid's responsiveness may be based on the contents of the Bid itself without recourse to extrinsic evidence.

6.4.3 Any minor non-conformity or irregularity in a Technical Proposal that does not constitute a material deviation, reservation or omission may be waived by KW&SB or required by KW&SB to be rectified, provided such waiver or rectification does not prejudice or affect unfairly the competitive position of other responsive Technical Proposals.

6.4.4 Provided that a Bid is substantially responsive, TFEC may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify non-material non-conformities in the Bid related to documentation requirements. Requesting information or documentation on such non-conformities shall not be related to any aspect of the Financial Proposal. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

6.4.5 If a Bid is not substantially responsive to the requirements of the RFP, it shall be rejected by TFEC and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.

6.4.6 A responsive Financial Proposal is one which meets the requirements of the RFP without any deviation, reservation or omission. No change in the Financial Proposals shall be allowed and shall be evaluated as per the information provided by the Bidders. A non-responsive Financial Proposal may not subsequently be made responsive by correction of the deviation, reservation, or omission.

6.4.7 If a Financial Proposal, in the opinion of TFEC, is seriously unbalanced or is seen to unfairly exploit the evaluation mechanism, TFEC may require the relevant Bidder to produce detailed price analysis for any or all items of the Bid, to demonstrate the internal consistency of those prices. After evaluation of the price analysis, taking into consideration the terms of payments, KW&SB / TFEC may require the Bidder to rationalize the costs and / or terms of payments.

6.5 EVALUATION CRITERIA

6.5.1 In addition, and subject to the requirements set out in Sub-Section 6.3 (*Preliminary Examination of Bids*) and Sub-Section 6.4 (*Determination of Responsiveness of Bids*) each of the Instructions to Bidders, the Bidders shall be evaluated against the evaluation criteria for the Technical Proposals and the Financial Proposals set out in Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP.

6.5.2 The Technical Proposals will be evaluated based on the "pass" or "fail" basis. A Bidder whose Technical Proposal meets the technical evaluation criteria (in KW&SB's / TFEC's determination) set out in Section I (*Technical Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP shall be considered "*pass*" and a Bidder whose Technical Proposal fails to meet the technical evaluation criteria (in KW&SB's / TFEC's determination) set out in Section I (*Technical Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP shall be considered "*fail*".

6.5.3 The Bid Price, including NPV of Service Payment shall be calculated as per the methodology set out in Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP. The Bid Price shall be clearly stated as a single figure, denominated in PKR, and shall not include any provision for amendment or adjustment (whether for inflation, foreign exchange movements or otherwise).

6.5.4 Any Bid that fails to meet the evaluation criteria for the Technical Proposals and the Financial Proposals set out in Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP, shall be rejected.

6.5.5 The capabilities of the Proposed Contractors proposed in a Bid will be evaluated for acceptability in accordance with Annexure A (*Eligibility Criteria for Proposed Contractors*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP. The net worth requirements applicable to the Proposed Contractors as set out in Section I (*Technical Evaluation Criteria*) of Annexure B (*Evaluation Criteria*), shall be calculated on the following parameters, based on the latest audited financial statements:

(a) **"***Net Worth***"** shall be calculated as the relevant Proposed Contractor's (or in case of consortium, each consortium member's) "*Total Assets*" minus its: (i) "*Total Liabilities*"; and (ii) "*Revaluation Surplus*" (or similar entry) on a consolidated basis.

(b) "*Total Assets*" shall be calculated as the total consolidated assets of such entity measured in accordance with either IFRS or any other similar accounting or public accounting standard which is permissible in the jurisdiction in which the relevant Proposed Contractor (or in case of consortium, each consortium member) is incorporated.

(c) "*Total Liabilities*" shall be calculated as the total consolidated liabilities of such entity measured in accordance with either IFRS or any other similar accounting or public accounting standard which is permissible in the jurisdiction in which the relevant Proposed Contractor (or in case of consortium, the relevant consortium member) is incorporated.

(d) "*Revaluation Surplus*" (or similar entry) shall be calculated as the total consolidated figure for any upward changes in the value of the capital / fixed assets of such entity measured in accordance with either IFRS or any other similar accounting or public accounting standard which is permissible in the jurisdiction in which the relevant Proposed Applicant (or in case of consortium, the relevant consortium member) is incorporated. It is typically under the '*Equity*' line item in balance sheet.

6.5.6 Should all the Proposed Contractors be determined to be non-compliant with the requirements set out in the RFP, the respective Bid shall be rejected.

6.5.7 In case more than one of the Proposed Contractors are determined to be compliant with the requirements set out in the RFP, including the Annexure A (*Eligibility Criteria for Proposed Contractors*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP, the Bidders shall be allowed to choose any of the compliant Proposed Contractors as the Approved Contractor for the performance of the relevant Project Activities, provided that KW&SB is informed in writing by the Bidder, the name of the Approved Contractor.

6.5.8 In case only one of the Proposed Contractors is determined to be compliant with the requirements set out in the RFP, including the Annexure A (*Eligibility Criteria for Proposed Contractors*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP, the Bidders shall nominate such compliant Proposed Contractor as the Approved Contractor for the performance of the relevant Project Activities and the Successful Bidder shall notify KW&SB the name of the Approved Contractor prior to the execution of the Concession Agreement.

6.6 SUCCESSFUL BIDDER

6.6.1 A Bidder whose bid has been determined the Best Evaluated Bid in terms of lowest Bid Price shall be declared the Successful Bidder.

6.6.2 In the event it is determined that two (2) or more Bidders have quoted same lowest Bid Price, KW&SB may require such Bidders to re-submit the revised Financial Proposals.

6.7 KW&SB'S RIGHT TO VERIFY DOCUMENTS

6.7.1 KW&SB retains the right to verify particulars regarding any information, statements and / or documents furnished with a Bid. Any Bidder found to be misrepresenting information may be disqualified at any stage of the Bidding Process and their Bid Security shall be forfeited.

7. AWARD OF CONCESSION

7.1 AWARD CRITERIA

7.1.1 Subject to Sub-Section 7.2 (*KW&SB's Right to Accept / Reject Bids*), KW&SB shall award the Concession to the Bidder whose Bid has been determined to be the Best Evaluated Bid in terms of the requirements of the Applicable Evaluation Documents and subject to the approval of the PPP Policy Board established under the Sindh PPP Act, provided that such Bidder continues to be eligible in accordance with the requirements set out in the Prequalification Document.

7.2 KW&SB'S RIGHT TO ACCEPT / REJECT BIDS

7.2.1 No Bid shall be considered to have been accepted, unless such acceptance is confirmed in writing and notified to the Successful Bidder by KW&SB.

7.2.2 KW&SB reserves the right to annul the Bidding Process and reject all Bids at any time prior to the issuance of the Notification of Award, without thereby incurring any liability to Bidders or providing any reason for rejection of the Bids. In case of such annulment, all Bids submitted and specifically, the Bid Securities, shall be promptly returned to the Bidders. The decision of KW&SB shall be final and binding.

7.2.3 KW&SB shall not be responsible for, or pay for, any expenses or losses which may be incurred by any Bidder in the preparation of, or in connection with, its Bid.

7.2.4 Each Bidder fully waives any and all rights to claim in respect of such expenses or losses and agrees to indemnify KW&SB, its affiliates and their advisors fully in respect of any direct or indirect losses, damages, costs or expenses of any kind incurred by any of them.

7.3 NOTIFICATION OF AWARD

7.3.1 Prior to expiration of the Bid Validity Period, KW&SB shall notify the Successful Bidder through the Notification of Award that its Bid has been accepted.

7.3.2 KW&SB shall, at least three (3) Business Days prior to the issuance of the Notification of Award, publish on the websites of PPP Unit, SPPRA and KW&SB, the results of the Bidding Process in the form of a report.

7.3.3 The Successful Bidder shall acknowledge and return the Notification of Award with its

acceptance (the "**Acceptance of Notification of Award**") within seven (7) days of the issuance of Notification of Award, failure of which may constitute sufficient grounds for the annulment of the award and forfeiture of its Bid Security.

7.3.4 The Successful Bidder shall be required to pay IFC Advisory Fee, in the manner specified in the Notification of Award, within thirty (30) days of issuance of the relevant invoice by IFC, after the issuance of Acceptance of Notification of Award. The IFC Advisory Fee shall be non-refundable.

7.4 FORMATION OF SPV BY THE SUCCESSFUL BIDDER

7.4.1 The Successful Bidder shall incorporate a wholly owned SPV (i.e., the Company) that shall be a registered company incorporated in accordance with the Laws of Pakistan exclusively for the implementation of the Project.

7.4.2 The Successful Bidder / Company shall be obligated to replace the Bid Security (prior to expiry of the Bid Security) with the C&O Performance Security as per the requirements set out in Sub-Section 7.5.1 of the Instructions to Bidders.

7.5 C&O PERFORMANCE SECURITY

7.5.1 The Successful Bidder / Company shall, at least five (05) Business Days prior to the date of signing of the Concession Agreement, furnish to GoS satisfactory C&O Performance Security and shall maintain the same in full force and effect until the C&O Performance Security Expiry Date, in accordance with the requirements of the Concession Agreement and the RFP.

7.5.2 Failure of the Successful Bidder to comply with the requirements of Sub-Section 7.5.1 of the Instructions to Bidders shall constitute sufficient grounds for the annulment of the award and forfeiture of its Bid Security. Prior to execution of the Concession Agreement, the C&O Performance Security may be encashed by GoS for the same reasons as the Bid Security and for such other purpose as specified in the RFP. Following execution of the Concession Agreement, the C&O Performance Security shall be encashed in terms of the Concession Agreement.

7.6 SIGNING OF THE CONCESSION AGREEMENT AND EFU AGREEMENT

7.6.1 The Concession Agreement shall be executed between, KW&SB, the GoS and the Company (as the concessionaire), and the EFU Agreement shall be executed between the GoS, the Successful Bidder and the Company, each within thirty (30) days of issuance of the Notification of Award or within such extended timeline as determined by KW&SB in its sole discretion. In case the Concession Agreement and / or the EFU Agreement is not executed within the aforesaid timeline, the Bid Security or the C&O Performance Security (as applicable) shall be forfeited and the award shall be cancelled, if such failure is due to reasons attributable to the Successful Bidder, in the sole determination of KW&SB and / or GoS.

8. OTHER CONSIDERATIONS

8.1 CONFIDENTIALITY

8.1.1 Subject to Sub-Section 8.1.3 of the Instructions to Bidders and Sub-Section 3.3 (*Clarifications of RFP*), no Bidder shall contact KW&SB / GoS / TFEC on any matter relating to its Bid from the time of Bid Submission Date.

8.1.2 Any attempt by a Bidder to influence KW&SB / GoS / TFEC in relation to the Bidding Process may result in the rejection of its Bid and encashment of its Bid Security.

8.1.3 Notwithstanding Sub-Section 8.1.2 of the Instructions to Bidders, from the time of Bid opening to the time of award of the Concession, if any Bidder wishes to contact KW&SB / TFEC on any matter related to the Bidding Process (including for the matters set out in Sub-Section 3.3 (*Clarifications of RFP*)), it should do so in writing via the modes specified in the Data Sheet.

8.1.4 Information relating to the examination, clarification, evaluation and recommendation for the Bidder shall not be disclosed to any person who is not officially concerned with the Bidding Process or is not a retained professional advisor advising KW&SB and / or the GoS in relation to, or matters arising out of, or concerning the Bidding Process. KW&SB will endeavour to treat all information, submitted as part of the Bid, in confidence and will require all those who have access to such material to treat the same in confidence. KW&SB may not divulge any such information, unless it is directed to do so by any statutory entity that has the power under law to require its disclosure, is required under the applicable laws in Pakistan, or it is to enforce or assert any right or privilege of KW&SB, a statutory entity and / or the GoS.

8.1.5 All information supplied by KW&SB / GoS (through KW&SB) in connection with this RFP, shall be treated as confidential and the Bidders shall not, without the prior written consent of KW&SB, at any time make use of such information for their own purposes or disclose such information to any person (except as may be required by applicable Laws). Subject to the provisions of this RFP, the RFP shall remain the property of KW&SB and is issued solely for the purpose of preparation and submission of the Bid in accordance herewith.

8.1.6 The RFP and every part of it and all other information provided by or on behalf of KW&SB must be treated as private and confidential. Bidders shall not disclose the fact that they have been invited to submit a Bid or release details of the RFP other than on a strictly confidential basis to those parties whom they need to consult for the purposes of preparing the Bids.

8.1.7 Bidders shall not at any time release any information concerning the RFP and / or their Bid and / or any related documents and / or any discussion with KW&SB in this connection for publication in the press or on radio, television, screen or any other medium without the prior written approval of KW&SB.

8.1.8 Each Bidder undertakes to indemnify KW&SB and the GoS and to keep KW&SB and the GoS indemnified against all actions, claims, demands, liability, proceedings, damages, costs, charges and expenses whatsoever arising out of or in connection with any breach of the provisions of this Sub-Section 8.1 (*Confidentiality*).

8.1.9 Any Bid submitted in response to the RFP is submitted upon a full understanding and agreement of terms of this Sub-Section 8.1 (*Confidentiality*) and therefore the submission of the Bid in response to the RFP would be deemed as an acceptance to the said terms.

8.2 CORRUPT AND FRAUDULENT PRACTICES

8.2.1 KW&SB / TFEC will reject a Bid if it determines that a Bidder (including its Affiliate) or a Proposed Contractor has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices or other integrity violations during the prequalification process for the Project or the Bidding Process and/or shall declare such Bidder or a Proposed Contractor ineligible, either indefinitely or for a stated period of time, to engage with the GoS Parties.

8.2.2 "*Corrupt and fraudulent practice*" means either one or any combination of the practices with respect to the Bidding Process and / or the Project given below:

(a) **"coercive practice"** means impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence the actions of a party to achieve a wrongful gain or to cause a wrongful loss to another party;

(b) **"collusive practice"** means any arrangement between two or more parties to the procurement process or contract execution, designed to achieve with or without the knowledge of the procuring agency to establish prices at artificial, non-competitive levels for any wrongful gain;

(c) **"corrupt practice"** means the offering, giving, receiving or soliciting directly or indirectly of anything of value to influence the acts of another party for wrongful gain;

(d) **"fraudulent practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation;

(e) "**obstructive practice**" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the procurement process for the Project, or affect the execution of a contract or deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements before investigators in order to materially impede an investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or acts intended to materially impede the exercise of inspection and audit rights.

8.3 INTEGRITY PACT

Each Bidder shall sign and stamp Bidding Form T2 (*Form of Integrity Pact*) of Part 2 *(Bidding Forms)* of the RFP (the "**Integrity Pact**"). Failure to provide such Integrity Pact may cause the Bid to be rejected by TFEC as non-responsive.

8.4 GRIEVANCE REDRESSAL

Any Bidder being aggrieved by any act or decision of KW&SB / TFEC, may after the issuance of the RFP, lodge a written complaint to the "*complaint redressal committee*" constituted by KW&SB in accordance with the Applicable Evaluation Documents. The mechanism for redressal of grievances of Bidders shall be as per the Applicable Evaluation Documents.

8.5 REQUIREMENTS WITH RESPECT TO FOREIGN EXCHANGE INDEXATION

The foreign exchange indexation (FE_RC as set out in appendix 8 of the Concession Agreement) shall only be applied to lower of: (a) actual equity of the Foreign Sponsor (defined below); and (b) seventy percent (70%) of the total equity (excluding VGF) stated in Bidding Form F3-I (*Sources and Uses*) of Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP and only with respect to the Bidders (including Consortium Members, in case a Bidder is a Consortium) who: (i) are foreign companies incorporated outside Pakistan; (ii) are owned and controlled by foreign shareholders / entities; and (iii) do not have any Pakistani shareholders (whether individual or corporate entity) with more than five percent

(5%) shareholding (directly, indirectly, legally or beneficially) in such Bidder or Consortium Member ("**Foreign Sponsor**").

Each Foreign Sponsor shall be required to submit as part of the Technical Proposal, a legal opinion from counsel qualified to opine in the jurisdiction of incorporation of the Foreign Sponsor confirming the conditions stated in (i) to (iii) above, and execute an undertaking in the form and substance attached as Bidding Form T4 (*Form of Undertaking*) of Part 2 *(Bidding Forms)* of the RFP.

Where a Bidder cannot satisfy the requirements of this Sub-Section 8.5, for the purposes of Bidding Form F3-B (*Cost Recovery Charges*) of Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP, equity should be included in the Local Equity component (LE_RC as set out in appendix 8 of the Concession Agreement).

8.6 FEES, DUTIES AND TAXES

The Company shall be responsible for payment of any stamp duty and other fees, duties and / or taxes that may be applicable with respect to the execution of the relevant documents (including the Concession Documents) in relation to the Project.

9. DATA SHEET

The following specific data shall supplement the provisions in the Instructions to Bidders.

1.	**Address for seeking clarifications on the RFP**	**Designation:** Project Director – Karachi Hub Water Canal Project **Address:** Room No. 26, 1st Floor, Block B, Office of The Karachi Water & Sewerage Board, 9th Mile, Karsaz, Karachi, Pakistan **Phone No.:** 0092 21 9924 5130 Requests for clarifications to be sent to the following email addresses: kwsc@ifc.org. karachihubwatercanalproject@gmail.com Subject of email to be Att. KWC – RFP ([*Name of Bidder*]).
2.	**Pre-Bid Meeting**	**Date:** 20 September 2022 **Time:** 14:00 hours (PST) **Venue:** Venue for the Pre-Bid Meeting shall be specified by KW&SB in writing one (1) week prior to the Pre-Bid Meeting. *Virtual attendance in the Pre-Bid Meeting shall be permitted. Link for the virtual meeting shall be shared with the Prequalified Applicants prior to the date of the Pre-Bid Meeting.*

3.	**Address for submission of Bids**	**Attention:** Staff Officer to Chairman Planning and Development Board, Government of Sindh (on behalf of the Project Director, Karachi Hub Water Canal Project). **Address:** 2nd Floor, Tughlaq House, Sindh Secretariat, Shahrah-e-Kamal Atta-Turk Road, Karachi, Pakistan. **Telephone:** 0092 21 99211922 **Cell:** 0092 333 319 5734
4.	**Address for opening of Bids**	Committee Room, Planning and Development Board, Government of Sindh, 2nd Floor, Tughlaq House, Sindh Secretariat, Shahrah-e-Kamal Atta-Turk Road, Karachi, Pakistan.
5.	**Bid Submission Date**	29 November 2022

PART 2
BIDDING FORMS

1. BIDDING FORMS

1.1 The Bidding Forms comprise the forms stated below and each relevant form is required to be submitted with the Technical Proposal and the Financial Proposal, as applicable.

1.2 In case a document / Bidding Form required to be submitted as part of the Technical Proposal, is submitted with Financial Proposal; or a document / Bidding Form required to be submitted with Financial Proposal, is submitted with Technical Proposal, it shall not be considered for evaluation and such document / Bidding Form shall be considered as not submitted by the Bidder and may also form the basis of rejection of a Bid.

(A) For the Technical Proposal:

(a) **FORM T1 – LETTER OF TECHNICAL PROPOSAL;**

(b) **FORM T2 – FORM OF INTEGRITY PACT;**

(c) **FORM T3 – FORM OF POWER OF ATTORNEY;**

(d) **FORM T4 – FORM OF UNDERTAKING;**

(e) **FORM T5 – FORM OF CONSORTIUM UNDERTAKING;**

(f) **FORM T6 – FORM OF AFFIDAVIT BY PROPOSED CONTRACTOR;**

(g) **FORM T7 – TECHNICAL PROJECT METHODOLOGY / APPROACH;**

(h) **FORM T8 – OPERATION & MAINTENANCE PLAN AND PROCEDURES;**

(i) **FORM T9 – IMPLEMENTATION SCHEDULE;**

(j) **FORM T10 – LIST OF MANUFACTURERS OF MAIN EQUIPMENT;**

(k) **FORM T11 – SCHEDULE OF EQUIPMENT & TECHNOLOGY SUPPLIERS;**

(l) **FORM T12 – ORGANIZATION & STAFFING;**

(m) **FORM T13 – QUALITY CONTROL PRACTICES AND PROCEDURES;**

(n) **FORM T14 – HEALTH & SAFETY PLAN AND PROCEDURES;**

(o) **FORM T15 – METHODOLOGY/APPROACH FOR THE ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN AND PROCEDURES;**

(p) **FORM T16 – OTHER TECHNICAL DATA SUBMISSION**

(q) **FORM T17 – PROJECT REFERENCES OF PROPOSED EPC CONTRACTOR**

(r) **FORM T18 – PROJECT REFERENCES OF PROPOSED O&M CONTRACTOR**

(s) **FORM T19 – NET WORTH REQUIREMENTS OF PROPOSED CONTRACTOR**

(B) For the Financial Proposal:

(a) **FORM F1 – LETTER OF FINANCIAL PROPOSAL;**

(b) **FORM F2 – FORM OF BID SECURITY;**

(c) **FORM F3 – FINANCIAL FORMS**

A. TECHNICAL PROPOSAL BIDDING FORMS

BIDDING FORM T1 – LETTER OF TECHNICAL PROPOSAL

[Date]

To: Karachi Water and Sewerage Board, Government of Sindh

Project Director – Karachi Hub Water Canal Project
Room No. 26, 1st Floor, Block B,
Office of The Karachi Water & Sewerage Board,
9th Mile, Karsaz, Karachi, Pakistan.

Re: Design, finance, build, rehabilitate, operate, maintain and transfer of the Karachi Hub Water Canal (the "**Project**").

Dear [Sir/Madam],

Reference the Request for Proposals document issued on August 29, 2022, by Karachi Water and Sewerage Board ("**KW&SB**"), (the "**RFP**") in relation to the Project.

We, [*Name of the Bidder*] hereby submit our Technical Proposal in conformity with the requirements of the RFP.

All capitalized terms unless defined herein shall bear the meaning as ascribed thereto in the RFP.

We, agree, confirm, undertake and declare that:

(a) We have examined and have no reservations to the RFP, including Addenda No(s) [●] / Corrigenda No(s) [●].

(b) We, [including all Consortium Members,] fully and completely understand and accept the terms of the RFP and hereby undertake to comply with the requirements specified therein.

(c) We offer to perform and undertake the works and services in respect of the Project in conformity with the RFP (including the Concession Documents) without any omission, reservation and deviation; and we accept and undertake to comply with all requirements in the RFP, including the appendices / annexures attached to the RFP.

(d) We, [including all Consortium Members,] and the Contractors, as per the requirements of the Prequalification Document and the RFP, respectively:

  (i) have nationalities of Eligible Countries;

  (ii) do not have any conflict of interest; and

  (iii) have not been declared ineligible/blacklisted by any of our employers, by any Federal or Provincial governmental or non-governmental department / agency in Pakistan, or any other provincial government / governments of any foreign countries or their governmental bodies and / or International Organizations (e.g., World Bank, Asian Development Bank, United Nations, International Monetary Fund etc.), as at the Bid Submission Date.

(e) Neither we, [including all Consortium Members], any Affiliate nor the Contractors,:

(i) are included as a debarred person pursuant to the public sanctions list of any multilateral development bank that is party to the Agreement on Mutual Enforcement of Debarment Decisions of 9 April 2010 (www.crossdebarment.org); or

(ii) are included on any sanctions lists promulgated by the UN Security Council or its Committees, or any other recognised international sanctions list.

(f) Our Bid consisting of the Technical Proposal and the Financial Proposal shall be valid for a period of one hundred twenty (120) days from the date fixed for the Bid Submission Date in accordance with the RFP, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

(g) We understand that all the volumes, appendices / annexures attached to the RFP are integral parts of the RFP.

(h) We have reviewed and accepted the form of the Concession Agreement along with the appendices attached thereto (attached as Volume III (*Concession Agreement and Appendices*) and form of the EFU Agreement (attached as Volume IV (*EFU Agreement*)) to the RFP), and undertake to execute the same within the time period stipulated in Notification of Award.

(i) We hereby:

(i) acknowledge and consent to any actual, potential or perceived conflicts of interests arising as a result of the multiple current or prospective roles of IFC, MIGA and IDA in connection with the development, delivery and financing of the Project, or in connection with any pre-existing financial or advisory relationships between an institution of the World Bank Group and a prospective Bidder [(including the Consortium Members)] (or its Affiliate), KW&SB and the GoS;

(ii) waive any liability to which any World Bank Group institution might otherwise be subject in connection with such actual, potential or perceived conflicts of interest; and

(iii) consent to the sharing of any information provided to or created by IFC in connection with the proposed financing of the Project among IFC, IDA and MIGA staff members engaged in the proposed financing of the Project.

(j) We acknowledge that KW&SB (and the GoS) will be relying on the information provided in our Prequalification Application and our Bid and the documents accompanying them to determine the Successful Bidder. We certify that all information provided in our Prequalification Application and our Bid is true and correct and that nothing has been omitted which renders such information misleading.

(k) We continue to satisfy and meet all the requirements specified in the Prequalification Document, including the qualifications requirements set out in the Prequalification Document and in our Prequalification Application and there has been no material event relating to us or, if we are a Consortium, to any of our Consortium Members, which would require disclosure to KW&SB (and the GoS) or which might cause us to fail to become a Prequalified Applicant.

(l) We understand that this Bid, together with your written acceptance thereof included in your Notification of Award, shall constitute a binding contract between us, until the Concession

Agreement (attached as Volume III (*Concession Agreement and Appendices*) to the RFP) is executed.

(m) We are not participating or any of our Consortium Members (or any of our Affiliates), as a Bidder in more than one Bid in this Bidding Process in accordance with the requirements of the RFP.

(n) We understand that KW&SB may cancel the Bidding Process at any time and that KW&SB is not bound either to accept any Bid that it may receive, without incurring any liability to the Bidders.

(o) We agree to permit KW&SB, the GoS and any persons, representatives or auditors appointed and authorized by KW&SB and / or the GoS to inspect and audit our accounts, records and other documents relating to our Bid.

(p) All the information submitted along with our Bid, including the enclosed forms and documents, is accurate in all respects.

(q) We accept the right of KW&SB to: (i) request additional information reasonably required to assess the Bid; (ii) amend the procedures and requirements or make clarifications thereof; and (iii) extend or amend the timelines as stipulated in the RFP.

(r) All information, representations and other matters of fact communicated (whether in writing or otherwise) to KW&SB by us or on our behalf, in connection with or arising out of the Bid are true, complete and accurate in all respects.

(s) We hereby declare that all the information and statements made in this Bid are true and accept that any misrepresentation contained in it shall lead to our disqualification, forfeiture of the Bid Security and / or our blacklisting by the KW&SB.

(t) We, [including all Consortium Members,] have made our own investigations and research and have satisfied ourselves in respect of all matters (whether actual or contingent) relating to the Bid and the Project.

(u) We undertake, if our Bid is accepted, to furnish the C&O Performance Security as per the requirements of the RFP.

(v) We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other person or persons making a Bid for the Project.

(w) We understand that the RFP has been issued by KW&SB for the Project; and undertake and confirm that if our Bid is accepted, we and the SPV (to be incorporated by us, in case the Project is awarded to us), as applicable, shall execute the Concession Agreement (including other applicable Concession Documents) (attached as Volume III (*Concession Agreement and Appendices*) and the EFU Agreement (attached as Volume IV (*EFU Agreement*)) to the RFP and all other instruments as may be required to be executed in relation to the Project as per the requirements of the RFP.

(x) We acknowledge that in case the Project is awarded to us, we shall be liable to pay IFC Advisory Fee in the manner specified in the Notification of Award, within thirty (30) days of issuance of the relevant invoice by IFC, after the issuance of Acceptance of Notification of Award.

Name .....

In the capacity of .....

Signed .....

…….. (Seal)…

Duly authorized to sign the Bid for and on behalf of: (*Insert Name of the Bidder/names of all Consortium Members*)

Date .....

Witness 1:	**Witness 2:**
Signature: _____	Signature: _____
Name: _____	Name: _____
Designation: _____	Designation: _____
Date: _____	Date: _____
CNIC/Passport No.:_____	CNIC/Passport No.:_____

BIDDING FORM T2 – FORM OF INTEGRITY PACT

Dated _____

[*name of Bidder*] (the "**Bidder**") hereby declares that it has not obtained or induced the procurement of any contract, right, interest, privilege or other obligation or benefit from Government of Sindh, Karachi Water and Sewerage Board, any administrative subdivision or agency thereof or any other entity owned or controlled by Government of Sindh (collectively to be hereinafter referred to as the "**GoS**") through any corrupt business practice.

Without limiting the generality of the foregoing, [*name of Bidder*] represents and warrants that it has fully declared the brokerage, commission, fees etc. paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within or outside Pakistan either directly or indirectly through any natural or juridical person, including its affiliate, agent, associate, broker, consultant, director, promoter, shareholder, sponsor or subsidiary, any commission, gratification, bribe, finder's fee or kickback, whether described as consultation fee or otherwise, with the object of obtaining or inducing the procurement of a contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoS, except that which has been expressly declared pursuant hereto.

[*name of Bidder*] certifies that it has made and will make full disclosure of all agreements and arrangements with all persons in respect of or related to the transaction with GoS and has not taken any action or will not take any action to circumvent the above declaration, representation or warranty.

[*name of Bidder*] accepts full responsibility and strict liability for making any false declaration, not making full disclosure, misrepresenting facts or taking any action likely to defeat the purpose of this declaration, representation and warranty. It agrees that any contract, right, interest, privilege or other obligation or benefit obtained or procured as aforesaid shall, without prejudice to any other rights and remedies available to GoS under any law, contract or other instrument, be voidable at the option of GoS.

Notwithstanding any rights and remedies exercised by GoS in this regard, [n*ame of Bidder*] agrees to indemnify GoS for any loss or damage incurred by it on account of its corrupt business practices and further pay compensation to GoS in an amount equivalent to ten times the sum of any commission, gratification, bribe, finder's fee or kickback given by [*name of Bidder*] as aforesaid for the purpose of obtaining or inducing the procurement of any contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoS.

Name of Employer: Karachi Water & Sewerage Board

Signature: …….

[Seal]

Name of Bidder: _____

Signature: …….

[Seal]

BIDDING FORM T3 – FORM OF POWER OF ATTORNEY

A. POWER OF ATTORNEY TO AUTHORIZE A PERSON TO SIGN THE DOCUMENTS

NOTES FOR EXECUTION OF POWER OF ATTORNEY

- *To be executed by each Bidder and in case the Bidder is a Consortium, by each Consortium Member, authorizing the relevant attorney to, inter alia, sign the required documents on its behalf in relation to the RFP.*
- *The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executant(s).*
- *This Power of Attorney shall be on stamp paper and notarised with the Notary Public.*
- *For a Power of Attorney executed and issued overseas, the same will have to be notarized by Notary Public and attested by the Pakistani Embassy / Consulate in the country where the Power of Attorney is executed; and once brought into Pakistan, the same is to be attested by Ministry of Foreign Affairs, Pakistan and adhesive stamped.*
- *This Power of Attorney shall be witnessed by two (2) male witnesses or one (1) male and two (2) female witnesses or four (4) female witnesses.*
- *See Bidding Documentary Requirements set out in Part 3 (Bidding Documentary Requirements) of Volume I (Bidding Procedure) of the RFP.*

KNOW ALL BY THESE PRESENTS, **WE**, [(*name of the entity and address of the registered office*)] do hereby irrevocably constitute, nominate, appoint and authorise Mr. / Ms. [(*Name*)], son / daughter / wife of [(*Name*)] holding [*CNIC / Passport*] Number [*insert number*] and presently residing at [*insert current residence details*], who is presently employed with us and holding the position of [*insert position*], as our true and lawful attorney (hereinafter referred to as the "**Attorney**") (with power to sub-delegate) to do in our name and on our behalf, all such acts, deeds and things as are necessary or required in connection with or incidental to the requirements of the request for proposals document issued on August 29, 2022 (the "**RFP**") by Karachi Water and Sewerage Board ("**KW&SB**") in relation to design, finance, build, rehabilitate, operate, maintain and transfer of the Karachi Hub Water Canal (the "**Project**"), including but not limited to signing and submission of all documents and providing information / responses to KW&SB in respect of the RFP, representing us in all matters before KW&SB, and generally dealing with KW&SB (and the GoS), and / or any other governmental agencies or any person, in all matters in connection with or relating to or arising out of our Bid and its acceptance by KW&SB and for the Project.

We hereby ratify all prior and future acts, deeds and things lawfully done by the Attorney in relation to the Project (including with respect to the submission of our Bid in response to the RFP) pursuant to this Power of Attorney and we hereby agree that all prior and / or future acts, deeds and things done by the Attorney in relation to the Project (including with respect to the submission of our Bid in response to the RFP) shall, and shall always be, deemed to have been done by us.

IN WITNESS WHEREOF WE, _____, HAVE EXECUTED THIS POWER OF ATTORNEY ON THIS _____ DAY OF _____, 20___.

For & On Behalf of:

_____ (*insert name of the entity)*

By Its Duly Authorized Signatory

……..

(*Signature*)

Name: _____ *[insert name of the person issuing this Power of Attorney who is authorized to issue this Power of Attorney on behalf of the entity]*

Title / Designation: _____ *[insert designation of the person issuing this Power of Attorney]*

Address: _____ *[insert address of the person issuing this Power of Attorney]*

WITNESSES:

WITNESS 1:	**WITNESS 2:**
……	……
NAME:	NAME:
CNIC / PASSPORT NUMBER:	CNIC / PASSPORT NUMBER:
ADDRESS:	ADDRESS:

SIGNATURE OF ATTORNEY

……

Name of Attorney: _____

CNIC / Passport Number of Attorney: _____

Title / Designation of Attorney: _____

Address of Attorney: _____

B. POWER OF ATTORNEY TO AUTHORIZE THE CONSORTIUM AUTHORIZED REPRESENTATIVE

NOTES FOR EXECUTION OF POWER OF ATTORNEY

- *This Power of Attorney for the appointment of Consortium Authorized Representative, is to be executed by the authorized representative of each Consortium Member (appointed pursuant to the power of attorney in Form A (Power of Attorney to Authorize a Person to Sign the Documents)). The Consortium Authorized Representative shall be the same entity (i.e., Lead Investor or the Lead Developer), appointed to represent the Consortium during the prequalification stage. Subject to the approval of KW&SB / TFEC, a different Consortium Authorized Representative (i.e., different from the representative appointed during the Prequalification Process) may be appointed pursuant to the Power of Attorney, provided that such Consortium Authorized Representative is the Lead Investor or the Lead Developer*

- *The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executant(s).*

- *This Power of Attorney shall be on a stamp paper and notarised with the Notary Public.*

- *For a Power of Attorney executed and issued overseas, the same will have to be notarized by Notary Public and attested by the Pakistani Embassy / Consulate in the country where the Power of Attorney is executed; and once brought into Pakistan, the same is to be attested by Ministry of Foreign Affairs, Pakistan and adhesive stamped.*

- *This Power of Attorney shall be witnessed by two (2) male witnesses or one (1) male and two (2) female witnesses or four (4) female witnesses.*

- *See Bidding Documentary Requirements set out in Part 3 (Bidding Documentary Requirements) of Volume I (Bidding Procedure) of the RFP.*

WHEREAS, the Karachi Water and Sewerage Board ("**KW&SB**") has invited bids from the Prequalified Applicants for the 'KARACHI WATER HUB CANAL PROJECT' (the "**Project**") pursuant to the request for proposals document issued on August 29, 2022 by KW&SB (as amended from time to time) (the "**RFP**");

WHEREAS, _____, _____ and _____ (each hereinafter referred to individually as a "**Consortium Member**" and collectively as "**Consortium Members**") have formed a consortium (the "**Consortium**") in accordance with the requirements of the Prequalification Document and the RFP and have issued a Consortium Undertaking as per the requirements of the RFP;

[**WHEREAS,** the Consortium Members during the Prequalification Process, designated [●], the [*Lead Investor / Lead Developer (insert as applicable)*], as identified in our Prequalification Application, as the "**Consortium Authorized Representative**" as per the requirements of the Prequalification Document to conduct all business for and on behalf of the Consortium during the Prequalification Process and to do on our behalf all or any of such acts, deeds or things as are necessary or required or incidental to the Project, including but not limited to, *inter alia*, signing and submission of all applications and other documents

and generally to represent the Consortium in all its dealings with KW&SB relating to or arising out of the Consortium's Prequalification Application;][1]

AND WHEREAS, the Consortium Members issue this Power of Attorney for the appointment of the '**Consortium Authorized Representative**' with all necessary powers and authority to represent and irrevocably bind all the Consortium Members in all matters connected with the Bidding Process and during execution of the relevant agreements in relation to the Project, in case the Consortium is awarded the Project.

KNOW ALL MEN BY THESE PRESENTS

WE, _____ , having our registered office at _____, M/s. _____, having our registered office at _____, and M/s. _____, having our registered office at _____, do hereby irrevocably designate, nominate, constitute, appoint and authorise M/s _____, having its registered office at _____, being one of the Consortium Members and the [*Lead Developer / Lead Investor (insert as applicable)*], as the Consortium Authorized Representative and true and lawful attorney of the Consortium (hereinafter referred to as the "**Attorney**") and hereby irrevocably authorise the Attorney (with power to sub-delegate) to conduct all business for and on behalf of the Consortium and any one of us during the Bidding Process being conducted by KW&SB pursuant to the RFP and to do on our behalf and on behalf of the Consortium, all or any of such acts, deeds or things as are necessary or required or incidental to the Project, including but not limited to signing and submission of our Bid, all applications and other documents and writings, participate in conferences / meetings, respond to queries, submit information / documents, sign and execute contracts and undertakings including the Acceptance of Notification of Award, as applicable (if awarded the Project) and generally to represent the Consortium in all its dealings with KW&SB (and the GoS), and / or any other governmental agencies or any person, in all matters in connection with or relating to or arising out of the Consortium's Bid and its acceptance by KW&SB.

We hereby ratify all prior and future acts, deeds and things lawfully done by the Attorney in relation to the Project (including with respect to the submission of our Bid in response to the RFP) pursuant to this Power of Attorney and we hereby agree that all prior and / or future acts, deeds and things done by the Attorney in relation to the Project (including with respect to the submission of our Bid in response to the RFP) shall, and shall always be, deemed to have been done by us.

IN WITNESS WHEREOF WE THE ABOVE NAMED HAVE EXECUTED THIS POWER OF ATTORNEY ON THIS _____ DAY OF _____ 20___.

For:_____ [*insert name of Consortium Member*]

(*Signature*)

Name: _____ [*Insert name of the person executing this Power of Attorney on behalf of the Consortium Member*]

Title / Designation: _____ [*Insert title / designation of the person executing this Power of Attorney on behalf of the Consortium Member*]

[1] Bidders to note that this provision may be deleted in case a different Consortium Authorized representative (i.e., different from the Consortium Authorized Representative appointed during the Prequalification Process) is being appointed pursuant to the Power of Attorney.

Address: [*Insert address of the person executing this Power of Attorney on behalf of the Consortium Member*]

For:_____ [*insert name of Consortium Member*]

(*Signature*)

Name: _____ [*Insert name of the person executing this Power of Attorney on behalf of the Consortium Member*]

Title / Designation: _____ [*Insert title / designation of the person executing this Power of Attorney on behalf of the Consortium Member*]

Address: [*Insert address of the person executing this Power of Attorney on behalf of the Consortium Member*]

For:_____ [*insert name of Consortium Member*]

(*Signature*)

Name: _____ [*Insert name of the person executing this Power of Attorney on behalf of the Consortium Member*]

Title / Designation: _____ [*Insert title / designation of the person executing this Power of Attorney on behalf of the Consortium Member*]

Address: [*Insert address of the person executing this Power of Attorney on behalf of the Consortium Member*]

WITNESSES:

WITNESS 1:	**WITNESS 2:**
……	……
NAME:	NAME:
CNIC / PASSPORT NUMBER:	CNIC / PASSPORT NUMBER:
ADDRESS:	ADDRESS:

(Executants)

(To be executed by all the Consortium Members in favour of Consortium Authorized Representative)

BIDDING FORM T4 – FORM OF UNDERTAKING

Note: See Bidding Documentary Requirements set out in Part 3 (Bidding Documentary Requirements) of Volume I (Bidding Procedure) of the RFP.

This Undertaking shall be witnessed by two (2) male witnesses or one (1) male and two (2) female witnesses or four (4) female witnesses.

[Date]

Re: Design, finance, build, rehabilitate, operate, maintain and transfer of the Karachi Hub Water Canal (the "**Project**").

Reference the Request for Proposals document issued on August 29, 2022, by Karachi Water and Sewerage Board ("**KW&SB**"), (the "**RFP**") in relation to the Project.

UNDERTAKING

(this "**Undertaking**")

We, [*insert name*], registered under incorporation / registration number [●] under the laws of [●], do hereby solemnly represent, declare, covenant, undertake and submit that:

(a) as at the date hereof, the representations, declarations, covenants and undertakings in our Prequalification Application remain correct, true and valid / [including the information representations, declarations, covenants and undertakings provided by [*insert name of new entity, in case new entity is proposed as shareholder in terms of Sub-Section 2.1.4 of the Instructions to Bidders*]];

(b) as at the date hereof, all submissions, documents, forms and other information provided in our Prequalification Application and during the Prequalification Process, on the basis of which we were prequalified, remain true, correct and valid;

(c) we shall notify KW&SB immediately, in writing, if any change in the structure, formation, personnel or qualifications reflected in our Prequalification Application that could affect our eligibility and qualification under the Prequalification Document and we acknowledge that such notification shall not render us eligible and qualified under the Prequalification Document;

(d) we acknowledge and accept that failure to notify KW&SB of such changes in a timely manner may result in our disqualification [(including the disqualification of the Consortium)] at any point in time at the discretion of KW&SB;

(e) [we confirm that we do not have any Pakistani shareholders (whether individual or corporate entity) with more than five percent (5%) shareholding (directly, indirectly, legally or beneficially);][2]

(f) in case the representations, declarations, covenants, undertakings and submissions contained in this Undertaking are found to be incorrect, untrue and / or invalid, we shall indemnify and hold harmless KW&SB and the GoS against any loss, damage or action / claim which may arise due

[2] Applicable in case of foreign entities.

to:

(i) any representation, declaration, covenant, undertaking and submission being found incorrect, untrue and / or invalid; and / or

(ii) our disqualification from the Bidding Process; and / or

(iii) cancellation of the award of Concession for the Project to us (in case the Concession has been so awarded at that time).

(g) For the purposes of the Project, the shareholding of the SPV shall be as follows[3]:

ROLE[4]	**NAME OF ENTITY**	**EQUITY SHARE/PERCENTAGE INTEREST IN THE SPV**
Lead Investor		
Lead Developer		
Consortium Member (If applicable)		
Name of the entity (Lead Developer or Lead Investor) with the power to direct the management, policies and decisions of the SPV.		

Capitalized terms used herein and not otherwise defined shall bear the meaning ascribed thereto in the RFP.

IN WITNESS WHEREOF, we have signed this Undertaking at _____ on this _____ day of _____ 20____

Very truly yours,

_____ [*Insert name of the Bidder / Consortium Member*]

[3] Bidders to note that the information (i.e., the names of the Lead Investor / Lead Developer / Consortium Authorized Representative and the respective shareholding percentages of the Consortium Members) to be provided in the table should be the same as provided during the Prequalification Process in the Prequalification Applications, without any alteration. Subject to the approval of KW&SB / TFEC, (i) a different Consortium Authorized Representative (i.e., different from the representative appointed during the Prequalification Process) may be appointed pursuant to the Power of Attorney, provided that such Consortium Authorized Representative is the Lead Investor or the Lead Developer; and (ii) name of new shareholder, as a Consortium Member, in case approved by KW&SB / TFEC in terms of Sub-Section 2.1.4 of the Instructions to Bidders, to be inserted.

[4] Bidders to note that in case the Bidder is a single entity, such Bidder shall be the Lead Investor and the Lead Developer for the purposes of the Project.

_____ [*insert name of authorized signatory, authorized to execute this Undertaking for and on behalf of the Bidder / Consortium Member*]

_____ [*signature of authorized signatory, executing this Undertaking*]

WITNESS 1:	**WITNESS 2:**
……	……
NAME:	NAME:
CNIC / PASSPORT NUMBER:	CNIC / PASSPORT NUMBER:
ADDRESS:	ADDRESS:

BIDDING FORM T5 – FORM OF CONSORTIUM UNDERTAKING

Note: See Bidding Documentary Requirements set out in Part 3 (Bidding Documentary Requirements) of Volume I (Bidding Procedure) of the RFP.

This Undertaking shall be witnessed by two (2) male witnesses or one (1) male and two (2) female witnesses or four (4) female witnesses.

[Date]

Re: Design, finance, build, rehabilitate, operate, maintain and transfer of the Karachi Hub Water Canal (the "**Project**").

Reference the Request for Proposals document issued on August 29, 2022, by Karachi Water and Sewerage Board, (the "**RFP**") in relation to the Project.

CONSORTIUM UNDERTAKING

(this "**Undertaking**")

We, _____, _____ and _____ (each hereinafter referred to individually as a "**Consortium Member**" and collectively as "**Consortium Members**") have formed a consortium (the "**Consortium**") in accordance with the requirements of the Prequalification Document and the RFP and hereby issue this Undertaking as per the requirements of the RFP.

We, the Consortium Members, do hereby solemnly represent, declare, covenant, undertake and submit that:

(a) the Lead Investor i.e., [*insert name of the Lead Investor*], as identified during the Prequalification Process:

(iv) shall hold minimum twenty-six percent (26%) equity/shareholding stake in the SPV;

(v) continues to meet the minimum net worth requirements set out in Section B (*Financial Criteria*) of Annexure B (*Evaluation and Qualification Criteria*) of the Prequalification Document; and

(vi) shall be liable in respect of the obligations of the Consortium Members in relation to the Project,

(b) the Lead Developer i.e., [*insert name of the Lead Developer*], as identified during the Prequalification Process, continues to meet the requirements set out in Section A (*Technical Criteria*) of Annexure B (*Evaluation and Qualification Criteria*) of the Prequalification Document;

(c) the Consortium Authorized Representative i.e., [*insert name*], shall have the authority to conduct all business for and on behalf of the Consortium during the Bidding Process, and in the event the Consortium is awarded the Concession for the Project, during signing of the Concession Documents;

(d) we have read the Concession Documents and shall execute the same as per the requirements of the RFP;

(e) we shall incorporate a SPV for the purposes of execution of the relevant agreements and for undertaking the Project, as per the requirements of the RFP and the applicable Laws;

(f) [*the Lead Investor / the Lead Developer*], as specified in the formal '*letter of intent to form a consortium*' submitted during the Prequalification Process as part of the Prequalification Application, shall have the power to direct the management, policies and decisions, in each case, of the SPV;

(g) each Consortium Member, other than the Lead Investor, shall hold the minimum net worth, as follows:

> [*list the net worth of each Consortium Member as specified in the formal 'letter of intent to form a consortium' submitted during the Prequalification Process or in case new entity is proposed as a shareholder (as approved by KW&SB / TFEC) in terms of Sub-Section 2.1.4 of the Instructions to Bidders, the net worth of each Consortium Member (including the new shareholder, approved by KW&SB / TFEC)*]

(h) for the purposes of the Project, the shareholding of the SPV shall be as follows[5]:

ROLE	**NAME OF ENTITY**	**EQUITY SHARE/PERCENTAGE INTEREST IN THE SPV**
Lead Investor / Consortium Authorized Representative (*if applicable*)		
Lead Developer / Consortium Authorized Representative (*if applicable*)		
Consortium Member (If applicable)		
Name of the entity (Lead Developer or Lead Investor) with the power to direct the management, policies and decisions of the SPV		

Capitalized terms used herein and not otherwise defined shall bear the meaning ascribed thereto in the RFP.

[5] Bidders to note that the information (i.e., the names of the Lead Investor / Lead Developer / Consortium Authorized Representative and the respective shareholding percentages of the Consortium Members) to be provided in the table should be the same as provided during the Prequalification Process in the Prequalification Applications, without any alteration. Subject to the approval of KW&SB / TFEC, (i) a different Consortium Authorized Representative (i.e., different from the representative appointed during the Prequalification Process) may be appointed pursuant to the Power of Attorney, provided that such Consortium Authorized Representative is the Lead Investor or the Lead Developer; and (ii) name of new shareholder, as a Consortium Member, in case approved by KW&SB / TFEC in terms of Sub-Section 2.1.4 of the Instructions to Bidders, to be inserted.

IN WITNESS WHEREOF, we, the Consortium Members, have signed[6] this Undertaking on this _____ day of _____ 20____

For:_____ [*insert name of Consortium Member*]

(*Signature*)

Name: _____ [*Insert name of the person executing this Undertaking on behalf of the Consortium Member*]

Title / Designation: _____ [*Insert title / designation of the person executing this Undertaking on behalf of the Consortium Member*]

Address: [*Insert address of the person executing this Undertaking on behalf of the Consortium Member*]

For:_____ [*insert name of Consortium Member*]

(*Signature*)

Name: _____ [*Insert name of the person executing this Undertaking on behalf of the Consortium Member*]

Title / Designation: _____ [*Insert title / designation of the person executing this Undertaking on behalf of the Consortium Member*]

Address: [*Insert address of the person executing this Undertaking on behalf of the Consortium Member*]

For:_____ [*insert name of Consortium Member*]

(*Signature*)

Name: _____ [*Insert name of the person executing this Undertaking on behalf of the Consortium Member*]

Title / Designation: _____ [*Insert title / designation of the person executing this Undertaking on behalf of the Consortium Member*]

Address: [*Insert address of the person executing this Undertaking on behalf of the Consortium Member*]

WITNESSES:

WITNESS 1:	**WITNESS 2:**
……	……
NAME:	NAME:
CNIC / PASSPORT NUMBER:	CNIC / PASSPORT NUMBER:
ADDRESS:	ADDRESS:

[6] Authorized representative of each Consortium Member is required to sign this Undertaking.

(To be executed by the authorized representatives of all the Consortium Members)

BIDDING FORM T6 – FORMAT OF AFFIDAVIT BY PROPOSED CONTRACTOR

Notes for Execution of Affidavit

- *The mode of execution of the Affidavit should be in accordance with the procedure, if any, laid down under applicable laws and the same should be under common seal affixed in accordance with the required procedure.*

- *The Affidavit is to be executed on a stamp paper of PKR 100/-; or if executed overseas, to adequately adhesive stamped when brought into Pakistan with a stamp duty of PKR 100/-.*

- *If executed in Pakistan, the Affidavit shall be notarised with the notary public and certified by the Oath Commissioner.*

- *For an Affidavit executed and issued overseas, the same will have to be notarized by Notary Public and attested by the Pakistani Embassy / Consulate in the country where the Affidavit is executed; and once brought into Pakistan, the same is to be attested by Ministry of Foreign Affairs, Pakistan and adhesive stamped.*

- *To be submitted by each Proposed Contractor / each consortium member of the Proposed Contractor.*

- *This Affidavit shall be witnessed by two (2) male witnesses or one (1) male and two (2) female witnesses or four (4) female witnesses.*

- *See Bidding Documentary Requirements set out in Part 3 (Bidding Documentary Requirements) of Volume I (Bidding Procedure) of the RFP.*

- *Bidders are required to ensure that the person issuing this affidavit on behalf of a Proposed Contractor (including a consortium member of a Proposed Contractor) has valid legal authority to execute the Affidavit on behalf of the Proposed Contractor or a consortium member of a Proposed Contractor.*

Please find below the form and substance of the Affidavit.

Affidavit

(this "**Affidavit**")

Date: _____

Re: Design, finance, build, rehabilitate, operate, maintain and transfer of the Karachi Hub Water Canal (the "**Project**").

Reference the Request for Proposals document issued on August 29, 2022, by Karachi Water and Sewerage Board, (the "**RFP**") in relation to the Project.

(1) I, [*in case of company, insert name of the authorized person and its designation*] of [*insert name of company*] / [*in case of sole proprietor, insert name of sole proprietor and its CNIC or Passport No.*] of [*insert name of sole proprietorship, if any*] / [*in case of partnership, insert name of authorized person and its CNIC or Passport No.*] of [*insert name of partnership, if any*] (the "**Entity**"), a [*in case of company / partnership, insert nature of company / partnership (if any)*]

duly organised and existing under the laws of [*Pakistan*] [*insert country of incorporation*] with its registered office located at [*insert registered address*], do hereby solemnly affirm, declare and state that:

(i) the Entity is not ineligible / blacklisted (due to reasons, including but not limited to corrupt practices and poor performance) by any Federal or Provincial governmental or non-governmental department / agency in Pakistan, or any other provincial government / governments of any foreign countries or their governmental bodies and / or International Organizations (e.g. World Bank, Asian Development Bank, United Nations, International Monetary Fund etc.) at the date of submission of this Affidavit;

(ii) the Entity is not included:

(i) as a debarred person pursuant to the public sanctions list of any multilateral development bank that is party to the Agreement on Mutual Enforcement of Debarment Decisions of 9 April 2010 (www.crossdebarment.org); or

(ii) on any sanctions lists promulgated by the UN Security Council or its Committees, or any other recognised international sanctions list;

(iii) no action, suit or other legal proceeding or governmental investigation is pending against the Entity or any of its respective officers, directors or employees, or that any of the foregoing has received any notice thereof, which questions the validity and execution of this Affidavit or the representations provided in this Affidavit;

(iv) the Entity has no tax liabilities or liabilities in respect of judgments awarded by any court or similar proceedings in the period of three (3) years prior to the date of this Affidavit, save in each case to the extent that it has made suitable accounting provision for such liabilities in accordance with applicable accounting regulations;

(v) the Entity has not directly or through an agent, engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the award of any contract, project or transaction;

(vi) the Entity is not in bankruptcy or liquidation proceedings or receivership, or wound up, or its affairs are not being administered by a court or a judicial officer, or its business activities have not been suspended or it is not the subject of legal proceedings of any of the foregoing and has a reasonable expectation of being able to discharge all financial liabilities as they fall due;

(vii) in case the Entity has been nominated as the Approved Contractor in terms of the RFP, the Entity shall execute all instruments as may be required to be executed by the Entity in relation to the Project as per the requirements of the RFP; and

(viii) there is no conflict of interest or potential conflict of interest arising from prior or existing contracts or relationships which could materially affect potential involvement of the Entity in the Project and to comply with the obligations set out in the RFP or with respect to the Project.

(2) That whatever stated above is true and correct to the best of my knowledge and belief and nothing has been concealed thereto.

All capitalized terms unless defined herein shall bear the meaning as ascribed thereto in the RFP.

_____

[Deponent

Verified on oath at _____ on this ____day of _____, 20___ that the contents of the above Affidavit are true and correct to the best of my knowledge and belief.]

[7]

_____

Deponent

Witnesses:

1. _____

Name: _____

Address:_____

_____

CNIC No.:_____

2. _____

Name: _____

Address:_____

_____

CNIC No.:_____

[7] Bidders to note that in case this Affidavit is executed outside Pakistan, such verification will not be required.

BIDDING FORM T7 – TECHNICAL PROJECT METHODOLOGY / APPROACH

This form must respond to the entire scope of work for the Project described in Volume II (*Technical Specifications*) of the RFP.

The Bidder must outline the proposed technical approach / methodology to design, carry out the construction works and operations of the Project during C&O Period and O&M Period. The approach paper should articulate what added value the Bidder will provide in achieving the stated objectives for the Project and how compliance with requirements set out in the RFP (including Volume II (*Technical Specifications*) of the RFP will be achieved.

The Bidder must explain its understanding of the objectives and requirements of the Project, highlight the issues of importance, and explain the technical approach it would adopt to address such issues. The approach paper should explain the methodologies and technologies which are to be adopted and demonstrate the compatibility of those with the proposed approach, making it clear that only proven and reliable technologies will be used for the implementation of the Project. The approach should also indicate how risks will be managed and what contribution will be made regarding value engineering and management.

The Bidder must attach its approach paper as Bidding Form T7 (*Technical Project Methodology / Approach*). The approach paper should not be longer than 25 pages.

BIDDING FORM T8 – OPERATION & MAINTENANCE PLAN AND PROCEDURES

Bidders are required to develop an outline a Management, Operation & Maintenance (MOM) Plan which is specific to the Project and details the approach and procedures to be implemented as part of the Project to ensure overall efficient operations and maintenance of the Project, after commissioning, during the Operating Period, as well as define adequate management structures to ensure compliance with best practices.

A MOM Plan should include, as a minimum, the Bidder's approach towards overall asset management, monitoring and maintenance which should be integrated with an outline control philosophy for the infrastructure which considers interfaces with supporting utilities and intelligent solutions to optimize efficiencies where possible.

Such a plan should also detail the daily and monthly reports and communication protocols which will be provided to KW&SB in terms of performance specification compliance as well as operational and maintenance monitoring reporting in compliance with the requirements specified in Volume II (*Technical Specifications*) of the RFP.

The Bidder must attach its outline of the MOM Plan as Bidding Form T8 (*Operation & Maintenance Plan and Procedure*). The MOM plan should not be longer than 15 pages.

BIDDING FORM T9 – IMPLEMENTATION SCHEDULE

The Bidders are required to submit a detailed estimated implementation schedule of the proposed works to be attached as Bidding Form T9 (*Implementation Schedule*). The implementation schedule should detail, as minimum, the main planning and delivery components of the Project from inception up to the construction completion, operation and maintenance, plus the final handover to KW&SB, considering all aspects of the Project including long lead time items, time related to approvals, etc., each in accordance with the requirements of the RFP (including the Concession Agreement) The implementation schedule should also clearly indicate the Project's critical path. Compliance with the timelines set out in Appendix 2 (*Implementation Schedule*) shall be required to be ensured while preparing this Bidding Form T9 (*Implementation Schedule*).

Name of Bidder: _____

Signature: …….

[Seal]

BIDDING FORM T10 – LIST OF MANUFACTURERS OF MAIN EQUIPMENT

The Bidders shall list in the table below the proposed manufacturers for the main equipment specified in the Part 3 (*Technical Functional Specifications*) of Volume II (*Technical Specifications*) of the RFP.

Equipment	Name of Manufacturer	Address of Manufacturer	Years of Experience of the Manufacturer for the Equipment Proposed

The minimum main equipment to be considered when proposing manufacturers, but not limited to, the following:

- Metering equipment (flowmeters, online water quality metering, etc.)
- Piping (main transmission pipeline, pumping station, water treatment plant, etc.)
- Mechanical equipment (pumps, valves, blowers, etc.)
- Electrical equipment (transformers, motor control center (MCC), etc.)
- Instrumentation and control equipment (Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA) system, etc)

Name of Bidder: _____

Signature: …….

[Seal]

BIDDING FORM T11 – SCHEDULE OF EQUIPMENT & TECHNOLOGY SUPPLIERS

The Bidders shall list in the table below the proposed equipment & technology suppliers to be engaged for the Project and include any relevant documents (specifically Quality Control Certification i.e. ISO 9001), data sheets, performance guarantees and warranties relevant to major components and equipment specified in the Part 3 (*Technical Functional Specifications*) of Volume II (*Technical Specifications*) of the RFP.

Name of the Proposed EPC Contractor	**Component / Major Equipment**	**Details of Equipment Supplier (Name, Country, Contact, Quality Control Accreditation/Certification, etc.)**	**Data Sheets submitted [Y/N]**	**Estimated lead time for equipment delivery**

The minimum main equipment to be considered includes, but is not limited to, the following:

- Metering equipment (flowmeters, online water quality metering, etc.)
- Piping (main transmission pipeline, pumping station, water treatment plant, etc.)
- Mechanical equipment (pumps, valves, blowers, etc.)
- Electrical equipment (transformers, motor control center (MCC), etc.)
- Instrumentation and control equipment (Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA) system, etc)

Name of Bidder: _____

Signature: …….

[Seal]

BIDDING FORM T12 – ORGANIZATION & STAFFING

The Bidders should propose the structure and composition of their team i.e., the main disciplines involved, the key staff member / expert responsible for each discipline, and the proposed managerial, technical and support staff and site staff. The roles and responsibilities of each key staff member / expert should be set out as job descriptions. In the case of an association / joint venture / consortium, it should, indicate how the duties and responsibilities are to be shared.

The Bidder shall list in the table below the key personnel to be engaged for the Project and include any relevant document required to demonstrate the suitable level of experience and qualifications for each role and project responsibilities.

Role	Project Responsibility	Name	Nationality	Qualifications	Working years in the entity	Years of relevant experience

Name of Bidder: _____

Signature: …….

[Seal]

BIDDING FORM T13 – QUALITY CONTROL PRACTICES AND PROCEDURES

The quality control practices and procedures which will ensure compliance with the Project requirements and international best practices, should be attached as Bidding Form T13 (*Quality Control Practices and Procedures*).

Bidders should briefly outline their procedures in relation to the Project and attach any relevant documentation such as ISO 9001 certification, etc.

The quality control practices and procedures paper should not be longer than 5 pages.

BIDDING FORM T14 – HEALTH & SAFETY PLAN AND PROCEDURES

Bidders are required to develop an outline health & safety plan which is specific to the Project and details the approach and procedures to be implemented as part of the Project to ensure the overall health and safety compliance with international best practices and other applicable laws, including the Environmental and Social Standards (as specified in the Concession Agreement) applied throughout the Project lifecycle.

The health & safety plan should also include an outline methodology of risk assessments, health & safety audits, safety check lists and confirmation that all necessary allowances have been made for these procedures and the required personal protective and other equipment, training, inductions and control, etc.

Bidders should briefly outline their procedures in relation to the Project and attach any relevant documentation such as OSHAS 18001 certification, etc.

The Bidder must attach details regarding health and safety plan and procedure as Bidding Form T14 (*Health & Safety Plan and Procedures*), which should not be longer than 5 pages.

BIDDING FORM T15 – METHODOLOGY APPROACH FOR THE ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN AND PROCEDURES

Bidders are required to develop an outline Environmental & Social Management Plan (ESMP) which is specific to the Project and sets out the approach and procedures to be implemented as part of the Project to ensure protection of the environment and community as well as compliance with relevant international best practices and the Laws. Bidders should review the requirements set out in Volume II (*Technical Specifications*) of the RFP while preparing this form.

The ESMP should include the approach to develop the Project ESIA and an indication of how this plan will be developed and audited to ensure compliance. Confirmation should be provided that all necessary allowances have been made for these procedures.

Bidders should briefly outline their procedures in relation to the project and attach any relevant documentation such as ISO 14001 certification, etc.

The Bidder must attach relevant details as Bidding Form T15 (*Methodology Approach for the Environmental & Social Management Plan and Procedures*), which should not be longer than 15 pages.

BIDDING FORM T16 – OTHER TECHNICAL DATA SUBMISSION

Bidders shall attach to any additional relevant technical data including process descriptions, designs calculations, drawings, specifications, data sheets etc., which should be summarized, clear and practically grouped per section of the proposed works for ease of evaluation, in each case as per the requirements of the RFP.

The Bidder must attach relevant details as Bidding Form T16 (O*ther technical data submission*), which should not be longer than 10 pages.

BIDDING FORM T17 – PROJECT REFERENCES OF PROPOSED EPC CONTRACTOR

Bidders shall attach to this form information that describes the Proposed EPC Contractor's background and experience in similar works. A summary table shall be provided for each project or reference, and relevant documents shall be attached herein as evidence (completion certificates, technical reports, etc.).

Note: Please do not include projects under development or under construction or projects executed more than 15 years ago.

Suitable relevant project experience with specific details of the Proposed EPC Contractor	**Two (2) water supply or sanitation projects which include one (1) pipeline of 5 km with minimum diameter of 600 mm**	**One (1) water supply project which include canal new execution or rehabilitation, with more than 10 km length and with a design flow of at least 20 MGD**	**One (1) water pumping station installation, new execution or rehabilitation, with a design flow of at least 20 MGD**	**One (1) water filtration/sewage treatment/wastewater treatment/desalination plant, new execution or rehabilitation, having a design flow of at least 20 MGD**	**In case solar PV plant is proposed in the Technical Proposal, one (1) solar PV plant, with a minimum capacity of 5 MW**
[*Insert name of the Project*]	[Y/N]	[Y/N]	[Y/N]	[Y/N]	[Y/N]
[*Insert name of the Project*]	[Y/N]	[Y/N]	[Y/N]	[Y/N]	[Y/N]

PROJECT DETAILS

Name of plant/project	**Location and country of project**	**Description (overview) of the project /plant along with project/plant components**	**Scope of work undertaken by the Proposed EPC Contractor**	**Date of plant/project commercial operation**	**Ownership in plant/project (if applicable)**
[one line per plant /project]					

Name of Developer counterparty, organization and / or individual for reference.	Capacity of plant /project	Project cost (USD)[8]	Name of project company	Value of contract (USD)[9]	Principal manufacturers of main equipment	Duration of construction period
[one line per plant /project]						

[8] **Note:** For conversion of values in USD, the exchange rate will be calculated using the January month-end exchange rates as specified in the 'Month-End Ex for the relevant year of the project commercial operations. Rates in 'US $' tab in the file uploaded by State Bank of Pakistan which can be accessed using the following link https://www.sbp.org.pk/ecodata/IBF_Arch.xls. For currencies not mentioned in the file, Bidders are advised to contact GoS/KW&SB and relevant conversion rates shall be provided.

[9] **Note:** For conversion of values in USD, the exchange rate will be calculated using the January month-end exchange rates as specified in the 'Month-End Ex for the relevant year of the project commercial operations. Rates in 'US $' tab in the file uploaded by State Bank of Pakistan which can be accessed using the following link https://www.sbp.org.pk/ecodata/IBF_Arch.xls. For currencies not mentioned in the file, Bidders are advised to contact GoS/KW&SB and relevant conversion rates shall be provided.

BIDDING FORM T18 – PROJECT REFERENCES OF PROPOSED O&M CONTRACTOR

Bidders shall attach to this form information that describes the Proposed O&M Contractor's background and experience in similar works. A summary table shall be provided for each project or reference, and relevant documents shall be attached herein as evidence (completion certificates, technical reports, cover letters, etc.).

Note: Bidders may include concession or operation and maintenance projects under development specifying the period in which the Proposed O&M Contractor has provided services which shall not be beyond 15 years.

Suitable relevant project experience with specific details of the Proposed O&M Contractor	**One (1) water supply or sanitation project which include one (1) pipeline of 5 km with minimum diameter of 600 mm and with a design flow of at least 10 MGD**	**One (1) water supply project which include canal with more than 5 km length and with a design flow of at least 10 MGD**	**One (1) water pumping station with a design flow of at least 10 MGD**	**One (1) water filtration/sewage treatment/wastewater treatment/desalination plant having a design flow of at least 10 MGD**	**In case solar PV plant is proposed in the Technical Proposal, one (1) solar PV plant, with a minimum capacity of 5 MW**
[*Insert name of the Project*]	[Y/N]	[Y/N]	[Y/N]	[Y/N]	[Y/N]
[*Insert name of the Project*]	[Y/N]	[Y/N]	[Y/N]	[Y/N]	[Y/N]

PROJECT DETAILS

Name of plant/project	**Location and country of project**	**Description (overview) of the project /plant along with project/plant components**	**Scope of work undertaken by the Proposed O&M Contractor**	**Date of plant/project commercial operation**	**Ownership in plant/project (if applicable)**
[one line per plant /project]					

Name of Developer counterparty, organization and / or individual for reference.	**Capacity of plant /project**	**Number of employees (total)**	**Name of project company**	**Annual operating budget (USD million)[10]**	**Period, in which the contractor provided operations and maintenance services**
[one line per plant /project]					

[10] **Note:** For conversion of values in USD, the exchange rate will be calculated using the January month-end exchange rates as specified in the 'Month-End Ex for the relevant year of the project commercial operations. Rates in 'US $' tab in the file uploaded by State Bank of Pakistan which can be accessed using the following link https://www.sbp.org.pk/ecodata/IBF_Arch.xls. For currencies not mentioned in the file, Bidders are advised to contact GoS/KW&SB and relevant conversion rates shall be provided.

BIDDING FORM T19 – NET WORTH REQUIREMENTS OF PROPOSED CONTRACTOR

NET WORTH REQUIREMENTS OF PROPOSED CONTRACTOR[11]						
	[2021]		**[2020]**		**[2019]**	
Currency	**In currency of the financial statements** [insert name of currency] **Million**	**In USD Million**	**In currency of the financial statements** [insert name of currency] **Million**	**In USD Million**	**In currency of the financial statements** [insert name of currency] **Million**	**In USD Million**
Exchange rate (in comparison to financial statements currency)		[Financial statement currency to USD]		[Financial statement currency to USD]		[Financial statement currency to USD]
Total Assets (for three most recent full financial years)						
Total Liabilities (for three most recent full financial years)						
Revaluation Surplus (or similar entry)						
Net Worth						

[11] For financial statements in currencies other than USD, the financial statements in USD, for the purposes of completing Form T19 (*Net Worth Requirements of Proposed Contractor*), will be calculated using the **December month-end** exchange rates for the relevant year as specified in the 'Month-End Ex. Rates in USD' tab in the file uploaded by State Bank of Pakistan which can be accessed using the following link https://www.sbp.org.pk/ecodata/IBF_Arch.xls. For currencies not mentioned in the file, Bidders are advised to contact GoS/KW&SB and relevant conversion rates shall be provided.

B. FINANCIAL PROPOSAL BIDDING FORMS

BIDDING FORM F1 – LETTER OF FINANCIAL PROPOSAL

[Date]

To: **Karachi Water and Sewerage Board, Government of Sindh**
Project Director – Karachi Hub Water Canal Project
Room No. 26, 1st Floor, Block B,
Office of The Karachi Water & Sewerage Board,
9th Mile, Karsaz, Karachi, Pakistan.

Re: Design, finance, build, rehabilitate, operate, maintain and transfer of the Karachi Hub Water Canal (the "**Project**").

Dear [Sir/Madam],

Reference the Request for Proposals document issued on August 29, 2022, by Karachi Water and Sewerage Board ("**KW&SB**"), (the "**RFP**") in relation to the Project.

We, [*Name of the Bidder*] hereby submit our Financial Proposal in conformity with the requirements of the RFP.

All capitalized terms unless defined herein shall bear the meaning as ascribed thereto in the RFP.

We, agree, confirm, undertake and declare that:

(a) We have examined and have no reservations to the RFP, including Addenda No(s) [●] / Corrigenda No(s) [●].

(b) We, [including all Consortium Members,] fully and completely understand and accept the terms of the RFP and hereby undertake to comply with the requirements specified therein.

(c) Our Bid Price, comprising of NPV of Service Payments and GoS Equity Amount, inclusive of all federal, provincial and local duties, levies and taxes is **PKR [*insert amount in figures*]/- (Pakistani Rupees [*insert amount in words*] only)**, where NPV of Service Payments is **PKR [*insert amount in figures*]/- (Pakistani Rupees [*insert amount in words*] only)** and GoS Equity Amount is **PKR [*insert amount in figures*]/- (Pakistani Rupees [*insert amount in words*] only)**.

(d) The Total Project Cost[12] based on our Financial Proposal (read with our Technical Proposal) is **PKR [*insert amount in figures*]/- (Pakistani Rupees [*insert amount in words*] only)**.

(e) We offer to perform and undertake the works and services in respect of the Project in conformity with the RFP, including the Concession Documents, without any omission, reservation and deviation; and we accept and undertake to comply with all requirements in the RFP including the appendices / annexures attached to the RFP.

(f) As security for due performance of the undertakings and obligations of this Bid, we submit

[12] Total Project cost should be equal to the sources of funding including GoS Equity Amount, local and foreign equity (including sponsor loan) and local and foreign debt. The Total Project Cost should be consistent with the figure stated in Bidding Form F3-I (*Sources and Uses*).

unconditionally herewith a Bid Security equivalent to PKR [●]/- (Pakistani Rupees [●] only) (i.e., one percent (1%) of the Bid Price) drawn in your favour or made payable to you and valid for a period twenty-eight (28) days beyond the period of validity of Bid. We confirm that the Bid Security has been issued and maintained in accordance with the requirements of the RFP.

(g) We, [including all Consortium Members,] and the Contractors, as per the requirements of the Prequalification Document and the RFP, respectively:

(i) have nationalities of Eligible Countries;

(ii) do not have any conflict of interest; and

(iii) have not been declared ineligible/blacklisted by any of our employers, by any Federal or Provincial governmental or non-governmental department / agency in Pakistan, [or any other provincial government / governments of any foreign countries or their governmental bodies and / or International Organizations (e.g., World Bank, Asian Development Bank, United Nations, International Monetary Fund etc.)], as at the Bid Submission Date.

(h) Neither we, [including all Consortium Members, any Affiliate], nor the Contractors:

(i) are included as a debarred person pursuant to the public sanctions list of any multilateral development bank that is party to the Agreement on Mutual Enforcement of Debarment Decisions of 9 April 2010 (www.crossdebarment.org); or

(ii) are included on any sanctions lists promulgated by the UN Security Council or its Committees, or any other recognised international sanctions list,

(i) Our Bid consisting of the Technical Proposal and the Financial Proposal shall be valid for a period of one hundred twenty (120) days from the date fixed for the Bid Submission Date in accordance with the RFP, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

(j) We understand that all the volumes, appendices / annexures attached to the RFP are integral parts of the RFP.

(k) We have reviewed and accepted the form of the Concession Agreement along with the Appendices attached thereto (attached as Volume III (*Concession Agreement and Appendices*) and form of the EFU Agreement along with the appendices attached thereto (attached as Volume IV (*EFU Agreement*)) to the RFP) and undertake to execute the same within the time period stipulated in Notification of Award.

(l) We hereby:

(i) acknowledge and consent to any actual, potential or perceived conflicts of interests arising as a result of the multiple current or prospective roles of IFC, MIGA and IDA in connection with the development, delivery and financing of the Project, or in connection with any pre-existing financial or advisory relationships between an institution of the World Bank Group and a prospective Bidder [(including the Consortium Members)] (or its Affiliate), KW&SB and the GoS;

(ii) waive any liability to which any World Bank Group institution might otherwise be

subject in connection with such actual, potential or perceived conflicts of interest; and

(iii) consent to the sharing of any information provided to or created by IFC in connection with the proposed financing of the Project among IFC, IDA and MIGA staff members engaged in the proposed financing of the Project.

(m) We acknowledge that KW&SB (and the GoS) will be relying on the information provided in our Prequalification Application and our Bid and the documents accompanying them to determine the Successful Bidder. We certify that all information provided in our Prequalification Application and our Bid is true and correct and that nothing has been omitted which renders such information misleading.

(n) We continue to satisfy and meet all the requirements specified in the Prequalification Document, including the qualifications requirements set out in the Prequalification Document and in our Prequalification Application and there has been no material event relating to us or, if we are a Consortium, to any of our Consortium Members, which would require disclosure to KW&SB (and the GoS) or which might cause us to fail to become a Prequalified Applicant.

(o) We understand that this Bid, together with your written acceptance thereof included in your Notification of Award, shall constitute a binding contract between us, until the Concession Agreement (attached as Volume III (*Concession Agreement and Appendices*) to the RFP) is executed.

(p) We are not participating, as a Bidder in more than one Bid in this Bidding Process in accordance with the requirements of the RFP.

(q) We understand that KW&SB may cancel the Bidding Process at any time and that KW&SB is not bound either to accept any Bid that it may receive, without incurring any liability to the Bidders.

(r) We agree to permit KW&SB, the GoS and any persons, representatives or auditors appointed and authorized by KW&SB and / or the GoS to inspect and audit our accounts, records and other documents relating to our Bid.

(s) All the information submitted along with our Bid, including the enclosed forms and documents, is accurate in all respects.

(t) We accept the right of KW&SB to: (i) request additional information reasonably required to assess the Bid; (ii) amend the procedures and requirements or make clarifications thereof; and (iii) extend or amend the timelines as stipulated in the RFP.

(u) All information, representations and other matters of fact communicated (whether in writing or otherwise) to KW&SB by us or on our behalf, in connection with or arising out of the Bid are true, complete and accurate in all respects.

(v) We hereby declare that all the information and statements made in this Bid are true and accept that any misrepresentation contained in it shall lead to our disqualification, forfeiture of the Bid Security and / or our blacklisting by the KW&SB.

(w) We, [including all Consortium Members,] have made our own investigations and research and have satisfied ourselves in respect of all matters (whether actual or contingent) relating to the Bid and the Project.

(x) We undertake, if our Bid is accepted, to furnish the C&O Performance Security as per the requirements of the RFP.

(y) We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other person or persons making a Bid for the Project.

(z) We understand that the RFP has been issued by KW&SB for the Project; and undertake and confirm that if our Bid is accepted, we and the SPV (to be incorporated by us, in case the Project is awarded to us), as applicable, shall execute the Concession Agreement (including other applicable Concession Documents) (attached as Volume III (*Concession Agreement and Appendices*) and the EFU Agreement (attached as Volume IV (*EFU Agreement*)) to the RFP and all other instruments as may be required to be executed in relation to the Project as per the requirements of the RFP.

(aa) We acknowledge that in case the Project is awarded to us, we shall be liable to pay IFC Advisory Fee in the manner specified in the Notification of Award, within thirty (30) days of issuance of the relevant invoice by IFC, after the issuance of Acceptance of Notification of Award.

(bb) We confirm that the financial model advisor, who has issued the letter required in terms of Sub-Section 4.5.3(e) of the Instructions to Bidders, and attached with our Financial Proposal, meets the criteria for financial model advisor as specified in Sub-Section 4.5.3(e) of the Instructions to Bidders.

Name .....

In the capacity of .....

Signed .....

…….. (Seal)…

Duly authorized to sign the Bid for and on behalf of: (*Insert Name of the Bidder/names of all Consortium Members*)

Date .....

Witness # 1:	**Witness # 2:**
Signature: _____	Signature: _____
Name: _____	Name: _____
Designation: _____	Designation: _____
Date: _____	Date: _____
CNIC/Passport No.:_____	CNIC/Passport No.:_____

BIDDING FORM F2 – FORM OF BID SECURITY

BANK GUARANTEE

Guarantee No._____

(hereinafter referred to as the "**Bank Guarantee**")

Executed on _____

Expiry date _____

Name of Guarantor (Bank) with address:_____

[Name of Principal (Bidder) with address:][13] _____

_____

Guaranteed Amount (express in words and figures):_____

_____

Date of Bid _____

The above premised, we (the "**Guarantor Bank**") hereby undertake irrevocably and unconditionally on demand to pay to the Karachi Water & Sewerage Board ("**KW&SB**"), without any notice, reference or recourse to the Bidder or to any other entity or without any recourse or reference to any document, agreement, instrument or deed, any sum or sums (or any part thereof) equivalent in aggregate up to but not exceeding a maximum amount of:

[●] [●]/- ([●][●])

(the "**Guaranteed Amount**")

at sight and immediately upon the receipt of the KW&SB's first written demand (the "**Demand**") at the Guarantor Bank's offices located at [●] or through SWIFT instructions transmitted by KW&SB's bank on behalf of KW&SB, to the Guarantor Bank, or through fax sent by KW&SB at the Guarantor Bank's fax number i.e., [●], such Demand stating:

(a) that the Bidder is in breach of its obligations towards KW&SB; and

(b) the total amounts demanded.

A Demand shall only be honoured by us: (i) in the case of a written Demand, if it is made by and bears the signature of an authorised officer or other representative of KW&SB; or (ii) in the case of a Demand transmitted through SWIFT, if it is transmitted through authenticated SWIFT instructions by KW&SB's bank on behalf of KW&SB; or (iii) in the case of a Demand made through fax, it is made by and bears the signature of an authorised officer or other representative of KW&SB.

[13] Bidders to note that the Bid Security may be issued by any Consortium Member.

We, the Guarantor Bank, shall unconditionally honour a Demand hereunder made in compliance with this Bank Guarantee at sight and immediately on the date of receipt of your Demand, as stated earlier, and shall transfer the amount specified in the Demand to the bank account, as notified in the Demand, in immediately available and freely transferable funds in the currency of this Bank Guarantee, free and clear of and without any set-off or deduction for or on account of any present or future taxes, levies, imposts, duties, charges, fees, deductions or withholdings of any nature whatsoever and by whomsoever imposed.

This Guarantee shall come into force and shall become automatically effective upon its issuance.

Such demand must be received by us on or before the [●] (the "**Expiry Date**"), when this Bank Guarantee shall expire and shall be returned to us.

Upon expiry, this Bank Guarantee shall be returned to the Bidder without undue delay. Multiple Demands may be made by KW&SB under this Bank Guarantee, but our aggregate liability will be restricted up to the Guaranteed Amount.

We hereby agree that any amendment, renewal, extension, modification, compromise, release or discharge by mutual agreement by KW&SB, the Bidder or any other entity of any document, agreement, instrument or deed shall not in any way impair or affect our liabilities hereunder and maybe undertaken without notice to us and without the necessity for any additional endorsement, consent or guarantee by us.

This Bank Guarantee for its validity period shall not be affected in any manner by any change in our constitution or of the Bidder's constitution or of their successors and assignees and this Bank Guarantee shall be legally valid, enforceable and binding on each of their successors and permitted assignees.

All references to any contract, agreement, deed or other instruments or documents are by way of reference only and shall not affect our obligations to make payment under the terms of this Bank Guarantee.

If one or more of the provisions of this Bank Guarantee are held or found to be invalid, illegal, or unenforceable for any reason whatsoever, in any respect, any such invalidity, illegality, or unenforceability of any provision shall not affect the validity of the remaining provisions of this Bank Guarantee.

The Guarantor Bank hereby declares and confirms that under its constitution and applicable laws and regulations, it has the necessary power and authority, and all necessary authorizations, approvals and consents thereunder to enter into, execute, deliver and perform the obligations it has undertaken under this Bank Guarantee, which obligations are valid and legally binding on and enforceable against the Guarantor Bank under the laws of Pakistan.

Further, the Guarantor Bank hereby declares and confirms that the signatory(ies) to this Guarantee is/are its duly authorized officer(s) to execute this Guarantee.

This Bank Guarantee and all rights and obligations arising from this Bank Guarantee shall be governed and construed in all respects in accordance with the laws of Pakistan. The courts in Pakistan shall have exclusive jurisdiction in respect of any dispute relating to any matter contained herein.

The issuance of this Bank Guarantee is permitted according to the laws of Pakistan and the laws of the jurisdiction where this Bank Guarantee is issued.

This Bank Guarantee is subject to the Uniform Rules for Demand Guarantee, ICC Publication No.758. To the extent that there is any inconsistency between the terms of this Bank Guarantee and the Uniform Rules for Demand Guarantees, ICC Publication No. 758, the terms of this Bank Guarantee shall prevail.

Name: …….

Designation: ……...

BIDDING FORM F3 –FINANCIAL FORMS

Bidding Form F3 (*Financial Forms*) comprises of the following forms:

(A) Bidding Form F3-A – Projected Available NWO

(B) Bidding Form F3-B – Cost Recovery Charges

(C) Bidding Form F3-C – Electricity

(D) Bidding Form F3-D – Availability Payment

(E) Bidding Form F3-E – Output Payment

(F) Bidding Form F3-F – Service Payment and NPV

(G) Bidding Form F3-G – Termination Payments

(H) Bidding Form F3-H – Financing Term Sheet

(I) Bidding Form F3-I – Sources and Uses

***Notes for filling in the forms in Bidding Form F3 (Financial Forms)*:**

Capitalized terms (including the abbreviations) used in the aforesaid forms, shall have the meaning given to them in Concession Agreement (including appendix 8 of the Concession Agreement).

The aforementioned forms are required to be prepared in Microsoft Excel file. Bidders are required to fill in the Bidding Forms F3-A to F3-G and F3-I available at the following websites:

SPPRA – https://ppms.pprasindh.gov.pk/PPMS/

PPP Unit – https://www.pppunitsindh.gov.pk/

KW&SB – https://www.kwsb.gos.pk

Bidders are also required to submit hard copies (as printouts) of the forms in Bidding Form F3 (Financial Forms). Note that hard copies of the forms in Bidding Form F3 (Financial Forms) submitted by the Bidders shall prevail over soft copies in case of inconsistency.

BIDDING FORM F3-A – PROJECTED AVAILABLE NWO

			Contracted Available Net Water Output	Hours in Contract Year		Projected Loss of Net Water Output due to Unavailability				Projected Available Net Water Output
				Summer	Winter	Summer - Unplanned	Winter - Planned	Winter - Unplanned	Total	
			m3/day	hours	hours	m3	m3	m3	m3	m3
	Year		Year	CAW	PHs	PHw	$LCWp_{ns}$	$LCWp_{nw}^{P}$	$LCWp_{nw}^{U}$	$LCWp_{n} = LCWp_{ns} + LCW_{pnw}^{P} + LCW_{pnw}^{U}$	$ANWO_{pn}$
C&O Period	1	Concession Year	1	454,609	4,380	4,380	1,818,436	909,218	1,818,436	4,546,090	161,386,195
	1.5		1.5	454,609	2,190	2,190	909,218	454,609	909,218	2,273,045	80,693,098
Operating Period	1		2.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	2		3.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	3		4.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	4		5.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	5		6.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	6		7.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	7		8.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	8		9.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	9		10.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	10		11.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	11		12.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	12		13.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	13		14.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	14		15.5	454,609	4,380	4,380	-	-	-	-	165,932,285
	15		16.5	454,609	4,380	4,380	-	-	-	-	165,932,285

Note: The values for Summer - Unplanned (LCWpns), Winter - Planned (LCWpnwP) and Winter - Unplanned (LCWpnwU) each, during the Operating Period are, subject to the maximum limit of 909,218 m^3

	Input to be provided by bidders
	Input provided by KWSB
	Output

BIDDING FORM F3-B – COST RECOVERY CHARGES

	Year		Year	Indexation Year	Cost Recovery Charges (before indexation/adjustment)								Devaluation Factor	Inflation Factor	Cost Recovery Charges (after indexation/adjustment)								
					Foreign Debt Principal Recovery Charge	Foreign Debt Interest Recovery Charge	Local Debt Principal Recovery Charge	Local Debt Interest Recovery Charge	Foreign Equity Recovery Charge	Local Equity Recovery Charge	Fixed O&M Cost Recovery Charge	Variable O&M Cost Recovery Charge											
					PKR/ m3	PKR/ m3	PKR/ m3	PKR/ m3	PKR/ m3	PKR/ m3	PKR/ m3	PKR/ m3											
					FD_P_RC	FD_I_RC	LD_P_RC	LD_I_RC	FE_RC	LE_RC	FOMRW	VOMRW	EXR	IR	Year	FD_P_RC	FD_I_RC	LD_P_RC	LD_I_RC	FE_RC	LE_RC	FOMRW	VOMRW
C&O Period	1		1	1	-	-	-	-	-	-	-	-	1.00	1.00	1	-	-	-	-	-	-	-	-
	1.5		1.5	1.5	-	-	-	-	-	-	-	-	1.04	1.04	1.5	-	-	-	-	-	-	-	-
Operating Period	1	Concession Year	2.5	2.5	-	-	-	-	-	-	-	-	1.14	1.14	1	-	-	-	-	-	-	-	-
	2		3.5	3.5	-	-	-	-	-	-	-	-	1.24	1.24	2	-	-	-	-	-	-	-	-
	3		4.5	4.5	-	-	-	-	-	-	-	-	1.35	1.35	3	-	-	-	-	-	-	-	-
	4		5.5	5.5	-	-	-	-	-	-	-	-	1.47	1.47	4	-	-	-	-	-	-	-	-
	5		6.5	6.5	-	-	-	-	-	-	-	-	1.61	1.61	5	-	-	-	-	-	-	-	-
	6		7.5	7.5	-	-	-	-	-	-	-	-	1.75	1.75	6	-	-	-	-	-	-	-	-
	7		8.5	8.5	-	-	-	-	-	-	-	-	1.91	1.91	7	-	-	-	-	-	-	-	-
	8		9.5	9.5	-	-	-	-	-	-	-	-	2.08	2.08	8	-	-	-	-	-	-	-	-
	9		10.5	10.5	-	-	-	-	-	-	-	-	2.27	2.27	9	-	-	-	-	-	-	-	-
	10		11.5	11.5	-	-	-	-	-	-	-	-	2.47	2.47	10	-	-	-	-	-	-	-	-
	11		12.5	12.5	-	-	-	-	-	-	-	-	2.69	2.69	11	-	-	-	-	-	-	-	-
	12		13.5	13.5	-	-	-	-	-	-	-	-	2.94	2.94	12	-	-	-	-	-	-	-	-
	13		14.5	14.5	-	-	-	-	-	-	-	-	3.20	3.20	13	-	-	-	-	-	-	-	-
	14		15.5	15.5	-	-	-	-	-	-	-	-	3.49	3.49	14	-	-	-	-	-	-	-	-
	15		16.5	16.5	-	-	-	-	-	-	-	-	3.80	3.80	15	-	-	-	-	-	-	-	-

Input to be provided by bidders

Input provided by KWSB

Output

Note: In respect of Foreign Equity Recovery Charge (FE_RC) above, the foreign exchange indexation shall only be applied to lower of: (a) actual equity of the Foreign Sponsor (defined in Volume I/RFP); and (b) seventy percent (70%) of the total equity (excluding VGF)

BIDDING FORM F3-C – ELECTRICITY

				Contracted Specific Net Electrical Energy Consumption	Contracted Specific Net Solar Generation												
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
				kWh/m3	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
	Year		Year	ECR_{CCn}	ESG												
C&O Period	1	Concession Year	1	0.35													
	1.5		1.5	0.35													
Operating Period	1		2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2		3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3		4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4		5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5		6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6		7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7		8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	8		9.5	-	-	-	-	-	-	-		-	-	-	-	-	-
	9		10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10		11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11		12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12		13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13		14.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14		15.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15		16.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: The values for Contracted Specific Net Electrical Energy Consumption (ECRccn) during the Operating Period are subject to the maximum limit of 0.3

	Input to be provided by bidders
	Input provided by KWSB
	Output

BIDDING FORM F3-D - AVAILABILITY PAYMENT

			Projected Available Net Water Output	Local Principal Repayment	Local Interest Payment	Total Local Debt Service	Foreign Principal Repayment	Foreign Interest Payment	Total Foreign Debt Service	Total Debt Service	Local Equity Component	Foreign Equity Component	Total Equity Component	Capital Cost Recovery Payment	Fixed O&M Cost Recovery Payment	Availability Payment
			m3	PKR	PKR	PKR	PKR	PKR	PKR	PKR	PKR	PKR	PKR	PKR	PKR	PKR
	Year		Year	ANWOpn	LPR	LIP	LDSY = LPR+LIP	FPR	FIP	FDSY = FPR+FIP	TDSY = (LDSY+AFDSY)	LE	FE	AEY = AFE + LE	AW	BW	APW=AW + BW
C&O Period	1		1	161,386,195													
	1.5		1.5	80,693,098													
Operating Period	1	Concession Year	2.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	2		3.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	3		4.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	4		5.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	5		6.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	6		7.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	7		8.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	8		9.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	9		10.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	10		11.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	11		12.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	12		13.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	13		14.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	14		15.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-
	15		16.5	165,932,285	-	-	-	-	-	-	-	-	-	-	-	-	-

Input to be provided by bidders
Input provided by KWSB
Output

BIDDING FORM F3-E – OUTPUT PAYMENT

	Year		Year	Indexation Year	Net Water Input	Allowable Non Revenue Water (NRW)	Net Water Output	Electricity Price	Electricity Price Growth Rate	Project Electricity Consumption	Electricity Consumption Payment	Variable O&M Cost Recovery Payment	Output Payment
					m3	%	m3	PKR/kWh		kWh	PKR	PKR	PKR
					NWI	ANRW	W	EP	EPI	PEC	CW	DW	OPW = CW + DW
C&O Period	1	Concession Year	1	1	161,386,195	25.00%	121,039,646	38.00	1.00	42,363,876	1,609,827,295	-	1,609,827,295
	1.5		1.5	1.5	80,693,098	25.00%	60,519,823	38.00	1.04	21,181,938	840,354,519	-	840,354,519
Operating Period	1		2.5	2.5	165,932,285	0.00%	165,932,285	38.00	1.14	-	-	-	-
	2		3.5	3.5	165,932,285	0.00%	165,932,285	38.00	1.24	-	-	-	-
	3		4.5	4.5	165,932,285	0.00%	165,932,285	38.00	1.35	-	-	-	-
	4		5.5	5.5	165,932,285	0.00%	165,932,285	38.00	1.47	-	-	-	-
	5		6.5	6.5	165,932,285	0.00%	165,932,285	38.00	1.61	-	-	-	-
	6		7.5	7.5	165,932,285	0.00%	165,932,285	38.00	1.75	-	-	-	-
	7		8.5	8.5	165,932,285	0.00%	165,932,285	38.00	1.91	-	-	-	-
	8		9.5	9.5	165,932,285	0.00%	165,932,285	38.00	2.08	-	-	-	-
	9		10.5	10.5	165,932,285	0.00%	165,932,285	38.00	2.27	-	-	-	-
	10		11.5	11.5	165,932,285	0.00%	165,932,285	38.00	2.47	-	-	-	-
	11		12.5	12.5	165,932,285	0.00%	165,932,285	38.00	2.69	-	-	-	-
	12		13.5	13.5	165,932,285	0.00%	165,932,285	38.00	2.94	-	-	-	-
	13		14.5	14.5	165,932,285	0.00%	165,932,285	38.00	3.20	-	-	-	-
	14		15.5	15.5	165,932,285	0.00%	165,932,285	38.00	3.49	-	-	-	-
	15		16.5	16.5	165,932,285	0.00%	165,932,285	38.00	3.80	-	-	-	-

Note: The values for Allowable Non-Revenue Water (ANRW) during the Operating Period are subject to the maximum limit of 4%

Input to be provided by bidders
Input to be provided by KWSB based on market data
Output

BIDDING FORM F3-F – SERVICE PAYMENT AND NPV

	Year		Year	Indexation Year	Capital Cost Recovery Payment	Fixed O&M Cost Recovery Payment	Electricity Consumption Payment	Variable O&M Cost Recovery Payment	Service Payment	Discount Factor	NPV of Service Payments
					PKR AW	PKR BW	PKR CW	PKR DW	PKR SPW	DR	PKR NPV_SC
C&O Period	1		1	1			1,609,827,295	-	1,609,827,295	1.00	1,609,827,295
	1.5		1.5	1.5			840,354,519	-	840,354,519	0.95	801,246,596
Operating Period	2.5	Concession Year	2.5	2.5	-	-	-	-	-	0.87	-
	3.5		3.5	3.5	-	-	-	-	-	0.79	-
	4.5		4.5	4.5	-	-	-	-	-	0.72	-
	5.5		5.5	5.5	-	-	-	-	-	0.65	-
	6.5		6.5	6.5	-	-	-	-	-	0.59	-
	7.5		7.5	7.5	-	-	-	-	-	0.54	-
	8.5		8.5	8.5	-	-	-	-	-	0.49	-
	9.5		9.5	9.5	-	-	-	-	-	0.44	-
	10.5		10.5	10.5	-	-	-	-	-	0.40	-
	11.5		11.5	11.5	-	-	-	-	-	0.37	-
	12.5		12.5	12.5	-	-	-	-	-	0.33	-
	13.5		13.5	13.5	-	-	-	-	-	0.30	-
	14.5		14.5	14.5	-	-	-	-	-	0.28	-
	15.5		15.5	15.5	-	-	-	-	-	0.25	-
	16.5		16.5	16.5	-	-	-	-	-	0.23	-
	Sum of Net Present Value of Service Payment, including Availability Payment and Output Payment (Σ NPV):										**2,411,073,891**
	GoS Equity Amount*										-
	Sum of Net Present Value of Service Payment and GoS Equity Amount										**2,411,073,891**

NOTES:

(1) Electricity Price PKR / kWh	38
(2) Growth rate of National Consumer Price Index (IR) of:	9%
(3) Growth Rate of Electricity Price (EPI):	9%
(4) Exchange Rate variation (EXR):	9%
(5) Based on a Discount Rate (DR) of:	10%
(6) Reference Exchange Rate PKR/USD	

The exchange rate shall be the TT selling rate prevailing seven (7) Business Days before the Bid Submission Date, as notified by National Bank of Pakistan. The rate can be accessed on https://www.nbp.com.pk/RATESHEET/index.aspx

*** GoS Equity Amount is the Class B Equity to be issued to GoS which will be the lower of 49% of Total Equity and PKR 2.5 Billion as proposed by the Bidder in the Financial Proposal**

Input to be provided by bidders
Input to be provided by KWSB based on market data
Output

BIDDING FORM F3-G – TERMINATION PAYMENTS

Description	Unit	Value
Percentage of Foreign Debt Interest Recovery Charge linked with LIBOR (Ff)	%	
Percentage of Local Debt Interest Recovery Charge linked with KIBOR (Fk)	%	
Maximum Foreign Equity	PKR	-
Maximum Local Equity	PKR	-
Total Equity	PKR	-
Equity IRR (USD) for Foreign Equity	%	
Equity IRR (PKR) for Local Equity	%	

Debt Repayment Profile

	Year	Quarter	Repayment Date	Principal Repayment US Dollars Loan PKR	Outstanding Principal Amount US Dollars Loan after Repayment PKR	Principal Repayment PKR Loan PKR	Outstanding Principal Amount PKR Loan after Repayment PKR	Outstanding Principal Amount PKR
C&O Period	1							
	1.5							
PCOD			PCOD		-		-	-
Operating Period	1	1	PCOD + 1 Quarter	-	-	-	-	-
		2	PCOD + 2 Quarter	-	-	-	-	-
		3	PCOD + 3 Quarter	-	-	-	-	-
		4	PCOD + 4 Quarter	-	-	-	-	-
	2	1	PCOD + 5 Quarter	-	-	-	-	-
		2	PCOD + 6 Quarter	-	-	-	-	-
		3	PCOD + 7 Quarter	-	-	-	-	-
		4	PCOD + 8 Quarter	-	-	-	-	-
	3	1	PCOD + 9 Quarter	-	-	-	-	-
		2	PCOD + 10 Quarter	-	-	-	-	-
		3	PCOD + 11 Quarter	-	-	-	-	-
		4	PCOD + 12 Quarter	-	-	-	-	-
	4	1	PCOD + 13 Quarter	-	-	-	-	-
		2	PCOD + 14 Quarter	-	-	-	-	-
		3	PCOD + 15 Quarter	-	-	-	-	-
		4	PCOD + 16 Quarter	-	-	-	-	-
	5	1	PCOD + 17 Quarter	-	-	-	-	-
		2	PCOD + 18 Quarter	-	-	-	-	-
		3	PCOD + 19 Quarter	-	-	-	-	-
		4	PCOD + 20 Quarter	-	-	-	-	-
	6	1	PCOD + 21 Quarter	-	-	-	-	-
		2	PCOD + 22 Quarter	-	-	-	-	-
		3	PCOD + 23 Quarter	-	-	-	-	-
		4	PCOD + 24 Quarter	-	-	-	-	-
	7	1	PCOD + 25 Quarter	-	-	-	-	-
		2	PCOD + 26 Quarter	-	-	-	-	-
		3	PCOD + 27 Quarter	-	-	-	-	-
		4	PCOD + 28 Quarter	-	-	-	-	-
	8	1	PCOD + 29 Quarter	-	-	-	-	-
		2	PCOD + 30 Quarter	-	-	-	-	-
		3	PCOD + 31 Quarter	-	-	-	-	-
		4	PCOD + 32 Quarter	-	-	-	-	-
	9	1	PCOD + 33 Quarter	-	-	-	-	-
		2	PCOD + 34 Quarter	-	-	-	-	-
		3	PCOD + 35 Quarter	-	-	-	-	-
		4	PCOD + 36 Quarter	-	-	-	-	-
	10	1	PCOD + 37 Quarter	-	-	-	-	-
		2	PCOD + 38 Quarter	-	-	-	-	-
		3	PCOD + 39 Quarter	-	-	-	-	-
		4	PCOD + 40 Quarter	-	-	-	-	-
	11	1	PCOD + 41 Quarter	-	-	-	-	-
		2	PCOD + 42 Quarter	-	-	-	-	-
		3	PCOD + 43 Quarter	-	-	-	-	-
		4	PCOD + 44 Quarter	-	-	-	-	-
	12	1	PCOD + 45 Quarter	-	-	-	-	-
		2	PCOD + 46 Quarter	-	-	-	-	-
		3	PCOD + 47 Quarter	-	-	-	-	-
		4	PCOD + 48 Quarter	-	-	-	-	-
	13	1	PCOD + 49 Quarter	-	-	-	-	-
		2	PCOD + 50 Quarter	-	-	-	-	-
		3	PCOD + 51 Quarter	-	-	-	-	-
		4	PCOD + 52 Quarter	-	-	-	-	-
	14	1	PCOD + 53 Quarter	-	-	-	-	-
		2	PCOD + 54 Quarter	-	-	-	-	-
		3	PCOD + 55 Quarter	-	-	-	-	-
		4	PCOD + 56 Quarter	-	-	-	-	-
	15	1	PCOD + 57 Quarter	-	-	-	-	-
		2	PCOD + 58 Quarter	-	-	-	-	-
		3	PCOD + 59 Quarter	-	-	-	-	-
		4	PCOD + 60 Quarter	-	-	-	-	-

Year	Principal Repayment US Dollars Loan PKR	Outstanding Principal Amount US Dollars Loan after Repayment PKR	Principal Repayment PKR Loan PKR	Outstanding Principal Amount PKR Loan after Repayment PKR
1				
1.5		-		-
2.5	-	-	-	-
3.5	-	-	-	-
4.5	-	-	-	-
5.5	-	-	-	-
6.5	-	-	-	-
7.5	-	-	-	-
8.5	-	-	-	-
9.5	-	-	-	-
10.5	-	-	-	-
11.5	-	-	-	-
12.5	-	-	-	-
13.5	-	-	-	-
14.5	-	-	-	-
15.5	-	-	-	-
16.5	-	-	-	-

Year	Dollars Loan PKR	Loan after Repayment PKR	PKR Loan PKR	Loan after Repayment PKR
1				
2		-		-
3	TRUE	-	TRUE	-
4	TRUE	-	TRUE	-
5	TRUE	-	TRUE	-
6	TRUE	-	TRUE	-
7	TRUE	-	TRUE	-
8	TRUE	-	TRUE	-
9	TRUE	-	TRUE	-
10	TRUE	-	TRUE	-
11	TRUE	-	TRUE	-
12	TRUE	-	TRUE	-
13	TRUE	-	TRUE	-
14	TRUE	-	TRUE	-
15	TRUE	-	TRUE	-
16	TRUE	-	TRUE	-
17	TRUE	-	TRUE	-

Equity Payment Profile

Operating Contract Year	Foreign Equity Tariff Component %	Local Equity Tariff Component %
1	0%	0%
2	0%	0%
3	0%	0%
4	0%	0%
5	0%	0%
6	0%	0%
7	0%	0%
8	0%	0%
9	0%	0%
10	0%	0%
11	0%	0%
12	0%	0%
13	0%	0%
14	0%	0%
15	0%	0%

NOTES:
(1) PCOD = Project Commercial Operations Date
(2) For the purposes of filling the 'Principal Repayment US Dollars Loan' column in PKR, please use the Reference Exchange Rate stated in sheet 'F3-F Service Payment and NPV'

	Input to be provided by bidders
	Input to be provided by KWSB based on market data
	Output

BIDDING FORM F3-H – FINANCING TERM SHEET

Borrower/Customer	
Project Sponsors	
Shareholders	
Transaction/ Project	
Project cost	
Mandated Lead Advisors & Arrangers / Agent Bank	
Facility Financiers	
Facility Amount	
Currency of the Facility	
Pricing on Facility (Fixed or floating, including floating base rate and margin)	
Tenor	
Facility Effective Date	
Availability Period	
Repayment of Facility (Period and Frequency of Repayment)	
Security/ collateral	
Arrangement/ Commitment Fee	
Debt Service Reserve / Major Maintenance Reserve	
Conditions Precedent	
Indemnification/ Representation and warranties	
Taxes and Payments	
Governing Law	

Validity	
Dispute Resolution	

Signatory for and on behalf of
[*insert name of the financial institution*]

_____
Name:
Designation:

Signatory for and on behalf of
[*insert name of the relevant Bidder*]

_____
Name:
Designation:

BIDDING FORM F3-I – SOURCES AND USES

	Input to be provided by bidders
	Input to be provided by KWSB based on market data
	Output

Uses of Funds	PKR
EPC Cost	-
Contingencies	-
Insurance	-
Other Non-EPC Costs	
Development, Consultancy and Advisory	-
Independent Appointees Cost	-
Interest During Construction	-
Financing Fees	-
Total	**-**

Sources of Funds	PKR
Debt	-
Local Equity (including Local Currency Shareholder Loans)	-
Foreign Equity (including Foreign Currency Shareholder Loans)	-
GoS Equity Amount	-
Total	**-**

Notes:

(1) In respect of equity of the Foreign Sponsor (defined in Volume I/RFP) above, the amount should be less than or equal to seventy percent (70%) of the total equity (excluding VGF)

(2) For the purposes of converting the Foreign Equity in PKR, please use the Reference Exchange Rate stated in sheet 'F3-F Service Payment and NPV'

F3-I2: Project Cost

Description	PKR
Canal Rehabilitation	-
New Pipeline Construction	-
Pumping Stations	-
K-III Connection and Pumping	-
Rehabilitation/Replacement of Rising Mains	-
Water Treatment Plant	-
SCADA, Metering and Communications	-
Solar PV Plant	-
Other Costs	-
Taxes, Custom Duties and other Fees	-
Total Construction Cost	**-**
EPC related Contingencies	-
EPC related Insurance	-
Design, Supervision and Project Management	-
Total EPC Cost	**-**
Project Contingencies	-
Project Insurance	-
Other Non-EPC Costs	-
Development, Consultancy and Advisory	-
Independent Appointees Cost	-
Interest During Construction	-
Financing Fees	-
Total Project Cost	**-**

F3-I3: Shareholding Composition

Description	%
Local Sponsors	0%
Foreign Sponsors	0%

F3-I4: Cashflow Statement

Operational Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Revenue	2,450,181,815	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Less:																
Taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fixed O&M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variable O&M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Local Debt Service Payment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Foreign Debt Service Payment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cashflow Available for Dividends	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

F3-I5: Sponsor Equity Calculation

Local Equity Cashflows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Foreign Equity Cashflows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Local Equity	**-**															
Total Foreign Equity	**-**															

F3-I6: Applicable Taxes

Description	Rate	Comments

Note: The above table needs to be filled in by the Bidder based on the Tax Report submitted as part of the Financial Model

PART 3

BIDDING DOCUMENTARY REQUIREMENTS

BIDDING DOCUMENTARY REQUIREMENTS

NO.	DOCUMENT	REQUIREMENTS[14]	
		LOCAL ENTITY	FOREIGN ENTITY
1.	LETTER OF TECHNICAL PROPOSAL AND LETTER OF FINANCIAL PROPOSAL	To be dated, signed by the authorized representative, duly witnessed, duly stamped (PKR 100/-) and witnessed.	To be dated, signed by the authorized representative and to be adequately adhesive stamped when brought into Pakistan with a stamp duty of PKR 100/- and witnessed.
2.	FORM OF BID SECURITY	To be issued by Acceptable Bank; and dated, signed by an authorized representative and duly stamped (PKR 500/-).	To be issued by Acceptable Bank; and dated, signed by an authorized representative and duly stamped (PKR 500/-).
3.	POWER OF ATTORNEY	To be dated; witnessed; notarized; duly stamped (PKR 200/-); signed by an authorized representative; and in the language as required under the Instructions to Bidders.	To be dated; witnessed; signed by an authorized representative; notarized by the notary public in the country where it is issued and attested by the Pakistan Embassy / Consulate and Ministry of Foreign Affairs, Pakistan; and adequately adhesive stamped when brought into Pakistan with a stamp duty of PKR 200/-.
4.	UNDERTAKING	To be dated; signed by the authorized signatory; witnessed; duly stamped (PKR 100/-); and in the language as required under the Instructions to Bidders.	To be in the English language and in compliance with the requirements under the Instructions to Bidders; notarized by the notary public in the country where it is issued and attested by the Pakistan Embassy / Consulate and Ministry of Foreign Affairs, Pakistan; and to be adequately adhesive stamped when brought into Pakistan with

[14] Under the Laws of Pakistan (Qanun-e-Shahdat Order, 1984), the minimum witnessing requirement mandates the presence of either two males, or one male and two females to witness, for all instances of witnessing in financial matters.

			a stamp duty of PKR 100/-; to be dated; signed by the authorized signatory; and witnessed.
5.	INTEGRITY PACT	To be dated and signed by the authorized representative.	To be dated and signed by the authorized representative.
6.	AFFIDAVIT	To be dated; notarized and verified by Oath Commissioner, signed by the authorized signatory; witnessed; duly stamped (PKR 100/-); and in the format as required under the Instructions to Bidders.	To be in the English language and in compliance with the requirements under the Instructions to Bidders; notarized by the notary public in the country where it is issued and attested by the Pakistan Embassy / Consulate and Ministry of Foreign Affairs, Pakistan; and to be adequately adhesive stamped when brought into Pakistan with a stamp duty of PKR 100/-; to be dated; signed by the authorized signatory; and witnessed.

PART 4
ANNEXURES

ANNEXURE A – ELIGIBILITY CRITERIA FOR PROPOSED CONTRACTORS

A Technical Proposal received from Bidder, shall only be considered if all the following information / components have been provided and the requirements herein are satisfied:

In case any document / information furnished is in a language other than English, it will need to be accompanied by an English translation (duly notarized by Notary Public and attested by Pakistan Embassy / Consulate and Ministry of Foreign Affairs, Pakistan). In case of any discrepancy, the English translation shall prevail.

- **REGISTRATION WITH TAX AUTHORITIES**

  The Proposed Contractor must possess a valid registration certificate from the income tax authority (i.e., the NTN certificate) and relevant sales tax authority, if applicable. Valid NTN certificate(s) and tax returns filed for last three (3) years are to be attached and relevant sales tax certificate, if applicable.

  For foreign entities, a tax certificate of their country and tax returns filed for last three (3) years should be submitted.

- **NO CONFLICT OF INTEREST**

  The Proposed Contractor may be considered to be in a conflict of interest if it, *inter alia*, participated as a consultant in the preparation of the design or technical / commercial / financial / legal specifications for the works and / or services for the Project, for the purposes of preparation of the RFP, that are the subject of this Bidding Process.

  In case there is no conflict, the Proposed Contractor shall provide evidence in the form of an affidavit to this effect in the form and substance attached as Bidding Form T6 (*Format of Affidavit by Proposed Contractor*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP.

  In case the affidavit is issued by a foreign entity, outside Pakistan, such affidavit will have to be duly notarized by Notary Public and attested by Pakistan Embassy / Consulate and Ministry of Foreign Affairs, Pakistan.

- **NON-BLACKLISTING**

  The Proposed Contractor shall provide evidence, in the form of an affidavit (in the form and substance attached as Bidding Form T6 (*Format of Affidavit by Proposed Contractor*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP of non-blacklisting by its employers, by any Federal or Provincial governmental or non-governmental department / agency in Pakistan, or any other provincial government / governments of any foreign countries or their governmental bodies and / or International Organizations (e.g. World Bank, Asian Development Bank, United Nations, International Monetary Fund etc.) as at the Bid Submission Date.

  In case the affidavit is issued by a foreign entity, outside Pakistan, such affidavit will have to be duly notarized by Notary Public and attested by Pakistan Embassy / Consulate and Ministry of Foreign Affairs, Pakistan.

- **ELIGIBLE COUNTRIES**

The Proposed Contractor shall be incorporated in / have nationality of an Eligible Country. A Proposed Contractor shall be deemed to have the nationality of an Eligible Country, if the Proposed Contractor is a national of that country; or is constituted, incorporated, or registered and operates in conformity with the provisions of the laws of that country.

(I) TECHNICAL EVALUATION CRITERIA

Along with the requirements set out in the Instructions to Bidders and the information required pursuant thereto, this section will be used to determine whether a Bid is technically compliant to the requirements of the RFP. In case, a Bidder intends to undertake the works and / or services itself, such Bidder shall be required to submit the relevant information regarding its experience as per the requirements set out below.

NO.	DESCRIPTION	COMPLIANCE WITH RFP REQUIREMENTS	DETAIL TO BE EVALUATED
1	Suitable relevant project experience with specific details of the Proposed EPC Contractor	Yes/No	Proposed EPC Contractor (or a Bidder (including a Consortium Member), in case the Bidder (or the relevant Consortium Member) intends to undertake the relevant engineering, procurement and construction works for the Project itself) must have undertaken engineering, procurement and construction works for at least: (i) one (1) water supply or sanitation project which include one (1) pipeline of 5 km with minimum diameter of 600 mm; (ii) one (1) water supply project which include canal new execution or rehabilitation, with more than 10 km length and with a design flow of at least 20 MGD; (iii) one (1) water pumping station installation, new execution or rehabilitation, with a design flow of at least 20 MGD; (iv) one (1) water filtration or sewage treatment or wastewater treatment or desalination plant, new execution or rehabilitation, having a design flow of at least 20 MGD; and (v) in case solar PV plant is proposed in the Technical Proposal, one (1) solar PV plant, with a minimum capacity of 5 MW.
			Net worth Requirements:

			A Proposed EPC Contractor shall be required to satisfy the following net worth requirements and submit the relevant supporting documentation, such Proposed EPC Contractor shall have a Net Worth of at least USD 40,000,000/- (United States Dollars Forty Million only), based on latest financial statements calculated pursuant to Sub-Section 6.5.5 of Instructions to Bidders.[15]
2	Suitable relevant project experience with specific details of the Proposed O&M Contractor	Yes/No	Proposed O&M Contractor (or a Bidder (including a Consortium Member), in case the Bidder (or the relevant Consortium Member) intends to undertake the relevant operations and maintenance works for the Project itself) must have undertaken operations and maintenance works for at least: (i) one (1) water supply or sanitation project which include one (1) pipeline of 5 km with minimum diameter of 600 mm and with a design flow of at least 10 MGD; (ii) one (1) water supply project which include canal with more than 5 km length and with a design flow of at least 10 MGD; (iii) one (1) water pumping station with a design flow of at least 10 MGD; (iv) one (1) water filtration/sewage treatment/wastewater treatment/desalination plant having a design flow of at least 10 MGD; and (v) in case solar PV plant is proposed in the Technical Proposal, one (1) solar PV plant, with a minimum capacity of 5 MW.
			Net worth Requirements: A Proposed O&M Contractor shall be required to satisfy the following net worth requirements and submit the relevant supporting documentation, such Proposed

[15] Bidders to note that Net worth of the Proposed EPC Contractors, in case of a consortium, shall be determined on a consolidated basis.

			O&M Contractor shall have a Net Worth of at least USD 20,000,000/- (United States Dollars Twenty Million only), based on latest financial statements calculated pursuant to Sub-Section 6.5.5 of the Instructions to Bidders.[16]
3	Suitable Technical Project Methodology/ Approach	Yes/No	Bidding Form T7 (*Technical Project Methodology / Approach*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP. Bidding Form T7 (*Technical Project Methodology / Approach*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - Understanding of the scope of works; - Proposed technical approach / methodology to achieve compliance with C&O Activities requirements and the offered values during O&M Period, showing the rationale behind the technical proposal made; - Technical evaluation on the proven and reliable technologies offered for each component of the Project. Redundancy approach to ensure the system availability. - Risk management approach and proposed mitigation actions; - Value engineering approach; - Project management approach; reporting during C&O Period.
4	Suitable Operation & Maintenance Plan and Procedures	Yes/No	Bidding Form T8 (*Operation & Maintenance Plan and Procedure*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II

[16] Bidders to note that Net worth of the Proposed O&M Contractors, in case of a consortium, shall be determined on a consolidated basis.

			(*Technical Specifications*) of the RFP. Bidding Form T8 (*Operation & Maintenance Plan and Procedure*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - Approach and procedures considered when outlining the Management, Operation & Maintenance (MOM) plan; - Approach towards overall asset management; - Control philosophy proposed to optimize efficiencies; - Project Management approach; reporting during O&M Period.
5	Implementation Schedule suitable to PCOD target date	Yes/No	Bidding Form T9 (*Implementation Schedule*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP. Bidding Form T9 (*Implementation Schedule*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - Activities defined in detail for each component of the Project and aligned with C&O Activities and O&M Activities methodology; - Activities sequenced in a consistent way, including dependencies that may require a lead or a lag to define the logical relationship; - The duration of the activities is adequately estimated to meet Project milestones; - The implementation schedule is aligned with the resources defined in other Bidding Forms.

6	List of Manufacturers of Main Equipment	Yes/No	Bidding Form T10 (*List of Manufacturers of Main Equipment*) provided Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP. Bidding Form T10 (*List of Manufacturers of Main Equipment*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - The list of manufacturers of the minimum main equipment has been provided; - The proposed manufacturers are of recognized prestige and have proven technical solutions.
7	Suitable Schedule of Equipment & Technology Suppliers	Yes/No	Bidding Form T11 (*Schedule of Equipment & Technology Suppliers*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP. Bidding Form T11 (*Schedule of Equipment & Technology Suppliers*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - Estimated lead time for equipment delivery is aligned with the Bidding Form T9 (*Implementation Schedule*).
8	Suitable Organization & Staffing	Yes/No	Bidding Form T12 (*Organization & Staffing*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP. Bidding Form T12 (*Organization & Staffing*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following

			parameters: - Organization chart is provided, and the allocated resources are aligned with the Bidding Form T9 (*Implementation Schedule*); - The list of key personnel has been provided, and it is aligned with the organization chart. The adequacy and experience of the proposed staff will be considered.
9	Suitable Quality Control Practices & Procedures	Yes/No	Bidding Form T13 (*Quality Control Practices & Procedures*) provided Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with of Volume II (*Technical Specifications*) of the RFP. Bidding Form T13 (*Quality Control Practices & Procedures*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - Alignment of the quality control practices and procedures with the Project requirements and international best practices; - Alignment of the quality control practices and procedures with the international standards. ISO 9001 certification provided.
10	Suitable Health & Safety Plan and Procedures	Yes/No	Bidding Form T14 (*Health & Safety Plan and Procedures*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP. Bidding Form T14 (*Health & Safety Plan and Procedures*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - Adequacy of the health and safety approach and procedures to be

			implemented, and alignment with the Bidding Form T9 (*Implementation Schedule*); - Health and safety management approach, reporting during C&O Period and O&M Period.
11	Suitable Methodology/Approach for the Environmental & Social Management Plan and Procedures	Yes/No	Bidding Form T15 (*Methodology/Approach for the Environmental & Social Management Plan and Procedures*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP. Bidding Form T15 (*Methodology/Approach for the Environmental & Social Management Plan and Procedures*) submitted by a Bidder shall be assessed based on the requirements set out in the RFP, including the following parameters: - Proposed approach and procedures is complete, has been developed specifically for the Project and is aligned with the Bidding Form T7 (*Technical Project Methodology / Approach*) and the Bidding Form T9 (Implementation Schedule); - The environmental and social management plan is compliant with relevant international best practices and the applicable Laws; - Adequacy of the proposed monitoring procedure for the plan; - Alignment of the Environmental and Social Management Plan with the international standards. ISO 14001 certification provided.
12	Suitable Other Technical Data Submission	Yes/No	Bidding Form T16 (*Other Technical Data Submission*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in

			compliance with Volume II (*Technical Specifications*) of the RFP.
13	Project References of Proposed EPC Contractor	Yes/No	Bidding Form T17 (*Project References of Proposed EPC Contractor*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP.
14	Project References of Proposed O&M Contractor	Yes/No	Bidding Form T18 (*Project References of Proposed O&M Contractor*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP, prepared as per the requirements specified therein and in compliance with Volume II (*Technical Specifications*) of the RFP.
15	Net Worth Requirements of Proposed Contractors	Yes/No	Bidding Form T19 (*Net Worth Requirements of Proposed Contractors*) provided in Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP.

(II) FINANCIAL EVALUATION CRITERIA

KW&SB / TFEC shall evaluate the presence and completeness of all the supporting Bidding Forms and other documentation / information required to be submitted by a Bidder with the Financial Proposal, as per the requirements set out in the Instructions to Bidders.

A Bidder whose Bid has been determined the Best Evaluated Bid in terms of lowest Bid Price, shall be declared the Successful Bidder.

The Bid Price shall be calculated as per the following formula:

Bid Price = NPV of Service Payments + GoS Equity Amount

The Bid Price is calculated solely for the purpose of the evaluation and comparison of Bids and does not represent the actual payments that will be made by GoS to the Company in terms of the Concession Agreement.

Note: *Capitalized terms (including the abbreviations) used in herein, shall have the meaning given to them in the Concession Agreement (including appendix 8 of the Concession Agreement).*

METHODOLOGY FOR CALCULATION OF NPV OF SERVICE PAYMENT

1.1 Methodology

1.1.1 The NPV of Service Payment shall be calculated in accordance with the formulae set out in Sub-Section 1.3 (*Determination of the NPV of Service Payment*) below.

1.1.2 To standardise the calculation of the NPV of Service Payment, the Bidder is required to complete the relevant Bidding Form F3 (*Financial Forms*) of Part 2 (*Bidding Forms*) of Volume I (*Bidding Procedure*) of the RFP (using the Microsoft Excel file); using the underlying assumptions as set out in the Sub-Section 1.2 (*Assumptions for Calculations of Required Values*) below.

1.2 Assumptions for Calculation of Required Values

1.2.1 NPV of Service Payment will be calculated as the net present value of the annual payments in C&O Period and Operating Period under the Concession Agreement, as defined in Sub-Section 1.3 (*Determination of the NPV of Service Payment*) below, using the formulae outlined below, the Availability Payment and Output Payment calculation formulas set out in the relevant forms present in Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP (using Microsoft Excel File).

1.2.2 Indexation of charge rates and the relevant payments will be calculated in accordance with the relevant Microsoft Excel file of the relevant Bidding Forms set out in Bidding From F3 (*Financial Forms*), based on the following assumptions:

(a) Growth rate of National Consumer Price Index / N-CPI of Pakistan: 9% p.a.

(b) Growth rate of Electricity Price: 9% p.a.

(c) Exchange rate variation (USD:PKR): 9% p.a.

(d) KIBOR variation: 0% (constant local floating rate)

(e) LIBOR variation: 0% (constant foreign floating rate)

1.2.3 The following reference values will be used for evaluation (and should be assumed in the Bidder's model):

(a) Reference Inflation Rate: 183.35

(b) Electricity Price: 38 PKR / kWh

(c) Reference Exchange Rate: 1 USD = TT selling rate for USD expressed in PKR, as published by the National Bank of Pakistan, prevailing seven (7) Business Days before the Bid Submission Date (*e.g.*, 17th November 2022, based on the Bid Submission Date specified in the RFP). The rate can be accessed from https://www.nbp.com.pk/RATESHEET/index.aspx

(d) Reference KIBOR: 15.91%

(e) Reference LIBOR: 3.01%

1.2.4 ***Calculation of Projected Available Net Water Output, Net Water Output and Projected Electricity Consumption During C&O Period***

1.2.4.1 To calculate the Projected Available Net Water Output for the purposes of determination of NPV of Service Payments, in Contract Year "n", the Bidder should assume the Contracted Availability during the C&O Period after deducting for Outages by the Bidder as per below assumptions:

Contract Year 1:

(a) Unplanned Outages: Summer Period - **$LCWp_{ns}$ * 1,818,436m^3** and Winter Period - **$LCWp_{nw}^{U}$ 1,818,436 m^3**

(b) Planned Outages: Winter Period - **$LCWp_{nw}^{P}$ 909,218 m^3**

Contract Year 2 (6 months period):

(c) Unplanned Outages: Summer Period - **$LCWp_{ns}$ * 909,218 m^3** and Winter Period - **$LCWp_{nw}^{U}$ 909,218 m^3**

(d) Planned Outages: Winter Period - **$LCWp_{nw}^{P}$ 454,609 m^3**

1.2.4.2 To calculate the Net Water Output for the purposes of determination of NPV of Service Payments, in Contract Year "n", the Bidder should calculate Projected Available Net Water Output as detailed above, and deduct Allowable NRW at 25%

1.2.4.3 To calculate the Projected Electricity Consumption for the purposes of determination of NPV of Service Payments, in Contract Year "n", the Bidder should calculate Net Water Output as detailed above, and use the Contracted Specific Net Electricity Consumption kWh/m3 at 0.35.

1.2.5 ***Calculation of Projected Available Net Water Output, Net Water Output and Projected Electricity Consumption During Operating Period***

1.2.5.1 To calculate the Projected Available Net Water Output for the purposes of determination of NPV of Service Payments, in Contract Year "n", the Bidder should assume the Contracted Availability during the Operating Period after deducting for Outages (i.e., (i) **$LCWp_{ns}$**; (ii) **$LCWp_{nw}^{P}$**; and **$LCWp_{nw}^{U}$**) provided by the Bidder in its Bid.

1.2.5.2 To calculate the Net Water Output for the purposes of determination of NPV of Service Payments, in Contract Year "n", the Bidder should calculate Projected Available Net Water Output as detailed above and deduct Allowable NRW provided by the Bidder in its Bid.

1.2.5.3 To calculate the Projected Electricity Consumption for the purposes of determination of NPV of Service Payments, in Contract Year "n", the Bidder should calculate Net Water Output as detailed above, and use the Contracted Specific Net Electricity Consumption. The Contracted Specific Net Solar Generation provided by the Bidder will be deducted from the Projected Electricity Consumption to determine the electricity that is consumed from the Electricity Supplier.

1.2.5.4 Note that during the preparation of Bids, for the Operating Period Bidders should ensure that the Allowable NRW and the Outages do not exceed the caps as provided below:

(a) Allowable NRW at 4%

(b) Outages (*i.e.*: (i) **$LCWp_{ns}$** at 909,218m^3 (ii) **$LCWp_{nw}^{P}$** at 909,218m^3 and (iii) **$LCWp_{nw}^{U}$**) at 909,218$m)^3$

(c) Contracted Specific Net Electricity Consumption kWh/m3 at 0.30

1.3 Determination of the NPV of Service Payment

The NPV of Service Payments will be determined during the Concession Period as per the formulae provided in the relevant form present in Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP (using Microsoft Excel file), which is as follows:

$$\mathbf{NPV\_SC} = \sum_{n=1}^{16.5} \mathbf{(SPW_n / ((1+r) \wedge (n-1)))}$$

where:

SPW_n = Total Service Payment in Contract Years (in PKR)

n = Contract Year, including Construction Contract Year, i.e., 1 and 1.5, and Operating Contract Year, i.e. 2.5,3.5,4.5,5.5,6.5….16.5. Operating Contract Year assumed to start after two years of Commencement Date.

r = Annual discount rate (10%)

The Total Service Payments (SPW) for each Contract Year will be calculated as per the formulae provided in the relevant form present in Bidding Form F3 (*Financial Forms*) of Part 2 *(Bidding Forms)* of Volume I (*Bidding Procedure*) of the RFP, which is as follows:

$$\mathbf{SPW = AW_n + BW_n + CW_n + DW_n}$$

where:

SPW_n = Total Service Payment in Contract Years (in PKR)

AW_n = Capital Cost Recovery Payment (in PKR) in Contract Year "n" excluding Contract Year 1 and 1.5

BW_n = Fixed O&M Cost Recovery Payment (in PKR) in Contract Year "n" excluding Contract Year 1 and 1.5

CW_n = Electricity Consumption Payment (in PKR) in Contract Year "n"

DW_n = Variable O&M Cost Recovery Payment (in PKR) in Contract Year "n"

ANNEXURE C – FORM OF C&O PERFORMANCE SECURITY

SEE APPENDIX 6 OF THE CONCESSION AGREEMENT FOR THE FORMAT OF C&O PERFORMANCE SECURITY

VOLUME II:

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

1. PART 1: PROJECT DESCRIPTION 6

1.1 HUB DAM AND KW&SB WATER SYSTEM LOCATION 8

1.2 DESCRIPTION OF ACCESS TO SITE 10

1.3 SITE CONDITIONS 11

1.4 OVERVIEW OF THE WATER SUPPLY SYSTEM FROM HUB DAM 11

1.5 AREA OF ACTION WITHIN THE CONTRACT 13

2. PART 2: SCOPE OF WORK & DESIGN BASIS 13

2.1 OVERALL PROJECT SCOPE OF WORK 13

2.2 SURVEYS & TECHNICAL STUDIES 15

2.3 LAND RIGHTS & ACCESS TO THE PROPOSED SITES 17

2.4 MOBILISATION ACTIVITIES 17

2.5 CONSTRUCTION & OPERATION ACTIVITIES 19

2.6 OPERATION AND MAINTENANCE ACTIVITIES (O&M ACTIVITIES) 28

2.7 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) AND ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) 34

3. PART 3: TECHNICAL FUNCTIONAL SPECIFICATIONS 34

3.1 GENERAL REQUIREMENTS & DESIGN STANDARDS 34

3.2 GENERAL DESIGN BASIS 36

3.3 DESIGN LIFE & REDUNDANCY 38

3.4 DETAILED DESIGN REQUIREMENTS 38

3.5 MEICA GENERAL REQUIREMENTS 39

3.6 CIVIL, STRUCTURAL & ARCHITECTURAL REQUIREMENTS 41

3.8 GENERAL ENVIRONMENTAL REQUIREMENTS & PERMITS 47

4. PART 4: SPECIFIC REQUIREMENTS 47

4.1 MANAGEMENT, OPERATIONS & MAINTENANCE REQUIREMENTS 47

4.2 OPERATING AND MAINTENANCE PROCEDURES 48

4.3 GENERAL FACILITIES 50

4.4 WATER TANKERS 53

4.5 HEALTH & SAFETY REQUIREMENTS 53

5. PART 5: COMPLIANCE MONITORING METHODOLOGY AND TESTING & COMMISSIONING PROCEDURES 55

5.1 COMPLIANCE MONITORING METHODOLOGY 55

5.2 TESTING & COMMISSIONING PROCEDURES 59

FIGURE 1: EXISTING BULK WATER SUPPLY SYSTEM. SOURCE: JICA MASTERPLAN (2008) 6

FIGURE 2: GENERAL LAYOUT OF THE KWC (IN BLACK) AND THE WAPDA CANAL (IN BLUE)..... 8

FIGURE 3: GENERAL LAYOUT OF THE KWC. 9

FIGURE 4: GENERAL LAYOUT OF THE KWC, INCLUDING THE PUMP STATION AND THE TREATMENT PLANT. 9

FIGURE 5: ACCESS TO THE PUMP STATION FROM THE HUB DAM ROAD. 10

FIGURE 6: ACCESS ROAD FROM HUB DAM ROAD TO THE TREATMENT PLANT. 10

FIGURE 7: KWC, KIII CONDUIT, OLD AND NEW PUMP HOUSES – PRESENT CONFIGURATION. 12

FIGURE 8: GENERAL SCHEME FOR THE CONFIGURATION OF THE VALVE CHAMBER. 23

FIGURE 9. EXAMPLES OF CONNECTION & METERING DETAILS. 31

FIGURE 10: GENERAL SCHEME FOR MONITORING DURING THE OPERATING PERIOD. 32

FIGURE 12: WATER QUALITY METERING POINTS. 59

FIGURE 13: WATER QUALITY TESTING METHODOLOGY. 59

TABLE 1: MINIMUM FLOW AND WATER QUALITY METERING & MONITORING SYSTEMS FOR THE KWC. 30

TABLE 2: NORMAL WATER INFLUENT RANGE COMPLIANCE. 55

TABLE 3: NORMAL WATER OUTLET RANGE COMPLIANCE. 56

TABLE 4: WATER QUALITY PARAMETERS. 58

GLOSSARY

Unless otherwise specified / defined herein, all capitalized terms used herein shall bear the meanings set out in the Concession Agreement. References to: (a) any law, rule, regulation or standards shall include any amendments, modifications or any re-enactment thereof; (b) Sections are refences to a section in this document; (c) the Company for the proposes of bid submission, should be read as a reference to the bidder submitting its bid in terms of the RFP.

"AMTEC" means the technology and / or software tools that are used for low voltage electrical network design, load flow modelling, and protection setting calculations;

"BIM" means Building Information Modelling;

"CCU" means the Central Control Unit;

"CMMS" means Computerized Maintenance Management System;

"Concession Agreement" means the agreement titled "Concession Agreement" attached in Volume III of the RFP;

"DCS" means Distributed Control System;

"ERAC" or **"ETAP"** means the technology and software tools that are used for high voltage electrical network design, load flow modelling, and protection setting calculations;

"Head Regulator" means the bifurcation point, at the end of the WAPDA canal from where water is distributed into the KWC and the Lasbela canal, as more specifically described herein;

"Instructions to Bidders" means the Instructions to Bidders set out in Part 1 of Volume I of the RFP;

"Intelligent P&IDs" means Intelligent Process and Instrumentation Diagram;

"M^3" means cubic meters;

"MEICA" means Mechanical, Electrical, Instrumentation, Control & Automation;

"Metering and Testing Plan" has the meaning given to it in appendix 5 of the Concession Agreement;

"MGD" means Millions Imperial Gallons per Day (1 MGD = 0,0526 m3/s);

"Normal Influent Range" means the contractual limits for water quality to be provided at the Output Water Connection Point by the Company, as specified in table 4 under section 5.1.2;

"NRW" has the meaning given to it in appendix 8 of the Concession Agreement;

"PLC" means Programmable Logic Controller;

"RCD" means Residual Current Device;

"TAG" means the assignment of a unique number to Project equipment and items in accordance with the Project numbering system, to be used on the name plates, drawings and datasheets, and all correspondence;

"Technical Proposal" means the technical proposal (including all forms, documents and information required in terms of the RFP and submitted therewith), submitted by the Company as part of its Proposal pursuant to the RFP; and

"WAPDA" means the Water and Power Development Authority, a federal agency in Pakistan.

1. PART 1: PROJECT DESCRIPTION

Karachi is the seventh (7th) largest metropolitan city in the world right now, and the largest city and gateway of Pakistan. It is also the capital of Sindh province and the country's main seaport, economic and financial centre, sprawling over an area of about three thousand five hundred square kilometres (3,500 m^2). The population of this fast-expanding megacity has been growing annually by four point two percent (4.2%) since 1998 and is projected to grow from sixteen million (16,000,000) in 2017 to around thirty-two million five hundred thousand (32,500,000) in 2025 which will make it the second (2nd) largest city in the world.

One of the bulk water sources for Karachi is the Hub Dam through the KWC which has a design capacity of 100 MGD (5.26 m^3/s). This Hub Dam source is affected by the seasonal and annual water level fluctuations in the reservoir, and this situation is further aggravated due to losses attributed to leakages (see RFP Volume II Annexure 1 Due Diligence Relevant Information).

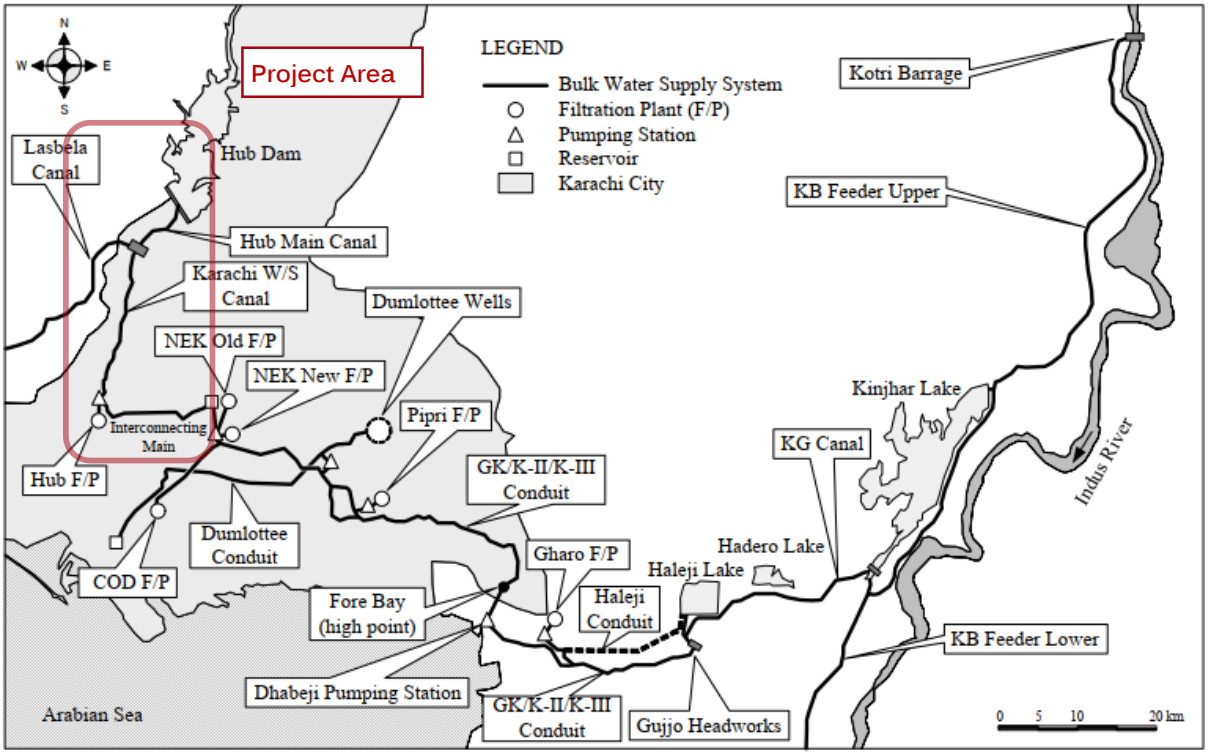


Figure 1: Existing Bulk Water Supply System. Source: JICA Masterplan (2008)

The main Hub canal (also known as the WAPDA Canal) offtakes from the Hub Dam and travels approximately eight kilometres (8 km) in a south-westerly direction. The WAPDA Canal is owned, operated and maintained by the WAPDA. The WAPDA Canal bifurcates into two (2) branches at about eight kilometres (8 km) downstream from the Hub Dam at the Head Regulator into (i) the Lasbela canal which flows west towards Balochistan, and (ii) the KWC which continues for around twenty-one kilometres (21 km) in a south-westerly direction towards the KW&SB pumping station and the Treatment Plant. Further relevant information can be found at RFP Volume II Annexure 1 Due Diligence Relevant Information.

The successful implementation of this Project will lead the KWC to reach the total expected capacity of 100 MGD (5.26 m^3/s). The Project entails, *inter alia*, the rehabilitation of the KWC, replacement of the existing pumps, and the rehabilitation and capacity enhancement of the Treatment Plant to achieve 100

MGD (5.26 m^3/s). In addition, the Project may include a solar PV generation solution to optimize energy requirements. With the exception of installation and operation and maintenance of the HD Input Water Metering System, no major intervention in WAPDA Canal is considered in the present scope of work.

The main components of the Project and some typical coordinates are provided below:

1. Head Regulator / start of the KWC (at the axis): E 304,854.800 N 2,787,734.050;

2. end of the KWC / intake chamber for pipeline stretch: E 302,710.500 N 2,777,029.700;

3. end of pipeline stretch at the existing old pump house: E 300,262.550 N 2,768,452.150;

4. Water Access Connection Points:

    a. Hamdard University and Hamdard Laboratories: E 301,847.08 N 2,774,754.55;

    b. Sherriar Ashraf (Gulf Mineral): Coordinates to be defined by the Company prior to the start of C&O Activities;

    c. Public Health Engineering and Rural Department (Government of Sindh): Coordinates to be defined by the Company prior to the start of the C&O Activities; and

    d. Marble City connection: Coordinates / location to be agreed between KW&SB and Company during the Mobilisation Period or during the C&O Activities, as instructed by KW&SB.

5. some of the existing utilities crossing the KWC:

    a. one (1) gas line: E 302,349.34 N 2,775,148.74;

    b. one (1) crude oil line, E 300,724.60 N 2,769,628.77;

    c. water lines: E 303,874.76 N 2,782,820.82 / E 302,372.40 N 2,775,221.92 / E 300,246.71 N 2,768,583.92; and

    d. underground electrical cables: Coordinates to be defined by the Company prior to the start of the C&O Activities;

6. KIII Conduit concession limit (representative point): E 300,256.885 N 2,768,536.660;

7. by-pass starting point (representative point): E 300,234.033 N 2,768,488.775;

8. pump station perimeter (intersection with rising mains): E 300,275.200 N 2,768,307.200;

9. end of rising mains (where they intersect the Treatment Plant perimeter): E 300,295.600 N 2,766,420.950;

10. Treatment Plant (around midway of the sand filters): E 300,418.700 N 2,766,328.800;

11. Reservoir (around centre): E 300,364.221 N 2,766,616.159; and

12. Solar Plant location (around centre): E 300,790.200 N 2,766,390.500.

All the coordinates are given as a first approximation to the points. It is the Company's responsibility to obtain any additional coordinates for other components and utilities and verify the same (including those noted above) before starting the Project Activities. The above list is not exhaustive. It is the responsibility of the Company to carry out such necessary diligence to confirm necessary components for the Project.

1.1 HUB DAM AND KW&SB WATER SYSTEM LOCATION

The KWC is situated fifty-six kilometres (56) km north from the Karachi city, in Karachi and Lasbela Districts on the border of the Sindh and Balochistan provinces.

The following figures 2, 3 and 4 aim at portraying the location of the main components of the KWC. Further information can be found at *RFP Volume II Annexure 1 Due Diligence Relevant Information*.

Figure 2: General layout of the KWC (in black) and the WAPDA Canal (in blue).

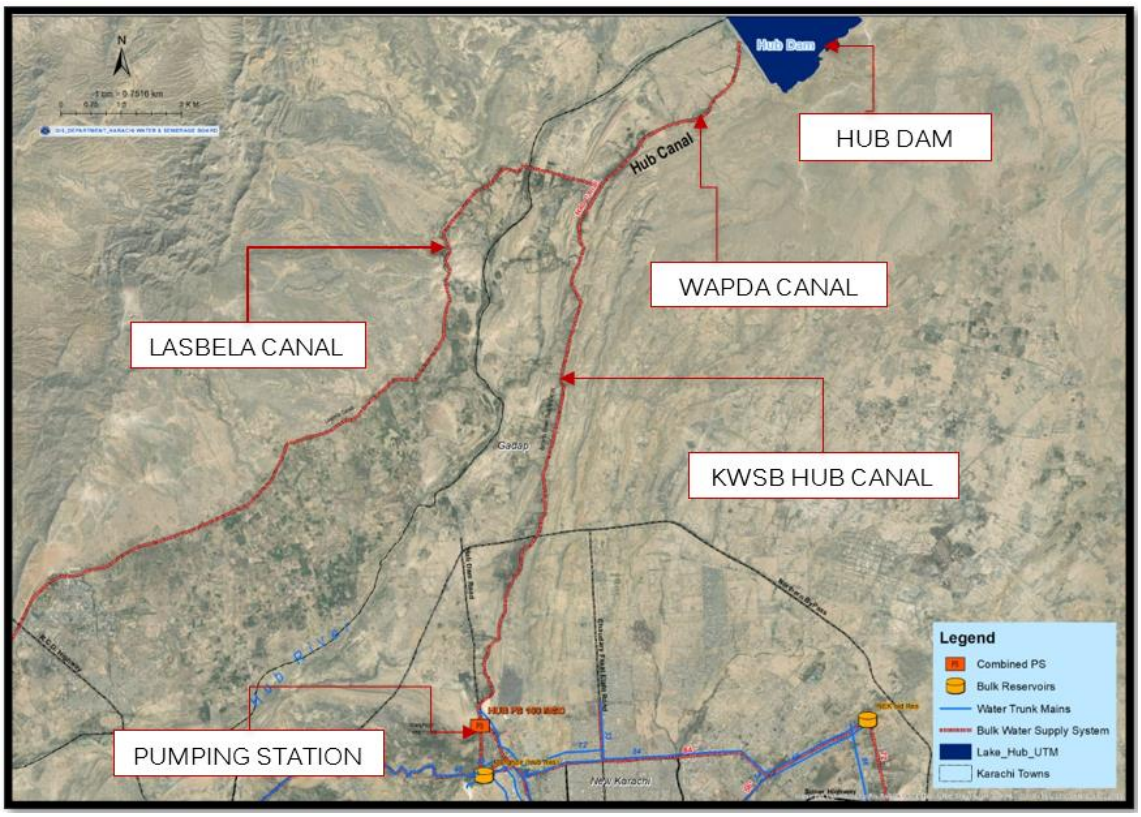


Figure 3: General Layout of the KWC.

Figure 4: General Layout of the KWC, including the Pump Station and the Treatment Plant.

1.2 DESCRIPTION OF ACCESS TO SITE

The KWC, in general, has access from the Hub Dam road and the M10 road. There is also an inspection road running along the KWC, which is crossed by the foregoing main roads, that is, M10 road at PK 17+300 and Hub Dam road at PK 20+400 which give access at these points. The pump station area and the Treatment Plant have direct access from the Hub Dam road as can be seen in the figures 5 and 6 provided below:

Figure 5: Access to the Pump Station from the Hub Dam Road.

Figure 6: Access Road from Hub Dam Road to the Treatment Plant.

1.3 SITE CONDITIONS

The provisions of this document are provided for information purposes only and will not relieve the Company of any liability it may otherwise have in relation to the conditions of the Site. The Company shall perform its own due diligence in terms of the existing Site conditions, including the potential impact of existing and future infrastructure in the proximity of the Site.

The KWC was designed and constructed around four (4) decades ago and has been in operations ever since. A facility assessment has been carried out while preparing the technical feasibility which can be found at RFP Volume II Annexure 1 Due Diligence Relevant Information.

1.4 OVERVIEW OF THE WATER SUPPLY SYSTEM FROM HUB DAM

The canal system of the Hub Dam consists of the WAPDA Canal (10.48 m^3/s and 8.32 km) that branches off at the Head Regulator into KWC (5.26 m^3/s and 21.15 km) and Lasbela canal (4.53 m^3/s and 33.6 km). At the Head Regulator, waters transferred to Lasbela and KWC are controlled by WAPDA personnel with manually operated vertical gates.

The following sources of water exist with respect to KWC at the pumping station:

- KWC, which currently contributes with a median output of 82 MGD of water throughout the year;

- KIII Conduit, an alternate bulk water source scheme which serves the other part of Karachi. The decision of using this second source to fill any water deficit coming from the WAPDA Canal is on KW&SB, whilst the Company shall be responsible for making this infrastructure available during the Concession Period, but in no circumstances shall the Company be permitted to benefit from use of water from the KIII Conduit and the same shall not constitute a waiver of their obligations under the Project.

- The Company is required to ensure that during the C&O Period, the water losses (%) and the electrical specific consumption (kwh/m^3) at the KWC, are not higher than the respective values for Allowable NRW and the Contracted Specific Net Electricity Consumption as specified in the Mobilisation Testing Acceptance Certificate as per the Mobilisation Testing criteria in appendix 5 of the Concession Agreement.

- The Company is required to ensure that following completion of the C&O Activities, the KWC can transfer up to 100 MGD (5.26 m^3/s) of water, meeting the offered contractual conditions for the Operating Period in respect of Output Water Quality Specifications, Allowable NRW, Contracted Specific Net Electricity Consumption and Outages.

Figure 7: KWC, KIII Conduit, Old and New Pump Houses – Present Configuration.

The KWC, which runs downstream of the Head Regulator, currently includes the following components:

- eleven (11) concrete aqueducts and fifteen (15) culverts;
- a road bridge, and several drainage and pedestrian bridges;
- Water Access Connection Points;
- KIII Conduit connection to provide up to a maximum of twenty (20) MGD of water, in the event water from the Hub Dam cannot match the required demand;
- by-pass system within KW&SB land boundaries, to direct discharge by gravity to the sea under extraordinary circumstances when the water received cannot be managed properly at the pumping station, the Treatment Plant, or the Reservoir;
- an old pump house (*circa* 1981) constituting of (6) pumps, with four (4) pumps having capacity of 24 MGD (1.263 m^3/s) and two (2) pumps with capacity of 12 MGD (0.63 m^3/s);
- a new pump house (2006) constituting of six (6) pumps, with four (4) pumps having capacity of 35 MGD (1.841 m^3/s) and two (2) pumps with capacity of 17.5 MGD (0.92 m^3/s);
- three (3) rising mains between the pump houses and the Treatment Plant;
- a Treatment Plant (2005), initially designed for 100 MGD (5.26 m^3/s), but with an actual treatment capacity of 80 MGD (4.31 m^3/s);
- an existing rectangular, semi buried, concrete Reservoir, with 15 MG (68,170 m^3) capacity; and
- KE grid at 11 KV power supply.

More relevant details can be found in RFP Volume II Annexure 1 Due Diligence Relevant Information.

1.5 AREA OF ACTION WITHIN THE CONTRACT

The area of operation affected by the Concession Agreement is defined from downstream of the Head Regulator to the point of connection after the Reservoir to the Output Water Connection Point.

Consequently, the section between the Hub Dam and the Head Regulator, and the following infrastructures are beyond the scope of the Project: Hub Dam downstream gate and Lasbela canal's and KWC's main gates at the Head Regulator, which are under the responsibility of the WAPDA. The Company, however, is required to install, maintain, and operate the HD Input Water Metering System.

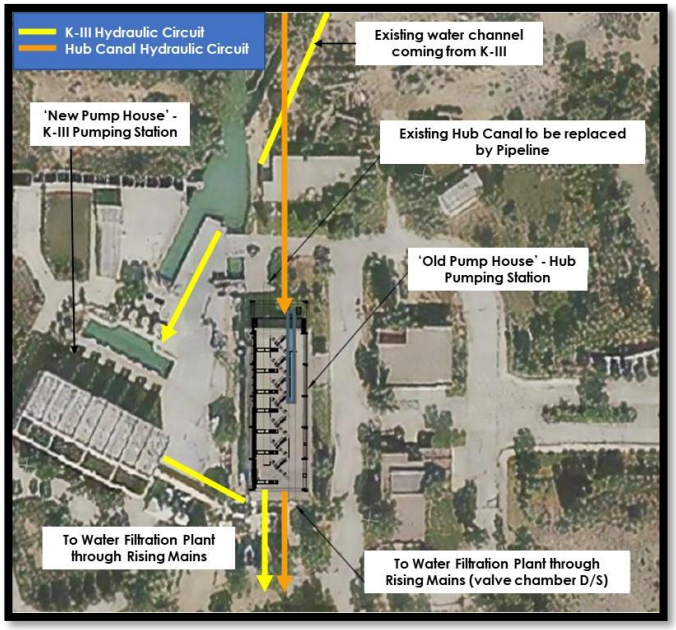
2. PART 2: SCOPE OF WORK & DESIGN BASIS

2.1 OVERALL PROJECT SCOPE OF WORK

The primary objective of the Project is to review, update and design, finance, build, rehabilitate, operate, maintain and, at the end of the Concession Period, transfer the KWC, ensuring that up to 100 MGD (5.26 m^3/s) of water can be delivered successfully, minimizing the losses and achieving the quality parameters specified for the Project. To accomplish the foregoing goals, the potential bidders shall make a proposal that should consider following measures:

- methodology for preparation of a Detailed Engineering Design, with the necessary surveys and campaigns;
- interventions upstream the Head Regulator, that is, installation and operation and maintenance of the HD Input Water Metering System. The exact location of the HD Water Connection Point shall be agreed with WAPDA;
- interventions downstream the Head Regulator (main gates are beyond the scope of the Project);
- the rehabilitation of approximately the first eleven kilometres (11 km) of the KWC;
- the rehabilitation of the aqueducts Nº 1 to Nº 10;
- construction of a new water transmission pipeline, with a length of about nine point eight kilometres (9.8 km);

- the construction of a new pump station at the old pump house;
- the refurbishment of the new pump house (if required in the opinion of the Company) to transfer the water coming from the KIII Conduit;
- the construction of a new valve chamber;
- the construction of a new rising mains, with a length of two point two kilometres (2.2 km);
- the refurbishment, and extension or adaptation to new needs of the Treatment Plant for capacity of 100 MGD;



- rehabilitate the existing rectangular, semi-buried, concrete Reservoir, with 15 MG (68,170 m^3) capacity, including, if necessary, the existing equipment;
- electrical rehabilitation and upgrade if necessary;
- a Solar Plant and electric connections (if required in the opinion of the Company);
- the automatization of control gates, and installation of required communication equipment;
- design and installation of a centralized SCADA and metering systems for management of the KWC, including the HD Input Water Metering System;
- laboratory, offices, and parking area;
- access roads rehabilitation;
- other Project Activities, such as relocation of existing utilities;
- provision of utilities for the Project Activities. There is an existing electricity connection in the name of KWSB which will be used for the Project Activities;
- development and implementation of an Environmental and Social Management Plan;
- operation and maintenance of the KWC for one point five (1.5) years during the C&O Period;
- operation and maintenance of the KWC for the Operating Period, i.e., fifteen (15) years after the Project Commercial Operations Date; and
- handover of the KWC to KW&SB in accordance with clause 21.10 of the Concession Agreement.

Additionally, the Company shall be responsible to deliver all such generic services for the Project as required, including:

- Project management, including Contactors' and sub-contractors' management and supervision, and all reporting activities during the different phases of the Project;
- process, equipment and civil detail designs and engineering works;
- provision of online collaboration and management system in relation to the Project for all Parties;
- provision of vehicles and tankers required for the Project, as specified herein;
- implementation and supervision of equipment, consumables, and spare parts procurement;
- implementation and supervision of all administrative systems and services of KW&SB;
- application and provision of Insurance Policies and Performance Securities in accordance with the Concession Agreement;
- preparation of the ESIA and obtaining the approval thereof; and
- procurement of all other required Approvals.

The KWC should be able to manage 100 MGD (5.26 m3/s).

Additional information to be used for the design can be found in Volume II Annexure 1 Due Diligence Relevant Information.

The correction factors in the payment mechanism and tariff structure under the Concession Agreement and appendix 8 thereto make allowances for variances in flow (non-revenue water), outages, electricity consumption and water quality with respect to the water entering the KWC and subsequent adjustments to the relevant Service Payments.

The Normal Influent Range and 100 MGD flow should be used as the minimal design basis of the KWC and overall Treatment Plant design (where applicable). The bidders shall make their own design decisions and risk assessment of optimum design within these parameters to ensure the Contracted Availability and compliance with quality standards and other performance and functional specifications. The specified design flows and maximum loadings shall be applicable regardless of weather conditions (including, whether dry or wet) and can be expected at any time during an annual climatic cycle.

2.2 SURVEYS & TECHNICAL STUDIES

The bidders will have access to the studies carried out as part of the technical feasibility in RFP Volume II Annexure 1 Due Diligence Relevant Information. However, the provision of such information shall not relieve the Company of any of its liabilities or obligations under the Project, and the Company shall remain responsible for (i) conducting its due diligence, (ii) obtaining all necessary information as to the risks, contingencies and other circumstances which may influence or affect the implementation of the Project, and (iii) assessing and confirming the data made available by the KW&SB and assuming all risks associated therewith under the Project Agreements.

The GoS Parties make no representations whatsoever, express, implicit or otherwise, regarding the

accuracy, adequacy, correctness, reliability and / or completeness of any assessment, assumptions, statement or information provided by either GoS Party and the Company confirms that it shall have no claim whatsoever against either GoS Party in this regard.

By way of summary, the studies that have been carried out as part of the technical feasibility are:

- **Topography study**: the topographical surveys carried out cover a wider buffer from the existing KWC axis and allow the Company to better analyse its alternatives, though it is entitled to remain in the existing right of way;

- **Flow measurement**: two (2) flow measurement campaigns have been carried out to serve as a starting point for hydrological analyses and flow estimation;

- **Hydrological Study**: this study has been developed with the aim to clarify the design flow that best matches the actual water conveyed by the KW&SB;

- **Water quality analysis**: in addition to KW&SB's historical documentation of water quality data, two (2) test campaigns have been carried out in the KWC, which serve as a basis for establishing the degree of compliance with the water quality standards currently provided by the Treatment Plant. Furthermore, a water quality test of the KIII flow required to elucidate the best option for including this flow in the design has been made available;

- **Geological, geotechnical and geophysical surveys**: a vast variety of surveys have been developed, including boreholes, laboratory tests, electrical soil resistivity tests, ferro scanning of RCC structures, and tomography. The soil resistivity tests have allowed the confirmation of the corrosion potential of the soils, which combined with the waters from the Hub Dam, have a high corrosion potential for iron or steel pipes. The ferro scanning and impact hammer have allowed to assess the conditions of reinforced concrete structures and buildings, and the tomography along the KWC has clearly identified the seepage from the KWC and consequent feeding of the groundwater. Finally, the geological mapping has allowed the determination of the percentage of soil and rock excavation in the pipeline stretch and has defined with accuracy the type of materials that lay underneath the KWC sections;

- **Seismic analysis**: during the on-Site visual inspections, it was noticed that the structural members (built around forty (40) years ago) are sufficiently sized and have withstood past earthquakes. Further, as Karachi falls under the seismic zone 2B, it can be concluded that the structures can perform adequately in case of an earthquake event;

- **Solar Plant feasibility study**: a complete study has been developed to identify such site of the Solar Plant that better fits the requirements of the Project. The site has been identified as the area next to the Treatment Plant, spanning over fourteen point five hectares (14.50 ha). The estimated global irradiation for the identified area is 1,944 kWh/m^2 and diffuse irradiation is estimated at 900.4 kWh/m^2 (46%), which makes the site suitable for solar power generation; and

- **Preliminary natural risk assessment**: it has been found that, a priori, the area is not vulnerable to the effects of the main agents (earthquakes and floods).

In any case, the Company is responsible for developing a Detailed Engineering Design and Construction Drawings for the rehabilitation and construction of the KWC, including all necessary additional surveys and technical studies.

2.3 LAND RIGHTS & ACCESS TO THE PROPOSED SITES

According to the collected documentation, the implementation of the proposed solutions should not require a new Land Acquisition and Involuntary Resettlement Process (LARP) because all areas involved would be owned by the KW&SB.

The Company shall develop a Detailed Engineering Design to verify the proposed design that recommends and considers that all C&O Activities remain within the existing RoW, and the proposed design also stays within the existing RoW. All these issues should be considered in the Detailed Engineering Design and the ESIA put forward by the Company.

In the event that such land is not within the RoW, or the Company needs additional temporary land, it would be the Company's responsibility to carry out a study about the ownership, to make available the land through a direct agreement with the owner or assess the need to resort to an expropriation process in accordance with the Legal Requirements as well as the procedures set out in IFC's Performance Standard 5.

Additional information on this matter along with the information on the utilities could be consulted in RFP Volume II Annexure 1 Due Diligence Relevant Information.

2.4 MOBILISATION ACTIVITIES

The Mobilisation Activities will take place during the Mobilisation Period, and they will lead the Company to be ready for receiving the facilities from KW&SB and begin responsibility for operations during the C&O Period.

At minimum, the equipment listed below shall be installed, tested and commissioned during the Mobilisation Period. The Company shall maintain such equipment throughout the Concession Period.

Ref.	Type	Metering Station	System description	Equipment/ Methodology
M1	Compliance Monitoring	Downstream of Head Regulator KW&SB gate. Metering and monitoring system. (Redundancy)	Raw water monitoring point: Downstream of the Head Regulator Canal's facilities; measure against design envelope, technical and correction limits; hourly metering.	Flow Meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.

Ref.	Type	Metering Station	System description	Equipment/ Methodology
M2	Compliance Monitoring	At each one of the Water Access Connection Points. (Redundancy)	Raw water monitoring point at: - Hamdard University; - Hamdard Laboratories; - Sherriar Ashraf (Gulf Mineral); - Public Health Engineering and Rural Department (Government of Sindh); - Marble City connection (if instructed by KW&SB during Mobilisation Period).	Flow Meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.
M3	Compliance Monitoring	Downstream of KIII Conduit, KW&SB valve. Metering and monitoring system. (Redundancy)	Raw water monitoring point: Downstream of KIII Conduit valve; measure against design envelope, technical and correction limits; hourly metering.	Flow Meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.
M5	Compliance Monitoring	Water quality metering and monitoring system. Pump station.	Monitoring of water quality for blended water from Hub Dam and KIII Conduit. Downstream of pump station and upstream of Treatment Plant; hourly metering.	Flow meter online water quality metering; auto-sampler and / or manual sampling point.
M7	Compliance Monitoring	Bypass flow metering & monitoring. (Redundancy)	Downstream of the existing discharge KWC connection point for measuring volumes. Hourly metering.	Flow meter (+ parallel back-up meter required)

Ref.	Type	Metering Station	System description	Equipment/ Methodology
M8	Compliance Monitoring	Water quality and flow metering & monitoring system for Net Water Output. (Redundancy)	Downstream of the Output Water Connection Point, water quantity and water quality. Hourly metering.	Flow meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.

The aforementioned table summarizes the water flow and water quality monitoring requirements (including sampling points) for the KWC prior to the start of the C&O Period. Section 2.6.2 provides the general scheme for monitoring and metering points detailed above.

During the Mobilisation Period, the contractual limit for Allowable NRW, Output Water Quality Specifications and Contracted Specific Net Electricity Consumption, that will be enforced during the C&O Period, will be defined through Mobilisation Testing (as detailed in appendix 5).

All monitoring, metering, sampling and testing of raw water and potable water shall be done at least one (1) daily sample at each point shall be analysed in full compliance with the National Water Quality Laboratory (NWQL), including compliance with the Output Water Quality Specification and recommendations as a minimum criteria, and shall be fully aligned to measure all parameters as required by the performance specifications. Detail of the sampling points are mentioned in the table above.

The physical samples taken on a daily basis will be analysed in an external accredited laboratory. The laboratory shall be proposed by the Company to the Independent Engineer for approval at least thirty (30) days before the scheduled starting date, including all the required certificates in the proposal.

2.5 CONSTRUCTION & OPERATION ACTIVITIES

2.5.1 *Detailed Engineering Design*

The Company shall develop a Detailed Engineering Design with all the necessary surveys and field campaigns to define all C&O Activities envisaged to undertake and complete the Project, according to the minimum functional requirements defined herein.

2.5.2 *Project Activities downstream the Head Regulator*

The Karachi and Lasbela canal's main gates are under the responsibility of WAPDA, and therefore beyond the scope of the Project.

The Company shall design and install a state of art facility for the purpose of measuring the flow rate at the beginning of KWC, to be located, downstream, as close to the existing Head Regulator sluice gates as the hydraulic conditions of the KWC regimen allows (minimum 50-100 m downstream). The aim is to allow the collection of data related to the quantity and quality of water entering the KWC. This facility shall provide the following capabilities:

- flowmeter device to measure up to 5.26 m³/s downstream of the Head Regulator;
- manual and automatic operation system;
- coated metallic structures and manoeuvring elements;
- data logger and radio communication with downstream gates and CCU;
- control pedestal, radio mast and photovoltaic module;
- fencing and anti-vandalism infrastructures;
- online and continuous water quality analysis equipment; and
- permanent sample point for monitoring water quality on a regular basis through third party analysis.

2.5.3 *Rehabilitation of the KWC*

The Company shall design the refurbishment works to adequate the KWC from the Head Regulator P.K. 0+000 up to P.K. 11+ 390 as to guarantee the conveyance of 100 MGD water flow (5.26 m³/s) under normal circumstances.

The C&O Activities shall be designed considering the critical requirement of ensuring that the KWC remains operational during the C&O Period. Therefore, the proposed solution presented by the bidders shall meet this mandatory requirement, with no other alternative solution being acceptable.

The designs shall be conducted based on the Building Code of Pakistan, the Sindh Canal Rules, and other relevant national and federal standards in force. The side canal lining shall be designed to minimize the losses of water and to meet (at minimum) the Allowable NRW.

In order to control the water flow delivered at the KWC, redundant flowmeters shall be installed at any intermediate water delivery points. The flowmeters shall be calibrated accordingly and connected to the SCADA to be provided at the CCU.

The rehabilitation of the existing KWC shall be conducted, considering the existing alignment and geometry. The bidders are required to propose a feasible solution for conducting the required rehabilitation works, guaranteeing at all times the continuity of the service offered by the existing KWC.

2.5.4 *Rehabilitation of the Aqueducts Nº 1 to Nº 10*

The Company shall study the existing aqueducts (Nº 1 to Nº10) and shall design adequate Project Activities as to guarantee the conduction of design flow with no water loses and the structural stability during the expected life of the infrastructures.

2.5.5 *KIII Conduit Connection Point with the KWC*

Before the pump station, the KIII Conduit connection point to the KWC has to be managed by the Company, implementing the flowmeter and quality monitoring system as specified herein, that is, the Primary KIII Input Water Metering System, the Back-up KIII Input Water Metering System, and the KIII Input Online Quality Monitoring System. K-III can provide up to 20 MGD to the system when Hub Reservoir is not capable of delivering 100 MGD into the KWC.

2.5.6 *Construction of a New Water Transmission Pipeline*

At PK 11+390, the significant slope of the KWC and the existence of a section of about three kilometres (3 km) with an excessive water velocity made KW&SB consider the construction of a new pipeline in the final section of around nine point eight kilometres (9.8 km) (P.K. 11+390 to P.K. 21+190) of the KWC for a flow of 100 MGD (5.26 m^3/s) of water.

A concrete infrastructure to act as a surge / intake chamber shall be designed as to allow the transition from the open canal to the pipe inlet. Since there will not be a load breakage at the pipe arrival at the pump station, the design of the surge chamber shall ensure that there is no intrusion of any solids or sand, that could damage the pump blades.

The intake chamber shall be provided with a level sensor as to be able to control the availability of water within the supply system. This level sensor shall be connected with the SCADA at the CCU.

This infrastructure shall include a diversion in case the pipeline system should need to be closed, in order to retain the water within the KWC and drain the water possible spills.

A flow meter shall be installed upstream the pipeline intake and provided with digital data capture and communication infrastructure to allow communication with the CCU.

An approximately nine point eight kilometres (9.8 km) long gravity pipe is proposed to connect the KWC with the new pump station located at current P.K. 21+000, approximately. This pipeline's final length, material, nominal pressure and diameter are to be proposed by the bidders. The pipeline alignment and protection shall be executed according to Good International Industry Practices.

The drainage and air / vacuum valves shall be implemented along the pipe to protect against the abnormal flow conditions in the pipe. Depending on the selection of the pipeline material, at locations of all changes in alignment (i.e., along pipe bends), the bends shall be encased in concrete, and thrust blocks shall be provided if necessary.

The drainage valves shall be globe valves to discharge the pipe flow to the nearest drain in case of emergency repairs.

The pipe outlet shall be provided with a control system to regulate the flow for seasonal variation. Before the valve and operation room, a thrust block is proposed to absorb the transient effects.

Additionally, flowmeters (non-contact ultrasonic flow meter or electromagnetic flowmeters), shall be installed at different sections to control possible water loses from the piped network. All units shall be provided with data loggers and communication devices that send data to the CCU.

Proper protection shall be given to metal surfaces using paints or other protective coatings and / or by cathodic protective devices, as per the applicable standards.

The Company must adapt their design during the C&O Period at their own cost and expense to consider any crossing or parallelism of the pipeline with existing pipes, asphalt roadways, electric poles, fibre optic lines, train railways as well as any other crossing.

2.5.7 *Construction of a New Pump Station at Existing Old Pump House*

The Company shall design a new pump station of 100 MGD capacity, to elevate water to the Treatment Plant inlet.

Different alternatives such as a traditional pump station or a solution based on booster pump units are accepted for the tender design. The bidders are encouraged to propose innovative solutions to minimize the CAPEX and OPEX for the Project.

The minimum technical specifications for the pump station are:

- a total capacity for 100 MGD;
- number of pumps, design flow, head and electric potential of each proposed pump and spare pumps;
- necessary pump head, taking into account that the input water is considered to have around twenty (20) m of energy per unit weight of water;
- installation of butterfly valves with dismantling joints, check valves, and air release valves;
- electromagnetic or ultrasonic flowmeters;
- surge vessels to avoid pipeline vacuum and hydraulic transient effects; and
- management of the pump station, which shall be done both on Site, and from a SCADA to be implemented at the CCU.

The Company shall design the communication system so as to allow a bi-directional communication between the pump station and the CCU.

The Company is entitled to analyse potential alternatives related to the replacement of the old pump station and the rehabilitation of the new pumping station.

2.5.8 *Rehabilitation of the New Pump Station: K-III Pump Station*

The existing new pump house shall convey KIII waters to the Treatment Plant. The replacement of all the mechanical equipment and associated valves along with refurbishment of the building shall be considered. Further, the chain raked screens and travelling band screens shall be replaced in this new pumping station.

The Company is entitled to analyse potential alternatives related to the replacement of the old pump station and the rehabilitation of the new pump station.

2.5.9 *Construction of a New Valve Chamber*

The Company is entitled to analyse the proposed design of a new common valve chamber downstream of the new KWC pump station (to be constructed at the current location of the one identified as “old pump house”) so as to be able to manage water flows from KWC and KIII to be delivered to the Treatment plant through the rising mains. A complete set of manholes shall be provided so as to be able to manage both systems.

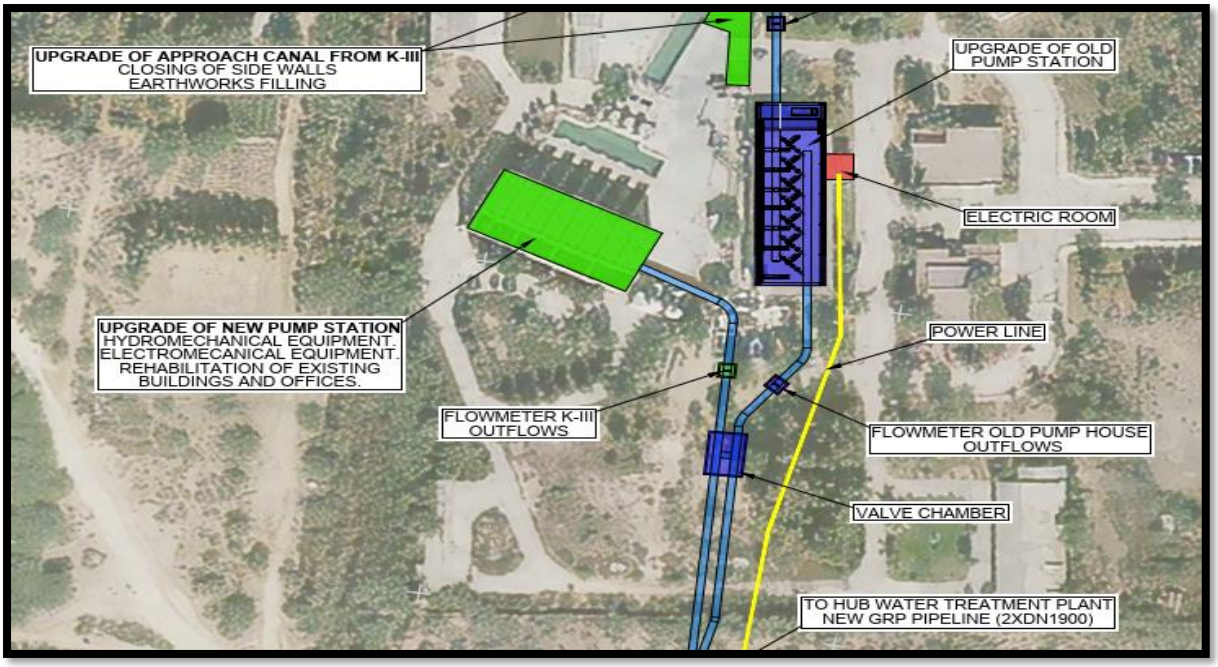


Figure 8: General Scheme for the Configuration of the Valve Chamber.

The Company shall provide a complete controlling system for:

- measurement of each flow, from (i) KWC and (ii) KIII Conduit;
- measurement of the quality of the waters coming from both water supply systems; and
- monitoring and connection to the new SCADA and metering system to be provided by the Company.

2.5.10 *Construction of New Rising Mains*

From the valve chamber, a double pipe network is proposed to conduct water up to the Treatment Plant inlet. The bidders are entitled to analyse potential alternatives and submit their technical proposal.

The solution retained at the document Volume II Annexure 1 Due Diligence can be used as a starting point for the proposal. The proposed solution shall consider:

- number of identical pipes to be implemented and nominal diameter;
- the proposed thickness of each pipeline should allow for safe operations and maintenance, and prolong the life of the pipelines with least damage accruing under normal operating conditions over a period of more than thirty (30) years;
- the Company must guarantee suitability and thickness of the pipe to satisfy all load requirements;
- grounded installation, with at least one point five metres (1.5 m) depth at upper generatrix; and
- cathodic protection only in metal sections (initial and final part and manholes deviations, if need be).

Proper protection shall be given to metal surfaces using paints or other protective coatings and / or by cathodic protective devices.

- AWWA D102 Coating Steel Water Storage Tanks;
- AWWA Standard D-103 Factory-Coated Bolted Steel Tanks for Water Storage; and
- AWWA D104 Cathodic Protection for Interior of Steel Water Tanks.

The Company must adapt their design during the C&O Period at their own cost and expense to consider any crossing or parallelism of the pipeline with existing pipes, asphalt roadways, electric poles, fibre optic lines, train railways as well as any other crossing.

2.5.11 *Rehabilitation and Upgrade of the Treatment Plant for 100 MGD*

The main goal is the refurbishment and upgrade from capacity of 80 MGD up to 100 MGD (5.26 m^3/s), with the aim of obtaining a Treatment Plant that is compliant with World Health Organization's and Pakistani standards (both include IFC Performance Standards), consistent with the bidder's proposal and meeting the requirements stated in the Concession Agreement.

The rehabilitation and upgrade works for the existing Treatment Plant shall consider:

- the analysis and assessment of the existing infrastructures;
- the upgrade of the existing infrastructures;
- the design of new infrastructures, if required;
- the implementation of level sensor(s) at the water storage facility(ies) as to manage the availability of water within the supply system, to be connected with the new SCADA system; and
- the upgrade and implementation of a SCADA and metering system.

The bidders may include their designs for the Treatment Plant upgrade, in accordance with the Legal Requirements, and considering as a minimum:

REHABILITATION	NEW ITEMS
• Replacement of all mechanical equipment, pipes, and valves; • Replacement of all electrical equipment and the generator; • Change of the "average" and the existing aeration system in the filters; • Rehabilitation of the chemical building by changing tanks, pipes, pumps, and valves; • Checking / rehabilitation of civil works on faulty tanks and buildings.	• Introduce flow meters, instrumentation (pH, turbidity, residual chlorine, etc.) and SCADA in the plant. • Expand the filters area with four (4) new filters (total twenty (20) = sixteen (16) existing + four (4) news) + new pumps and blowers for these filters. (Nº 2 layout below); • New Sludge Building including sludge pumps, a decanter centrifuge, a polyelectrolyte package with its own pumps, and a sludge storage area;

Additional information about the Treatment Plant can be found in Volume II Annexure 1 Due Diligence Relevant Information.

2.5.12 *Rehabilitate the Existing Reservoir (with Capacity of 15 MGD)*

The main goal is the refurbishment of the existing rectangular Reservoir, built in concrete and semi-buried, with 15 MG (68,170 m³) capacity, including, if necessary, the refurbishment and upgrade of the existing equipment.

The Company shall provide water from the Reservoir that meets the Output Water Quality Specifications for three (3) hours in any day to be used as back-up in the event of non-supply of water from the Head Regulator or KIII, or electricity outage.

2.5.13 *Electrical Rehabilitation and Upgrade if Necessary*

The Good International Industry Practices shall cover the basic guidelines and requirements for the design and supply of the electrical systems and equipment to be provided for the entire system.

Electricity grid connection at the electricity interconnection point of KWSB is to be used for the Project Activities.

The bidders shall propose the technical solution for the electrical system to be installed to operate in automatic mode with provisions to operate also in semi-automatic, in manual mode and for the operation and control of the entire system.

No single power component failure shall:

- cause any danger to personnel or the KWC;
- invalidate protection by inhibiting a trip;
- shut down more than one major equipment item;
- simultaneously trip a KWC component and invalidate its auto-changeover; and / or
- affect more than one plant group or process area.

Duty / standby and / or duty / assist / standby may be utilised as determined by the process design and mechanical equipment selection with all electrical equipment / controls being fail-safe.

The Company shall design and install a complete operating electrical system, without the need for additional equipment or wiring to make the systems fully functional.

The power system arrangement shall be selected based on evaluation of such factors as service continuity, reliability, flexibility, investment cost, and operations and maintenance requirements.

All equipment shall be of applicable standards and reliable design, in accordance with Good International Industry Practices. The highest extent of uniformity and interchangeability shall be realised. The design shall facilitate easy maintenance and repair of the components.

2.5.14 *Photovoltaic Plant and Electric Connections*

A complementary on-Site power supply system might be considered by the Company, as proposed in the conceptual design prepared in the due diligence report (see RFP Volume II Annexure 1 Due Diligence Relevant Information) or according to the best criteria of the Company (during the bidding process) considering the available land, by means of a Solar Plant. If implementing a Solar Plant is considered adequate, the transmission lines and other electrical facilities such as transformers or switchgears, shall be designed, installed, commissioned, tested, and operated in accordance with the Legal Requirements, and relevant international standards, including but not limited to those listed in the following sections.

The electricity generated from the Solar Plant shall be used for the internal consumption of the KWC only. The Company may also at their discretion install batteries or accumulators for the Solar Plant.

The Solar Plant shall integrate into the Site the electrical distribution network and include protection / disconnection of the renewable source in accordance with relevant Legal Requirements and Good International Industry Practices. It should be noted that supplementary on-Site power supply shall be limited by the land availability.

The bidders shall include, during the bidding stage and the preparation of the Detailed Engineer Design, a detailed proposal of any Solar Plant (if deemed to be required) to supplement power supply including load lists, connection points & interfaces, plans and details of the proposed implementation and operation of such infrastructure.

2.5.15 *Access Roads Rehabilitation*

The Company shall design, set up for the C&O Period, commission for the Operating Period, and maintain all access roads necessary for the performance of the Project Activities. This includes access to all components of the KWC, including the rehabilitated canal, new pipeline, pump stations and connection with KIII, rising mains, Treatment Plant, Solar Plant (if required), and all other appurtenant structures. The access roads shall remain within the area licensed under the License Agreement), notably along the two (2) sides of the existing KWC.

It is the responsibility of the Company to incorporate in the road design all the necessary features as per the current road standards, accounting for matters such as alignment, dimensions, drainage, signing, etc. The Company shall also prepare a plan to maintain access roads during the Mobilization Period and the Concession Period.

2.5.16 *Automatization of Control Facilities and Communication Equipment*

The management of the KWC shall be designed and operated in a state of art solution, based on a manual and automated systems.

Intelligent automated gates shall be installed at cross-regulating structures in series along the KWC. The overshot design and precision motor control shall provide fine control of the flow through the gates. Integrated sensors for an accurate measurement of levels and flow in real time shall be provided.

Accurate flow measurement, precise motor control, power supply and radio telecommunications shall be fully integrated in a single device. Flow shall be calculated from the gate’s own measurements of upstream water level, downstream water level, and gate position.

2.5.17 *Design and Installation of a Centralized SCADA and Metering System*

The Company shall design a centralized SCADA and metering system for management of the KWC infrastructures. It shall allow:

- obtaining information from the WAPDA Canal flow;
- obtaining information from the Head Regulator;
- the management of the KWC gates (if any), level sensors, quality parameters and flow metres;
- obtaining information from the KIII Conduit flow and water quality;
- daily monitoring of Net Water Output;
- the management of the new pipeline and flow metres;
- the management of the pump stations;
- the management of the Treatment Plant; and
- the management of the Solar Plant.

It will provide a modular and scalable architecture to enable specific modules to be easily and quickly installed and configured. The new SCADA shall be located at a CCU at a new or adequate room at an accessible site (the pump station or the Treatment Plant).

The management of the KWC shall be designed and operated in a state of art solution, based on a manual and automated systems. In any case, intelligent automated gates shall be installed at cross-regulating structures in series along the KWC. The overshot design and precision motor control shall provide fine control of the flow through the gates. Integrated sensors for an accurate measurement of levels and flow in real time shall be provided.

Accurate flow measurement, precise motor control, power supply and redundant telecommunications shall be fully integrated in a single device.

2.5.18 *Monitoring Methodology during the C&O Period*

When the KWC is handed over to the Company, the minimum equipment to be installed, tested and commissioned during the Mobilization Period should be in place, and it will be maintained during the Concession Period.

2.5.19 *Non-rehabilitated KWC Components*

During the C&O Period, the components of the KWC which are removed or replaced and not rehabilitated by the Company shall be handed over to KW&SB.

2.5.20 *O&M Activities during the C&O Period*

During the C&O Period, the Company shall execute the operation and maintenance activities in accordance with Operating and Maintenance Procedure to ensure, at minimum, the KWC continues to comply with the results / parameters established during the Mobilisation Testing.

2.6 OPERATION AND MAINTENANCE ACTIVITIES (O&M ACTIVITIES)

2.6.1 *Monitoring, Metering & Testing Requirements during the Operating Period*

The following are outline descriptions of the minimum flow and water quality monitoring requirements for the KWC, taking into consideration the performance specifications and compliance monitoring methodology. Flow and quality monitoring devices shall be installed, based on Good International Industry Practices, at the following locations, with reference to the metering and monitoring system schedule described below:

Ref.	Type	Metering Station	System description	Equipment/ Methodology
M0	Operational Monitoring	Immediately upstream of the WAPDA Canal.	Raw water monitoring point.	Flow meter.
M1	Compliance Monitoring	Downstream of Head Regulator KW&SB gate. Metering and monitoring system. (Redundancy)	Raw water monitoring point: Downstream of the Head Regulator Canal's facilities; measure against design envelope, technical and correction limits; hourly metering.	Flow Meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.
M2	Compliance Monitoring	At each one of the Water Access Connection Points. (Redundancy)	Raw water monitoring point at: - Hamdard University; - Hamdard Laboratories; - Sherriar Ashraf (Gulf Mineral); - Public Health Engineering and Rural Department (Government of Sindh); - Marble City connection (if not already installed during Mobilisation Period).	Flow Meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.

Ref.	Type	Metering Station	System description	Equipment/ Methodology
M3	Compliance Monitoring	Downstream of KIII Conduit, KW&SB valve. Metering and monitoring system. (Redundancy)	Raw water monitoring point: Downstream of KIII Conduit valve; measure against design envelope, technical and correction limits; hourly metering.	Flow Meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.
M4	Operational Monitoring	Total volume being managed by the KWC.	Monitoring volume that reaches the pump station from different sources. Upstream of pump station.	Flow meter possibility to implement water quality metering.
M5	Compliance Monitoring	Water quality metering and monitoring system. Pump station.	Monitoring of water quality for blended water from Hub Dam and KIII Conduit. Downstream of pump station and upstream of Treatment Plant; hourly metering.	Flow meter online water quality metering; auto-sampler and / or manual sampling point.
M6	Operational Monitoring	Treatment Plant production metering and monitoring system and control point for potable water quality.	Treatment Plant production monitoring point: Measure plant capacity / availability on hourly basis. Downstream of the Treatment Plant; upstream of supply point to potable water storage.	Water quality metering. Possibility to implement a single flow meter; manual sampling point
Reservoir volume	Operational Monitoring	Reservoir volume metering & monitoring for operational purpose.	Measure availability of storage on an hourly basis.	Sensor within each reservoir to determine overall storage availability within ±2% accuracy; possibility to implement water quality metering.

Ref.	Type	Metering Station	System description	Equipment/ Methodology
M7	Compliance Monitoring	Bypass flow metering & monitoring. (Redundancy)	Downstream of the existing discharge KWC connection point for measuring volumes. Hourly metering.	Flow meter (+ parallel back-up meter required)
M8	Compliance Monitoring	Water quality and flow metering & monitoring system for Net Water Output. (Redundancy)	Downstream of the Output Water Connection Point, water quantity and water quality. Hourly metering.	Flow meter (+parallel back-up meter required); online water quality metering; auto-sampler and / or manual sampling point.

Table 1: Minimum flow and water quality metering & monitoring systems for the KWC.

Additional metering and monitoring equipment can be installed by the Company, for redundancy or internal control purposes, at any part of the KWC infrastructure.

All flow meters, online meters, auto samplers and, where applicable, back-up equipment, forming part of the metering and monitoring systems shall be maintained and calibrated regularly. The calibration of the flow and water quality meters shall be certified every six (6) months by an accredited third-party agency and the results shall be reported to the Independent Engineer. The metering and monitoring systems shall also include adequate metering and monitoring of power supply and consumption of the KWC in accordance with the Concession Agreement.

All monitoring, metering, sampling and testing of raw water and potable water shall be done online and also at least one (1) daily sample at each point shall be analysed in full compliance with the National Water Quality Laboratory (NWQL), including compliance with the Output Water Quality Specification and recommendations as a minimum criteria, and shall be fully aligned to measure all parameters as required by the performance specifications. Detail of the sampling points are mentioned in the section above.

This shall include Good International Industry Practices and accepted methods and standards of QA/QC in terms of validating all monitoring, metering, sampling and testing results.

The Company shall make available the Metering Systems and Monitoring Systems data to the Independent Engineer online and in real time through a website or an APP, and the most relevant data shall be included in the reports submitted by the Company.

The physical samples taken on a daily basis will be analysed in an external accredited laboratory. The laboratory shall be proposed by the Company to the Independent Engineer for approval at least thirty (30) days before the scheduled starting date, including all the required certificates in the proposal.

The KWC shall use the existing facilities to dump the water not meeting any of the above quality requirements. These facilities shall be designed to the extent possible to ensure that decisions can be made before the water reaches the pump station and after the water exits the pumping stations through the bypass infrastructure, to guarantee that no off-specification quality water will pass the Output Water Connection Point unless it is accepted by the Independent Engineer. These facilities will comprise but not be limited to:

- online water quality monitoring system upstream of the pump station, measuring water turbidity, pH, alkalinity and conductivity;
- regardless of the final configuration proposed for receiving water from the KWC and KIII Conduit, the proposed solution must integrate the possibility of diverting the flow to the existing outfall channel; and
- the Company shall monitor the water quality requirements by means of calculations and measurements to be taken at the Output Water Connection Point to demonstrate the quality of the water dispatched to KW&SB.

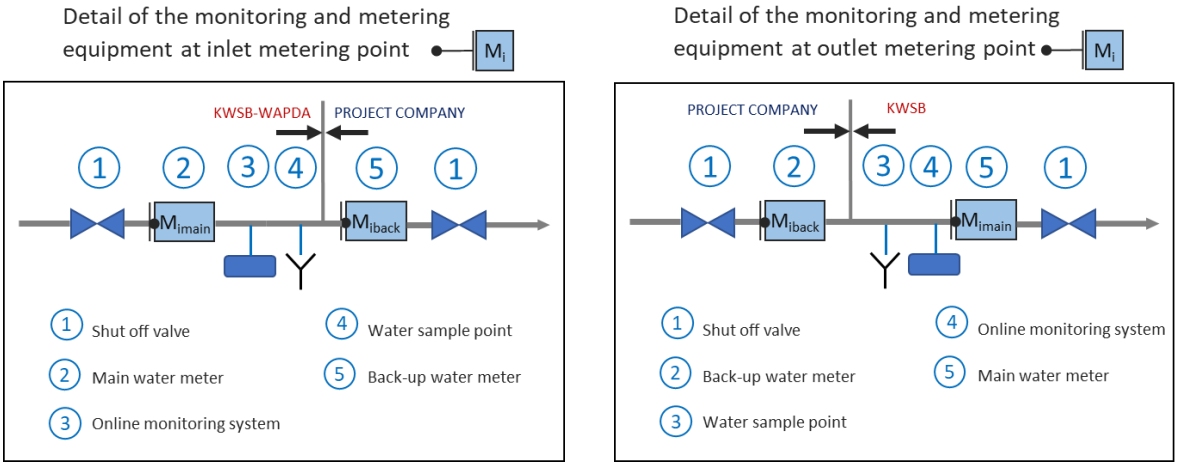


Figure 9. Examples of Connection & Metering Details.

A complete set of measuring devices shall be defined by the Company, to be connected with the new SCADA System. This set of instrumentation shall provide baseline information for the establishment of the bills and making of Service Payments to the Company during the Concession Period.

2.6.2 *Compliance Monitoring Methodology during the Operating Period*

The following outline compliance monitoring methodology will be followed:

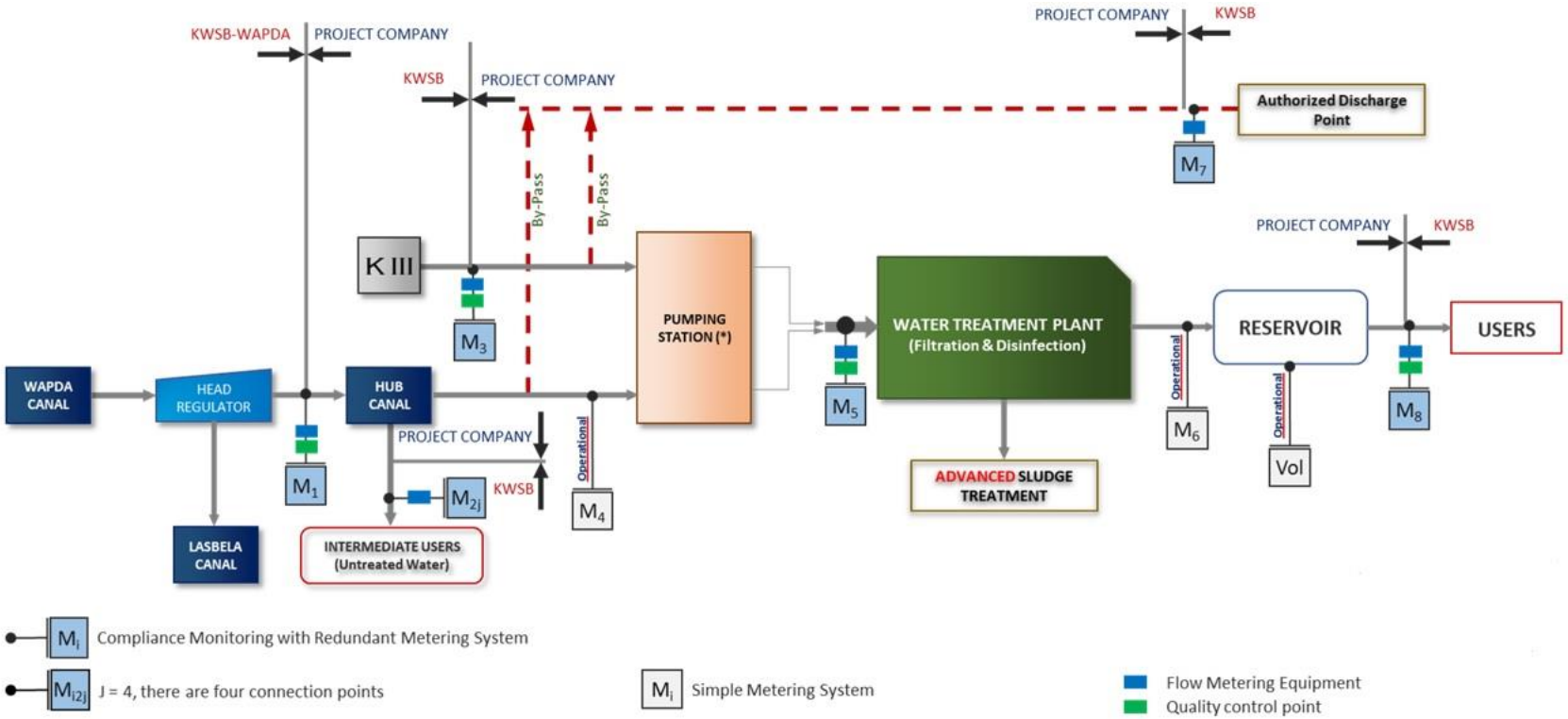


Figure 10: General Scheme for Monitoring during the Operating Period.

STEP 1: Immediately downstream of the Head Regulator gate, flow and quality will be measured and monitored continuously (at compliance metering station M1) with hourly recorded hydraulic flows and online water quality monitoring which is validated by means of daily sampling by an accredited laboratory & quality testing which will confirm the raw water quality compared against the design envelope. Accuracy of flow and water quality metering shall be, at minimum, in compliance with the National Water Quality Laboratory (NWQL) recommendations. This shall also be used for calculation of Service Payments.

STEP 2: Untreated water will continue to be served to existing Water Access Point Consumers, that is, Hamdard University, Hamdard Laboratories, Sherriar Ashraf (Gulf Mineral), and Public Health Engineering and Rural Department (Government of Sindh). A metering system (M21, M22, M23 and M24) shall be installed by the Company to measure the flow served on hourly basis downstream of the valve to be implemented. This shall also be used for calculation of Service Payments.

STEP 3: Upstream the KIII Conduit interface point, flow and quality will be measured and monitored continuously (at compliance metering station M3) with hourly recorded hydraulic flows and online water quality monitoring which is validated by means of daily sampling by an accredited laboratory & quality testing which will confirm the raw water quality compared against the design envelope. Accuracy of flow and water quality metering shall be in compliance with, at minimum, the National Water Quality Laboratory (NWQL) recommendations. This shall also be used for calculation of Service Payments.

STEP 4: For internal O&M purposes and in order to monitor losses at the KWC, hydraulic flows to be recorded at M4. The Company is entitled to propose quality monitoring equipment if considered adequate to optimize the O&M procedures.

STEP 5: Before the Treatment Plant, flow and quality will be measured and monitored continuously (at compliance metering station M5) with hourly recorded hydraulic flows and online water quality monitoring which is validated by means of daily sampling by an accredited laboratory & quality testing. The main goal is recording off specs and polluted influent before the Treatment Plant and monitoring flow that reaches the Treatment Plant. Accuracy of flow and water quality metering shall be in compliance, at minimum, with the National Water Quality Laboratory (NWQL) recommendations. This shall also be used for calculation of Service Payments.

STEP 6: Water output will be measured and monitored continuously (at compliance metering station M6) with hourly recorded hydraulic flows. The Company is entitled to propose quality monitoring equipment if considered adequate to optimize the O&M procedures.

STEP 7: Hourly recorded hydraulic flows bypassed on the Treatment Plant to be measured at M7. Accuracy of flow and water quality metering shall be in compliance, at minimum, with the National Water Quality Laboratory (NWQL) recommendations. This shall also inform the calculation of Service Payments.

STEP 8: Liquid discharge quality and flow will be measured and monitored continuously (at compliance metering station M8) with hourly recorded hydraulic flows and online water quality monitoring which is validated by means of daily sampling & quality testing which will confirm the compliance with water quality requirements (receiving waters standards

or similar). Accuracy of flow and water quality metering shall be in compliance, at minimum, with the National Water Quality Laboratory (NWQL) recommendations. This shall also be used for calculation of Service Payments.

The Company shall monitor and measure all environmental performance requirements as well technical efficiencies to be in full compliance with Environmental and Social Requirements, including the latest requirements of the Pakistan Environmental Protection Agency, Government of Pakistan and / or the Sindh Environmental Protection Agency, Government of Sindh. Noise levels to be confirmed at specified points in compliance with operational noise specifications.

2.7 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) AND ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

The Company shall be required to complete an ESIA and detailed ESMP that is fully compliant with E&S Standards, IFC's sustainability framework, World Bank Group EHS (sector specific) Guidelines for Water and Sanitation, ADB's standards, and Environmental and Social Laws in order to obtain Environmental and Social Approvals from the Sindh Environmental Protection Agency, Government of Sindh and other Competent Authorities, provided that where there is a contradiction amongst the foregoing, the most stringent standards shall apply.

Further details can be found in *RFP Volume II Annexure 2: ESIA ToR.*

3. PART 3: TECHNICAL FUNCTIONAL SPECIFICATIONS

3.1 GENERAL REQUIREMENTS & DESIGN STANDARDS

This section describes the guidelines for the minimum technical requirements and functional specifications for the design and construction of the KWC.

All items provided by the Company shall be designed, supplied and installed in accordance with the more stringent of the Pakistani standards and international standards.

In addition to the technical requirements of this section, the selection of the technology, the design and the arrangement shall be suitable for the conditions of the Site and optimized efficiency requirements.

The Project Activities shall be designed, manufactured and configured in such a way that they will maximize the ability to provide potable water which shall comply with the relevant best practices and accepted standards as specified herein.

The Company shall apply a well-established component classification and identification system for the Project Activities. The SI (International System) system of units shall be used for design, drawings, diagrams, and instruments, etc prepared or utilized for the purposes of the Project.

Permits, Licences & Wayleaves

It shall be the responsibility of the Company to obtain wayleaves, any additional rights of way from the ones provided by KW&SB, and all requisite Approvals from Competent Authorities to carry out the Project Activities and to ensure that the costs of procuring such Approvals and wayleaves are included in the cost of the Project as quoted in the Proposal.

Design Standards and Codes

The Company shall ensure that the provision of the Project Activities is in accordance with the more stringent of the Pakistan's standards and international standards (acceptable standards indicated below or stated elsewhere in this document), codes and best practices, provided that where there is a conflict amongst the foregoing, the most stringent framework shall apply. The current editions of the standards, codes and best practices issued by the following organizations shall apply and be allowed for the Project Activities. Only the following international standards shall be used for the purposes of the Project:

- ASCE - American Society of Civil Engineers
- ASA - American Standard Association
- ACI - American Concrete Institute (USA)
- AISI - American Iron and Steel Institute (USA)
- AISC - American Institute of Steel Construction (USA)
- ANSI - American National Standard Institute (USA)
- ASTM - American Society for Testing and Materials (USA)
- ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers (USA)
- AASHTO - American Association of State Highway & Transportation Officials.
- ANSI/AWWA Standards - American Water Works Association
- AWS - American Welding Society (USA)
- BS - British Standards (UK)
- CP - Codes of Practice (UK)
- ICAO - International Civil Aviation Organization
- IFC - International Finance Corporation Policies and Standards
- BSICP - British Standard Institute Code of Practice
- WPCP - West Pakistan Code of Practice for Highway Bridges 1967
- NHA - National Highway Authority
- PS - Pakistan Standards (Pak)
- PCA - Portland Cement Association
- PSI - Pakistan Standard Institute
- PBC - Pakistan Building Codes
- SSPC - Steel Structures Painting Council (USA)

- UBC - Uniform Building Code (USA)
- USBR - United States Bureau of Reclamation (USA)
- WHO - World Health Organization

If the Company, at any time and for any reason, wishes to deviate from the above standards, or desires to use material or equipment not covered by the above standards, it shall state the exact nature of the changes, the reason for making the change, and shall submit complete specifications of the materials and equipment to the Independent Engineer for approval.

3.2 GENERAL DESIGN BASIS

The Company's scope shall include, but is not limited to, Site preparation, the development, design, engineering, procurement, manufacturing, factory testing, transportation to Site, construction, installation, Site testing, commissioning and performance testing of all equipment and infrastructure. In addition, the Company shall operate and maintain the KWC during C&O Period and for the remaining duration of the Concession Period after the successful commissioning of the KWC.

The Company shall include in their scope all the equipment, works and services necessary for complete safe and prudent provision of the Project Activities, notwithstanding certain essential items not being expressly stated in the Instructions to Bidders or elsewhere.

To ensure competitiveness, the requirements are set out in a manner that allows a variety of technological solutions and choices of equipment suppliers. The requirements described in certain sections are minimum requirements that ensure the quality of technological processes for the Project.

The basis of design of the C&O Activities and performance thereof shall satisfy the following fundamental requirements:

- performance and reliability;
- the design concept for the C&O Activities must ensure modularity, with maximum flexibility and reliability;
- civil engineering and building works are to be designed based on an adequate service life period for the Site-specific conditions. The mechanical and electrical installations shall be suitable for continuous operation twenty-four (24) hours per day, as well as for intermittent operation, under all local climatic conditions;
- the design of the KWC components shall be adapted to local conditions, be state of the art and shall be such as to facilitate construction, operation, inspection and maintenance of all processes and equipment. All mechanical and electrical equipment to be supplied shall have a proven reliability record in similar works. The Company is to describe how problems caused by breakdowns and servicing will be minimized by the inclusion of stand-by equipment, spare capacity, etc.;
- adoption of design practices and approaches which will reduce and optimize capital and / or operating costs;

- standardization of components selected to reduce spares inventory, and reduce lead times for ordering of items not kept with spares; and
- availability of the KWC, including the Reservoir as per the applicable performance specifications.

Operability, maintenance and safety requirements shall be provided by the incorporation of the following:

- ease of access to equipment, controls and monitoring stations, etc.
- equipment lifting devices; electrical cranes should be provided for all pumping and engine rooms and generally where needed;
- separate storage facilities for chemicals, including secondary containment;
- lighting to all operating areas;
- ventilation of all covered operating areas, including adequate odour monitoring and control;
- machinery guards;
- proper electrical insulation facilities;
- noise suppression and insulation;
- stairs, handrails, covers, harness points, etc.;
- appropriate safety systems, monitors, meters and alarms;
- Good International Industry Practices in relation to health and safety procedures; and
- Good International Industry Practices in relation to asset management systems, including intelligent tagging, monitoring, maintenance and materials interfaces.

If the Company, at any time and for any reason, wishes to deviate from the Technical Proposal submitted, the provision of the Concession Agreement shall be followed. The minimum content of a Change in Scope proposal shall include:

- technical rationale of the proposed Change in Scope, and detailed technical proposal;
- estimated impact of the proposed Change in Scope on the CAPEX for the Project;
- estimated impact of the proposed Change in Scope on the OPEX for the Project;
- environmental impact evaluation of the proposed Change in Scope;
- health and safety considerations of the proposed Change in Scope;
- impact of the proposed Change in Scope on the Implementation Schedule;
- Stakeholders affected by the proposed change; and

- Project risk analysis of the proposed change.

3.3 DESIGN LIFE & REDUNDANCY

Design life

The minimum lifetime envisaged is as follows:

- twenty (20) years for all the new mechanical components with minimum maintenance;
- twenty-five (25) years for all the new electrical components with minimum maintenance; and
- forty (40) years for new and rehabilitated civil buildings and structures.

Redundancy

The Company shall be fully responsible to provide adequate redundancy for the pump stations and the Treatment Plant.

For vital equipment components, the installation of standby units is required, and when it is not practicable, a respective number of cold standby units will have to be provided.

The Company may optimize the provided concept such that higher redundancy and availability are achieved.

The Company shall include into their offer a detailed redundancy concept, demonstrating the operations of the pump stations and the Treatment Plant during breakdowns or regular revision and maintenance works for all relevant facilities.

3.4 DETAILED DESIGN REQUIREMENTS

The Company shall maintain a BIM compliant digital design data management platform for all the design information. All design will be digitally constructed, manipulated and stored; and any paper copies of design information shall only be for information to aid design, construction or to aid understanding of what is stored digitally. As-built design data shall also be digital and all of the above shall be provided to the KW&SB and / or the Independent Engineer in digital 3D (and 2D) format that is suitable to mainstream digital platforms.

The design and as-built data should ideally be digitally linked to a CMMS in real time so that any design data or component changes for maintenance are automatically updated on the as-built digital data records. This is to ensure a single version of accurate and up-to-date records and information, and a high level of data and operational management efficiency throughout the lifecycle of the system.

The Company is to use state of the art design tools and these shall include, but not limited to the following:

- Except for the canal and pipelines, the primary design is to be undertaken with a 3-dimensional (3D) model from which 2D drawings shall be generated. The 3D designs shall accurately detail the external surfaces of the facilities. All the system is to be TAG numbered and digitally linked to the Intelligent P&IDs and the CMMS.
- P&IDs shall be produced and will be the basis of all the mechanical, electrical and ICA designs. The P&ID system architecture shall be linked to the specific detail of each item of system and /

or instrument as attributes / metadata, that will be embedded in the software package used to construct the Intelligent P&ID. The P&ID software shall ensure performance curves can be captured and hyperlinked to the attributes / metadata. Unique TAG numbering will be digitally linked to the 3D design model components and the CMMS. The P&IDs shall be set up to generate all valve and instrument and system schedules.

- The mechanical and electrical (and ICA) 3D modelling shall be compatible and integrated with the civil, structural and architectural 3D packages to ensure there are no equipment interferences during operations and maintenance.

- For electrical network design, load flow modelling, and protection setting calculations, proper available technology and software tools shall be used; for instance, ERAC, ETAP, or similar tools for HV (high voltage), whereas AMTEC or similar tools can be used for LV (low voltage).

3.5 MEICA GENERAL REQUIREMENTS

The design of the KWC components shall be adapted to local conditions, be state of the art and shall be such as to facilitate the Project Activities. All MEICA equipment to be supplied shall, wherever possible, have a proven reliability record in similar works and conditions. The Company is to describe how problems caused by breakdowns and servicing will be minimized by the inclusion of stand-by equipment, spare capacity, by-passes etc.

The Company shall maximise, as is reasonably possible, on the standardisation and interchangeability of facilities and components so as to minimise on any downtime.

The Company shall ensure a robust supply chain from all suppliers and ensure in country representation of the manufacturers and suppliers.

(i) Electrical Power Requirements

The main objective is to provide a fully functional, automatic system, including the design, supply, installation of the electrical and ICA (EICA) infrastructure. The final design of the infrastructure must enable the KWC to cope with the flow demands and any associated scenarios.

International specifications and Good International Industry Practices shall apply to the design and installation of all electrical systems.

(ii) Instrumentation, Control & Automation (ICA)

The Company shall develop a system architecture for the Project but also to allow connectivity / interface with KW&SB for remote monitoring of the Site SCADA systems. The Company shall also liaise as necessary with KW&SB to establish the existing systems and protocols and thus ensure compatibility, so the system works effectively. The Company shall be responsible for the design of the remote monitoring system, based on Good International Industry Practices.

The control system architecture shall be capable of running the system automatically with manual override in the case of breakdown of automatic control. Each process area shall be controlled by a dedicated PLC; all PLCs shall be networked, and dual redundant PLCs shall be considered to provide additional redundancy.

Adjustable set points to modify the control parameters on any item of the system shall be adjustable only

on the manager's personal computer or the program development system. The central master station shall scan the sub masters. Block transfer of data shall be accepted. All alarms and any events' time and data recorded at the sub-master stations shall be transferred to the master station.

All the signals that are required for the system's safety operations, critical alarm / trips and controls shall be hard wired between the different installations.

Further, the Company shall establish and provide the necessary mechanisms to have data exchange and a systems integration between the SCADA, DCS, monitoring, metering data acquisition systems, and settlement systems, etc. The Company shall provide their functional design specifications of data exchange for the Independent Engineer's approval.

The DCS of the system shall be a programmable up-to-date modern digital process control system with self-diagnostic features, ensuring the operation for the remaining lifetime of the system. The software and system components like cards / modules, computer equipment shall be the most advanced version in operation. The Company shall also ensure that the supply of spare parts and technical support for the control system is available for the lifetime of the system.

The system shall fulfil the latest cybersecurity requirements (as per HCIS and the EC Controls). It shall be secured / protected from external intruder / virus and shall have provision to safeguard the system against malicious software and computer virus threats. The system shall be designed with security measures, segregation and availability to reflect the specified requirements, and have measures for disaster recovery. The system shall be designed to allow easy extension in case of subsequent modifications on the controls and the associated signal processing equipment for hardware and software.

(iii) Mechanical Requirements

It is in the Company's interest to ensure the suitability of the design of all mechanical equipment and that it is optimum for the purpose intended. The Company shall make their own assessment of materials and standards to fulfil their asset management objectives and international specifications and Good International Industry Practices shall apply to the design of all mechanical installations.

The Company shall ensure that the installation designs give easy, good and safe access to all the system. Adequate lifting facilities are to be provided that will enable removal for maintenance or replacement.

<u>Flow measurement</u>

The overshot gate and / or flow metres devices shall calculate the flow using measurements of upstream water level, downstream water level, and gate position, achieving independently verified measurement accuracy of ±2.5%. Water level measurement sensors shall be housed within the internal frame. A water-tight seal will separate the upstream and downstream sensors.

- Unique, integrated stilling wells unaffected by surrounding objects, as debris, foam, silt or other contaminants.

- Self-calibrates on every reading to eliminate drift in speed of sound variations due to changes in temperature or humidity.

Specifically designed for use in harsh canal environments.

3.6 CIVIL, STRUCTURAL & ARCHITECTURAL REQUIREMENTS

All civil, structural and architectural works shall be designed, constructed, operated and maintained in compliance with Good International Industry Practices and in conformance with the minimal requirements and guideline standards.

(i) Prior to the start of C&O Activities

The Company shall be responsible for conducting the technical evaluation of the proposed Site prior to the start of the C&O Activities, with particular cognisance of fluctuating levels in the groundwater table, geological and geotechnical conditions.

The Company shall undertake all necessary preparatory works, including:

- investigation of any existing facilities / infrastructure above and below the ground in the Site area;
- re-routing of any existing live facilities / infrastructure above and below the ground in the Site area in agreement with the owner of the facility / infrastructure at the cost and expense of the Company;
- removal of any existing facilities / infrastructure above and below the ground, including mechanical and electrical equipment, in the Site area at the cost and expense of the Company;
- provision of temporary laydown areas, warehouses, workshops, batch plant, vehicles, equipment, as required for the C&O Period;
- provision of temporary:
    - power and water supply;
    - firefighting and alarm system; and
    - site drainage, stormwater and sanitary drainage;
- disposal of sewage, as necessary;
- removal of existing buildings and structures as required;
- provision of temporary roads and fencing, including gates as necessary; and
- provision of first aid, and safety and security system for the Site for the duration of the C&O Period.

(ii) Earthworks & Site Grading

Ground surfaces shall be graded to slope away from structures towards the Site roads to facilitate surface water collection.

Embankment and cutting slopes shall be graded in accordance with the requirements of the Company's geotechnical design report.

Interceptor swales shall be provided at the top of any slopes to divert overland surface water flow from areas outside the Site boundary away from the main Site area.

Finished floor levels of buildings shall be one hundred fifty millimetres (150 mm) above the surrounding finished ground level, except where ramped access is required for vehicles or equipment.

(iii) Structural Design

The design of all structures shall be carried out in accordance with design codes, and the structural loading shall include, but is not limited to: dead / permanent loads; superimposed dead loads; imposed / variable loads; wind loading; seismic loading; accidental loading; thermal loads, both in-plane and through thickness differentials; traffic / live load surcharge; crane loading, both mobile and gantry type cranes; hydrostatic and hydrodynamic pressure; earth pressure; and construction loads.

Loads shall be combined in accordance with the selected design code requirements.

The Company shall prepare a durability assessment report which defines how the design and construction will achieve the minimum design life for each element of the Project Activities.

Early age thermal effects, autogenous shrinkage and drying shrinkage shall be considered in the design of reinforced concrete structures and adequate reinforcement shall be provided to control cracking.

Where possible, structures shall be designed without movement joints and the design shall follow current guidelines and best practice to limit shrinkage and thermal cracking in walls and slabs that are in contact with the ground.

(iv) Hydraulic Design

Hydraulic design shall be in accordance with Good International Industry Practices for conveying potable water.

When possible, sufficient redundancy within the pipework and structures must be provided to allow each element of the system to be taken out of service for routine maintenance activities.

When possible, flows shall be distributed equally in the pump stations and Treatment Plant facilities, among all operational process units under all flows and operating conditions.

The minimum freeboard in tanks and hydraulic channels shall be 0.5m from maximum top water level to top of wall level, under all flow and operating conditions.

Weirs shall be designed for free discharge under all flow and operating conditions and shall allow for a minimum fall of 100mm under peak flow conditions.

Hydraulic surge analysis shall be carried out for pump systems as required to design mitigating measures for surge and other detrimental transient conditions.

(v) Pipework Design

Pipe networks for the KWC shall be provided, including but not limited to water flows, sludge, wash water, compressed air, potable water, firefighting water and irrigation.

The minimum depth of cover to pipes is one point five metres (1.5 m). Where the aforementioned cover cannot be achieved, pipes shall be encased in concrete as a protection measure.

Pipes shall be designed for all foreseeable loading conditions, including live load surcharge from construction vehicles, maintenance plant and cranes.

Foul sewage pipe networks shall be separated from potable water networks to avoid cross contamination. The minimum clearance shall be six hundred millimetres (600 mm) vertical and three hundred millimetres (300 mm) horizontal from the outside of the sewage pipe to the outside of the water supply pipe. Potable water networks shall be located above sewage networks.

Cathodic protection only in metal sections (including initial and final part and manholes deviations, if need be).

Proper protection shall be given to metal surfaces using paints or other protective coatings and/or, by cathodic protective devices.

- AWWA D102 Coating Steel Water Storage Tanks
- AWWA Standard D-103 Factory-Coated Bolted Steel Tanks for Water Storage
- AWWA D104 Cathodic Protection for Interior of Steel Water Tanks

(vi) Ducts design

Ducts shall enter any below ground chambers or through tank walls a minimum of three hundred millimetres (300 mm) above maximum top water level. If the tank or chamber has an overflow, the ducts shall enter above this level. If ducts terminate above the ground level, the ducts shall be encased in a concrete surround with the duct terminating 150mm above the finished ground level. Ducts shall be sealed with a Denso Putty (or similar).

Draw pits and covers shall be designed for the maximum vehicle loading likely to be imposed on the cover or side wall of the chamber.

(vii) Surface Water Drainage

Surface water drainage systems within the Site shall be designed for a one (1) in ten (10) years, sixty (60) - minute duration event with a peak rainfall intensity derived from codes.

The surface water drainage system shall be easily maintainable. Where piped systems are employed, manholes shall be provided at every change of direction or every hundred metres (100 m) on straight runs to facilitate rodding and maintenance.

(viii) Site Access, Circulation and Egress

The permanent Site access & egress shall be determined prior to preparing the Detailed Engineering Design and approved by the Independent Engineer.

Site access roads and internal roads shall be designed for a target maximum speed of thirty (30) kph.

Roads shall have the following characteristics:

- eight (8) m minimum width for two-way access and 6m minimum width for one-way access;
- continuous around all tanks and buildings;
- minimum longitudinal gradient of zero point five percent (0.5%) and maximum four percent (4%);
- maximum ramp gradient into buildings shall be fifteen percent (15%);
- minimum cross fall or camber of two percent (2%);
- corner radii at junctions shall be twelve metres (12 m) minimum;
- horizontal clearance between carriageway edge and vertical objects adjacent to the access road shall be zero point six metres (0.6 m) minimum;
- vertical clearance between finished ground level or carriageway level and the soffit of any object crossing the carriageway or coming within zero point six (0.6) m of the carriageway edge shall be five point five (5.5) m minimum;
- visibility splays at junctions shall be two metres (2 m) x thirty-three metres (33 m) minimum between the driver's eye height of one metre (1 m) to two metres (2 m) and object height of zero point two five metres (0.25 m);
- surfacing shall be bituminous generally, but concrete shall be used for any areas of likely spill of sewage or chemicals, the Tanker Import Facility and sludge export area. Pavements shall be designed for the cumulative effect of the largest loads expected to use the KWC roads during the operational life of the pavement and the effects of any cranes expected to be used during maintenance operations;
- street lighting shall be designed and constructed in accordance with international codes;
- signage for all significant buildings shall be provided to facilitate wayfinding for regular vehicles and for emergency services vehicles entering the facilities; and
- road markings and signage shall be provided to indicate right of way at internal junctions.

Vehicle tracking shall be carried out at design stage for the largest vehicle likely to access the KWC on a regular basis (rigid tankers and articulated tankers) to ensure sufficient curve widening is provided on bends and no conflicts between opposing vehicles are likely to occur.

(ix) Landscaping

The Company shall prepare a landscaping plan, including planting plan, hardscape areas, Site amenities and external lighting.

Hard landscaping: A minimum two metres (2 m) width of hard standing shall be provided around the buildings. The finish shall be precast concrete paving slabs or in situ brushed concrete. The minimum fall on the hard standing shall be two percent (2%) away from the building towards a surface water drainage system.

Soft landscaping: Soft landscaping shall consist of drought-resistant, evergreen, low maintenance trees and shrubs local to the area. Irrigation systems shall be provided for any planted areas around the Site. Soft landscaping should be provided around any habitable / office / accommodation buildings. The boundary landscaping shall consist of a tree screen (maximum ten metres (10 m) spacing on a staggered pattern) to act as a visual screen to the Site. No trees or shrubs should be planted within twenty metres (20 m) of an open tank.

(x) External Lighting

External lighting shall be provided around all buildings and along all internal access roads. Task lighting shall be provided in any area where regular maintenance activities are planned.

(xi) Electricity Efficiency

Buildings shall be designed to minimise electricity use and maximise efficiency as far as possible. These measures shall include LED lighting, electricity efficient heating and cooling and insulation and ventilation systems design and power saving devices (such as movement sensors) as a minimum.

(xii) Building Finishes

External

- roofs – typically flat roofs with single ply solar reflective waterproofing membrane (with protection) over rigid insulation over concrete slabs. Maximum U-value shall be zero point one nine (0.19);
- walls – concrete structures with concrete masonry units as infill with insulation and a decorative render finish. Maximum U-value shall be zero point two (0.2);
- louvres – fixed aluminium with anodised finish, intake louvres shall be sand-trapping;
- windows – fixed, aluminium framed with anodised finish, glazing shall be tinted insulating glass;
- doors – habitable buildings: aluminium with anodised finish; non-habitable: steel, galvanised and painted. Equipment access doors shall be aluminium roller shutter type with anodised finish and motorised operations.

Internal

- doors – timber with painted, hollow metal frames;
- walls – habitable buildings: plastered and painted, tiled in wet areas; and non-habitable buildings: fair finish painted masonry suitable for wash-down and light reflectance;
- floors – habitable buildings: tiled concrete / screed, maximum U-value shall be zero point two (0.2); and non-habitable buildings / workshop areas: concrete with power floated finish and sealer;
- ceilings – habitable buildings: suspended ceilings; and non-habitable: painted for light reflectance; and
- safety equipment shall be provided as necessary.

(xiii) Rain Water Drainage

Rain water shall be diverted from roof structures via external down pipes to pipes at ground level where it shall then connect into the surface water drainage system for the Site.

Roof outlets shall be provided with sufficient redundancy to prevent build-up of water on roofs in the event of a blockage.

(xiv) Building Signage

The language of all signage shall be both Urdu and English.

- external signage: all buildings shall incorporate exterior identification nameplates for 'way finding' and use by any emergency response units;

- internal signage: interior doors shall incorporate room numbering and identification nameplates. Hazardous material signs, warning signs, caution signs and safety signs shall be provided as required; and

- emergency signage: emergency and 'way finding' signage shall be fitted at all appropriate locations to facilitate safe and controlled egress from each facility to a designated place of safety away from the buildings and other hazardous facilities that may be nearby.

3.7 BUILDING SERVICES REQUIREMENTS

The primary design parameters and requirements for buildings are as follows:

- fire Suppression: generally, all buildings shall be fully protected by a fixed wet sprinkler system. All main electrical rooms shall be protected by a clean agent gas suppression system using FM200 gas or similar. The gas shall be stored in bottles located in each of the protected areas. A pressurised sprinkler connection will be extended from the Site fire main to serve the sprinkler installation within the building;

- small power & lighting: general purpose 220V socket outlets will be provided and all items of fixed equipment will be provided with dedicated power supplies. Outlets and fused connection units will be protected by RCDs where necessary. Generally recessed, high frequency, luminaires shall be used, where a suspended ceiling is installed. In restrooms, and other utility areas, recessed down lighters shall be used. In plant areas, surface mounted / suspended luminaires shall be used. Emergency bulkhead luminaires shall be installed over exit doors. Emergency lighting will be supported by a central battery system;

- HVAC systems: all occupied areas within the building shall be provided with air conditioning and ventilation. The ventilation air shall be provided based on space occupancy levels and to meet the over pressurisation requirements for the building. The ventilation system shall be a variable air volume system with local temperature controls for each area. All mechanical systems shall be sized with a ten percent (10%) spare capacity for cooling and for ventilation air requirements; and

- lightning protection: the lightning protection system shall be designed and installed in accordance with existing regulations, with supplementary surge protective devices fitted. All lightning protection systems will be bonded to the building electrical earths. Test links will be provided.

Consideration should be given for LED luminaires throughout.

3.8 GENERAL ENVIRONMENTAL REQUIREMENTS & PERMITS

The Company shall conduct their own baseline studies and any surveys and investigations which may be required to obtain the Environmental and Social Approvals required for the Project.

On confirmation of the Company's proposed design and technologies, they will be required to perform a detailed ESIA assessment and permit application in order to meet the Legal Requirements, as well as World Bank / IFC Equator Principles, and the E&S Standards. These will typically include the following as a minimum:

- validation of any studies or surveys conducted by KW&SB;
- detailed assessment of the environmental impacts (air, noise, odour, soil quality, groundwater quality, marine impacts, etc.); and
- compliance with specific requirements include land availability & ownership, right of way, wayleaves and permitting / regulatory requirements, waste management (sludge), socio-economic impacts, etc;

In addition to the Environmental and Social Approvals, the Company shall also be responsible to obtain all other Approvals required for the Project Activities. These may involve Approvals (without limitation) for on-Site fuel storage, on-Site power supply, access & egress, security and communication requirements, building permits, traffic and transportation, health & safety, etc.

Additional information can be found in Annexure 2: ESIA ToR.

4. PART 4: SPECIFIC REQUIREMENTS

4.1 MANAGEMENT, OPERATIONS & MAINTENANCE REQUIREMENTS

Good management of the assets ensures that operational and maintenance costs are in line with the original projection and ensure that full design life is achieved. It also reduces the likelihood of major failure, which can carry significantly higher cost as well as the risk of failing performance commitments. It must also be considered that many equipment warranties will be linked to the ability of the Company to demonstrate that the KWC has been operated and maintained in line with manufacturer’s instructions.

To assist in this evaluation, it is important that the Company establishes robust asset management throughout the Concession Period that:

- maximizes operation and maintenance efficiency;
- records operation and maintenance activities; and
- maintains up-to-date asset data.

The Company, throughout the Concession Period, shall be required to administer all data through the use of modern and intelligent design and asset management tools.

The KWC long term data storage facilities shall incorporate the ability to maintain operational and maintenance data through the lifetime.

The Company is to ensure the systems and tools are administered by competent, well-trained and appropriately skilled operational teams and continuous training is implemented to match the technology improvements that will occur during the Concession Period.

Using the CMMS, the Company shall report to the Independent Engineer on a monthly basis, regarding the Net Water Input, the Net Water Output, water quality parameters, failures and repairs, replacements, main meantime between failure trending, asset condition, and predicted asset life.

The Company shall be required to carry out operations and maintenance of the Project in conformity with the applicable standards and the Operating and Maintenance Procedures.

4.2 OPERATING AND MAINTENANCE PROCEDURES

The Company shall submit drafts of the Operating and Maintenance Procedures to the Independent Engineer and KW&SB:

(i) for the C&O Period, no later than sixty (60) Days prior to the Scheduled Commencement Date; and

(ii) for the Operating Period, no later than ninety (90) Days prior to the Scheduled Project Commercial Operations Date,

as well as instructions and drawings in relation to all the equipment supplied. The Operating and Maintenance Procedures are to be provided in both Urdu and English.

The minimum content of the documents is detailed next:

Introduction

- A general description of the facilities and equipment, including the Treatment Plant process;
- A description of the operation of the facilities and equipment including the sequence of events required for operation of each equipment, and instructions on how to start and stop the equipment, stating any safety and / or sequencing requirements;
- Arrangements. The information may be used for instructing untrained personnel in the operation of the relevant equipment and facilities, and therefore must be set out in a simple and orderly manner to aid the instructor;
- A definition of technical terms used in subsequent sections of the manuals;
- A complete list of the facilities and equipment, valves, pipes etc., existing and supplied, including model and serial numbers; and
- A complete section on occupational health and safety policies and procedures for facilities managerial and operations personnel.

Detailed Description

- Full specification for each individual item of equipment, its accessories and components, including a complete list stating its clearances and tolerances;

- A list of all “as-built drawings”; and
- Operating manuals and vendor data for all items of equipment.

Operating Principles

- A summary description shall be given of the technical operating basis of the facilities or equipment, including, for example: flow sheets circuit and piping diagrams.

Operating Instructions

- The instructions shall contain the sequence of individual manipulations required for operation of each equipment installed at the facilities. The instructions shall be prepared in such a manner that they can be used for instructing untrained personnel in the operation of the facilities and its equipment.

Testing and Adjustment

- The entire testing and adjustment procedure for the facilities or equipment, which has to be done after overhauls and during operations, shall be provided.

Detailed Service and Maintenance Instructions

- Preventative maintenance to indicate the inspection required at regular intervals, the inspection procedures, the routine cleaning and lubricating operations, the regular safety checks and similar steps;
- Repair and adjustment, describing the inspections, fittings and dismantling of parts, fault tracing as well as the repair and adjustment procedure;
- Spare parts list containing all the necessary data for ordering spare parts;
- List of lubricants, and the required grades, including the trade names of the products;
- List of packing seals and gasket materials;
- List of chemicals required; and
- List of special tools.

Drawings

- Construction Drawings shall include sectional drawings of the equipment and workshop drawings.

Test Results

- All works testing and Site testing / commissioning results shall be included as part of the Operating and Maintenance Procedures.

Instrumentation & Control (I&C) System

Technical manuals and record (as built) drawings for the I&C systems shall be given, including the following:

- Process and instrumentation diagrams;
- Loop descriptions;
- Loop drawings;
- Instrument summary;
- Instrument data sheets;
- Sizing calculations;
- Instrument installation details;
- Test Procedures; and
- Test results (loop testing, pre-commissioning, and performance testing).

Requirements for Updating the Operating and Maintenance Procedures

- Operating and Maintenance Procedures shall be updated whenever necessary, such as, whenever there is a change in equipment, flow pattern(s), or operating procedures. Any time there is a change that affects the manner in which the KWC operates in order to meet the Output Water Quality Specifications is an event "necessary" for revision of the Operating and Maintenance Procedures; and
- Numbered Addenda shall be added to the manual and the index shall be revised accordingly. A new edition shall be prepared at least once every five (5) years that incorporates all previous addenda. This document shall be maintained both in hard copy and on soft copy.

Other Information

- A comprehensive index for each volume and an overall index volume;
- Addresses, e-mail addresses, telephone numbers, fax numbers of suppliers and local agents of all items of equipment; and
- The service providers, that is, manufacturers or specialized sub-contractors shall also furnish the manuals on soft copy.

4.3 GENERAL FACILITIES

(i) Central Administration Building including laboratory

A central administration building shall be established to accommodate the KWC management, the pump stations and the Treatment Plant administration, main technical staff, and the Treatment Plant laboratory. The final design solution for the central administration building shall be in compliance with the relevant design standards and shall be approved by KW&SB. As a minimum, the central administration building shall provide the following rooms:

- one (1) laboratory completely furnished and equipped as detailed below;
- one (1) SCADA room thirty (30) m^2;
- two (2) offices each twenty (20) m^2;
- three (3) offices each fifteen (15) m^2;
- one (1) meeting room thirty (30) m^2;
- one (1) store (archive) twenty (20) m^2;
- one (1) kitchenette fully equipped;
- sanitary facilities (WC, shower, locker etc.);
- one (1) prayer room; and
- two (2) offices each fifteen (15) m^2 and one (1) meeting room thirty square metres (30 m^2) for KW&SB or the Independent Engineer with separate entrance (to be confirmed).

At least one (1) lift capable of accommodating ten (10) persons shall be provided in the case of a multi-storey building.

The Company shall provide facilities for the KW&SB's / IE's representatives, including, as a minimum, the following to accommodate at least four (4) staff members during the C&O Period:

- Office: Total minimum area: twelve metres (12 m) x three point seven five metres (3.75 m), consisting of two (2) rooms, one (1) toilet with basin and one (1) kitchen.
- Furniture: four (4) office tables; six (6) chairs; four (4) tea tables; four (4) cabinets; four (4) fixed reception chairs; dining table & chairs for six (6) persons; desktop computers & software (including MS Office), A3 printer & scanner and an internet connection (with wi-fi router).

(ii) Vehicles

The Company shall provide the following vehicles for use of the representatives of the Project Implementation Unit and the Independent Engineer throughout the Concession Period:

- Project Implementation Unit:
    - one (1) x Toyota Corolla Grande or equivalent thereof;
    - one (1) x Toyota Revo Rocco or equivalent thereof; and
    - two (2) x Suzuki Jeep (Latest Model + A/T) or equivalent thereof;
- Independent Engineer:
    - one (1) x Toyota Double Cabin 4x4 (Latest Model + A/T) or equivalent thereof;
    - two (2) x Toyota Single Cabin 4x4 (Latest Model + A/T) or equivalent thereof;

- one (1) x Suzuki Jeeps (Latest Model + A/T) or equivalent thereof; and
- four (4) x Suzuki High-Roof (Latest Model) or equivalent thereof.

The vehicles shall be provided with driver, fuel, maintenance, insurance, registration etc., by the Company at all times during the duration of the Concession Period.

(iii) On-Site Laboratory

One (1) laboratory shall be updated / provided according to the needs of the Company. The laboratory shall be fully equipped for making the necessary analytical measurements and operating control tests to meet monitoring requirements. The laboratory shall have sufficient size, bench space, equipment, and supplies to perform all self-monitoring analytical work stipulated as required for operations of the KWC.

Laboratory instrumentation and size must reflect the Treatment Plant size, staffing requirements, process complexity, and applicable certification requirements. The laboratory shall be capable of performing chemical, physical and microbiological analysis of water and waste streams. The laboratory shall be equipped to carry out all tests in compliance with Good International Industry Practices in relation to water and wastewater testing. The analytic tests equipment shall provide highest levels of confidence as required by national and international standards.

KW&SB's representatives shall have the right to access the laboratory anytime during normal working hours in order to witness the execution of the analyses.

The laboratory is preferred to be located at the treatment site on ground level, with appropriate environmental control and health & safety compliance being an important consideration. It shall be isolated from vibrating, noisy, high temperature machinery or equipment which might have adverse effects on the performance of laboratory staff or instruments.

The laboratory floor space and facility layout must be based on an evaluation of the complexity, volume, and variety of sample analyses expected during the design life of the KWC, including testing for process control and potable water quality monitoring requirements in terms of the KWC's water safety plan.

Consideration shall be given to the necessity to provide separate (and possibly isolated) areas for some special laboratory equipment, glassware, and chemical storage. The analytical and sample storage areas must be isolated from all potential sources of contamination. Organic chemical facilities shall be isolated from other facilities.

Adequate security shall be provided for sample storage areas. Provisions for the proper storage and disposal of chemical wastes shall be provided. Office and administrative space needs must be considered including for KW&SB as outlined in above. The abovementioned on-Site laboratory requirements should be seen as a minimum requirement for the purpose of the Proposal.

(iv) Parking Facilities

Sufficient parking space for employees, KW&SB's staff and visitors shall be provided. All permanent used parking spaces shall be furnished with a sun shed. Size of the parking spaces shall be at least five metres (5 m) x two point five metres (2.5 m) for normal spaces and five metres (5 m) x four metres (4 m) for handicap parking spaces. The surface of all parking lots, parking spaces, drives, aisles and manoeuvring areas shall be asphalt or concrete. Striping is required and shall be maintained to define spaces and assure safe traffic flows. In the instance where no public access to the lot is paved, the lot may

remain on gravel (providing bumper guards or wheel stops to define each space). Parking spaces along the outer boundaries of a parking lot must be contained by a curb or wheel stops. Artificial lighting shall be provided for all parking lots and interior access lanes must be of sufficient width for all vehicle turning and manoeuvring. For the central administration building, the following parking spaces shall be provided:

- For KW&SB representatives, this shall include three (3) parking spaces plus one (1) handicap parking spaces;
- for visitors and for KWC staff, the Company shall propose the parking spaces to be provided, in their Proposal; and
- other parking spaces shall be provided as necessary for the pump stations area and the Treatment Plant's operations.

(v) Access and Security

The Company shall be responsible for the security of the Site and shall ensure that the security facilities are constructed within the Site boundary.

To enable free access to various Site areas (e.g., the fuel oil and chemical unloading stations), the Company shall make provision for the corresponding required permanent access roads to these areas, including outdoor lighting.

The Company shall put in place suitable security management and control.

Security system: comprehensive security solution shall be provided for all facilities, focusing on intrusion detection, video surveillance, access control, control centres and danger management.

Site perimeter security & access control: any boundary fence (if required) shall be constructed, subject to the ESIA visual impact assessment and the KW&SB or the Independent Engineer's approval.

4.4 WATER TANKERS

During the Mobilization Period, the Company will provide to KW&SB five (5) water tankers with capacity of three thousand (3,000) gallons each or the capacity defined in ESIA, that will be used to supply water to the Settlements in accordance with the technical specifications shown next:

4.5 HEALTH & SAFETY REQUIREMENTS

The Company and its Contractors shall prepare a health and safety plan in terms of the Sindh Occupational Safety and Health Act, 2017, ISO 45001, IFC Occupational Health and Safety guidelines and / or applicable Good International Industry Practices and in compliance with the Legal Requirements, including Sindh and national labour laws.

The Company shall be deemed to have read and fully understood the requirements of the abovementioned Legal Requirements and standards, which are relevant to the Project and to account for all costs necessary to ensure compliance therewith.

In this regard, appended to the relevant form sheet, an outline health and safety plan and approach in respect of the Project Activities shall be included in order to demonstrate the necessary competencies and resources to perform the Project Activities in accordance with the abovementioned regulations. The outline health and safety plan and approach shall be developed into a fully detailed health & safety plan

to be approved by the Independent Engineer and to cover *inter alia* the following details as a minimum:

- the safety management structure, including the names of all designated persons such as the construction supervisor and any other competent persons; and
- safety method statements, risk assessments and procedures to be adopted to ensure compliance with the Legal Requirements and Good International Industry Practices.

Aspects to be dealt with shall include but are not limited to:

- public vehicular and pedestrian traffic accommodation measures;
- control of the movement of construction vehicles;
- the storage and use of materials;
- COSHH
- the use of tools, vehicles and plant;
- temporary support structures;
- dealing with working at height;
- dealing with and working with water and wastewater;
- confined spaces;
- environmental conditions and hazards
- excavation work;
- demolition work;
- security, access control and the exclusion of unauthorised persons;
- the provision and use of temporary services;
- compliance with wayleaves, permissions, and Approvals;
- safety equipment, devices and clothing to be employed;
- emergency procedures;
- provision of welfare facilities;
- induction and training;
- signage;
- first aid;

- provision and maintenance of the health and safety file and other documentation; and
- arrangements for monitoring and control to ensure compliance with the safety plan.

5. PART 5: COMPLIANCE MONITORING METHODOLOGY AND TESTING & COMMISSIONING PROCEDURES

5.1 COMPLIANCE MONITORING METHODOLOGY

During the C&O Period, the water quality parameters established by Mobilisation Testing shall apply.

During the Operating Period, the main compliance monitoring of the KWC shall revolve around the metering, monitoring and analysis of the received and the delivered water, as well as the by-pass discharges. These main compliance criteria shall be measured against the prescribed range of influent volumes and quality and set limits. The combined compliance and impact of events will be applied to the financial payment mechanisms and deduction formulae to calculate the Service Payments due to the Company for each Billing Period, based on the Concession Agreement.

The following flow and flow event definitions are applicable to the compliance monitoring of the KWC with flow values indicated for the KWC.

5.1.1 *Inlet Water Quality Parameters*

The required Treatment Plant to be implemented by the Company should be able to provide the adequate water quality when receiving influent quality parameters within the range shown next:

Parameters	**Unit**	**Normal Influent Range Compliance**	
pH	-	6,50	8,50
Turbidity	NTU	0	50
Aluminium	mg/l	0	1
Chlorine residual	mg/l	0	0,02
Faecal Coliform	E. Coli – cfu/100ml	0	100
Total Coliforms	cfu/100ml	0	100

Table 2: Normal Water Influent Range Compliance.

The Project scope assumes the Treatment Plant is expected to operate with water inflows that respect the water quality parameters presented in the above limits.

5.1.2 *Outlet Water Quality Parameters*

The Company shall ensure full compliance of water produced by the Treatment Plan with the National

Standards for Drinking Water Quality (NSDWG - Pakistan Environmental Protection Agency, Government of Pakistan – Sindh Environmental Protection Agency, Government of Sindh) as well as all requirements and procedures in force as specified by the Pakistan Environmental Protection Agency, Government of Pakistan and / or the Sindh Environmental Protection Agency, Government of Sindh, and the WHO drinking water guidelines.

The table below shows the contractual limits for water quality to be provided at the Output Water Connection Point by the Company:

Parameters	**Unit**	**Normal Influent Range Compliance**	
pH	-	6,50	8,50
Turbidity	NTU	0	5
Aluminium	mg/l	0	0,20
Chlorine residual	mg/l	0,20	0,50
Faecal Coliform	E. Coli – cfu/100ml	0	0
Total Coliforms	cfu/100ml	0	0

Table 3: Normal Water Outlet Range Compliance.

The other parameters are requested to be analysed, but no contractual impact is considered with respect to the Company's obligations under the Project.

The Treatment Plant shall be able to operate and deliver potable water to the Output Water Connection Point within that range, and at least the performance guarantees included in Attachments 1, 2 and 3 of the Appendix 5 to the Concession Agreement, otherwise, the outlet will be considered as not compliant.

5.1.3 *Outlet Water Quality Parameters*

Other parameters are requested to be analysed, but no contractual impact is considered with respect to the Company's obligations under the Project. The complete table that summarizes all the parameters is shown below.

The testing of the output water quality parameters listed in table below shall be conducted in accordance with the Metering and Testing Plan, and pursuant to the Operating and Maintenance Procedures.

The pH, turbidity, aluminium, chlorine residual, faecal coliform and total coliform levels are to be tested on a regular / daily basis as per the Concession Agreement.

Parameters	Inlet Limits Contractual values	Outlet limits		
		WHO	**Pakistan Standards**	**Contractual**
pH	**6,50-8,50**	**6,50-8,50**	**6,50-8,50**	**6,50-8,50**
Odour	-	Odourless	Odourless	NO
Taste	-	Sweet	Sweet	NO
Colour (Pt-Co)	-	⩽15	⩽15	NO
Turbidity (NTU)	**⩽50**	**⩽5**	**⩽5**	**⩽5**
Total dissolved solids (TDS – mg/l)	-	<1000	<1000	NO
Total Hardness (mg/l)	-		<500	NO
Fluoride (mg/l)	-	1,5	⩽1,50	NO
Nitrate Nitrogen (NO_3 – mg/l)	-	50,0	⩽0,50	NO
Nitrite Nitrogen (NO_2 – mg/l)	-	3,00	⩽3,00	NO
Aluminium (mg/l)	**⩽1**	**0,20**	**⩽0,20**	**⩽0,20**
Arsenic (mg/l)	-	0,01	⩽0,50	NO
Boron (mg/l)	-	0,30	0,30	NO
Barium (mg/l)	-	0,70	0,70	NO
Cadmium (mg/l)	-	0,003	0,01	NO
Chromium (mg/l)	-	0,5	⩽0,50	NO
Copper (mg/l)	-	2,00	2,00	NO
Manganese (mg/l)	-	0,5	⩽0,50	NO
Nickel (mg/l)	-	0,020	⩽0,020	NO
Lead (mg/l)	-	0,01	⩽0,050	NO
Antimony (mg/l)	-	0,02	⩽0,0050	NO

Parameters	Inlet Limits Contractual values	Outlet limits		
		WHO	**Pakistan Standards**	**Contractual**
Selenium (mg/l)	-	0,01	0,01	NO
Zinc (mg/l)	-	3,00	5,00	NO
Mercury (mg/l)	-	0,0010	⩽0,0010	NO
Chloride (mg/l)	-	250,0	<250,0	NO
Chlorine residual (mg/l)	**<0,02**	**<0,02**	**0,2-0,5**	**0,2-0,5**
Cyanide (mg/l)	-	0,07	⩽0,05	NO
Total Phenols (mg/l)	-	⩽0,002		NO
Chlorined Pesticides (µm/l)	-			NO
Total PAH (mg/l)	-	10,00		NO
Total Alkalinity (mg/l)	-			NO
Acidity as $CaCO_3$	-			NO
BOD5	-			NO
T[a]	-			NO
Faecal Coliform (E. Coli – cfu/100ml)	**⩽100**	**Absent**	**Absent**	**Absent**
Total Coliforms (cfu/100ml)	**⩽100**	**Absent**	**Absent**	**Absent**

Table 4: Water Quality Parameters.

5.1.4 *Water Quality Testing Methodology*

The water quality will be analysed in different points of the KWC, but the compliance methodology is summarized next:

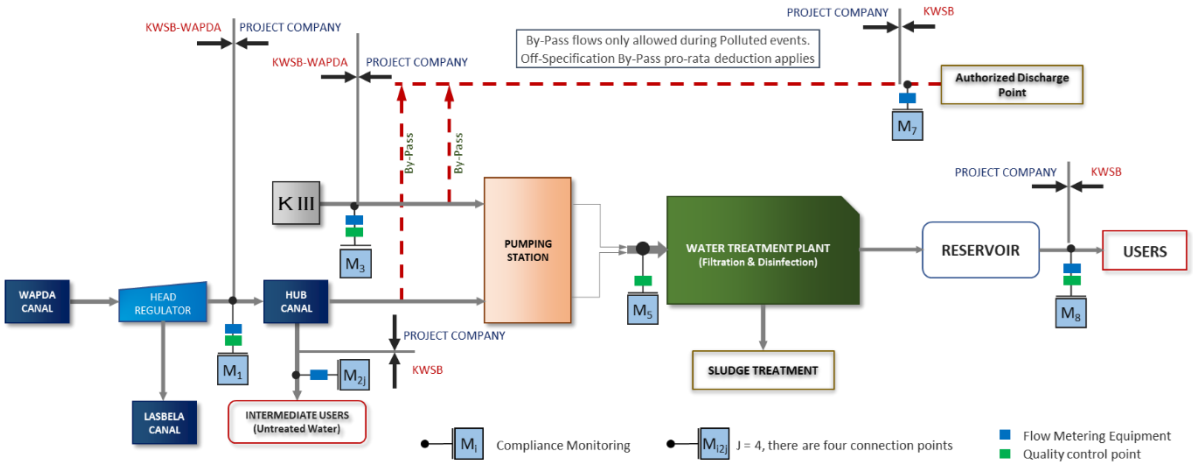


Figure 11: Water Quality Metering Points.

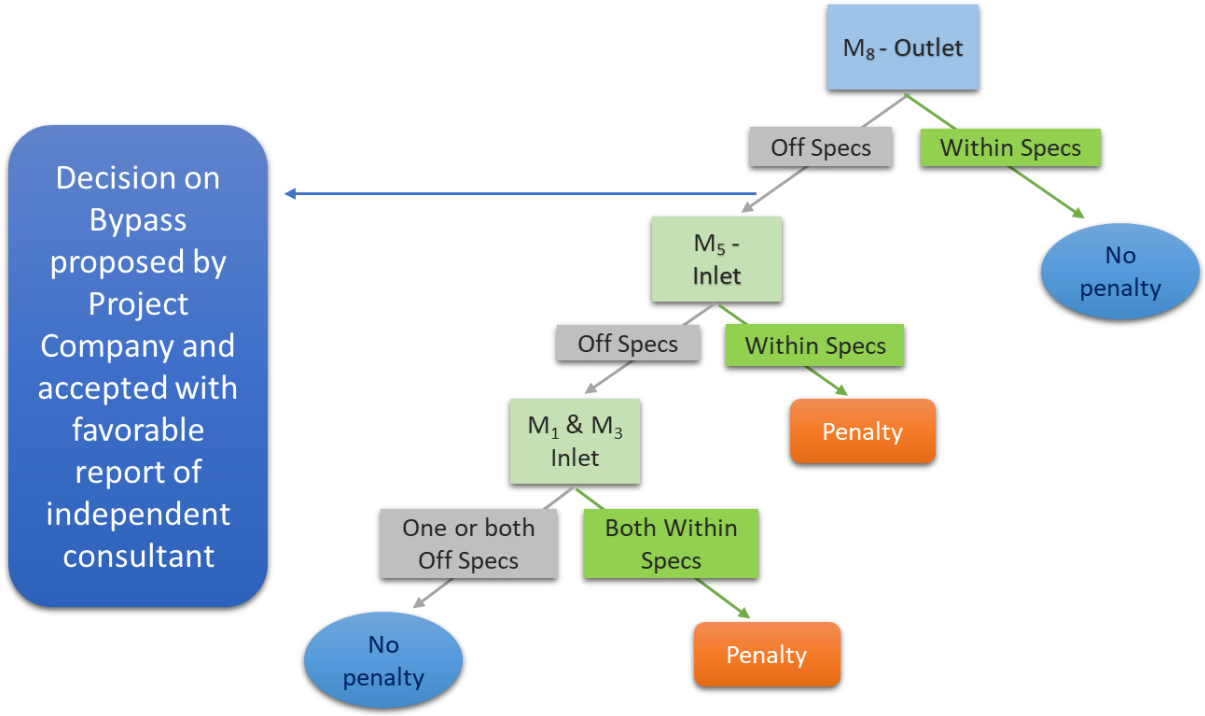


Figure 12: Water Quality Testing Methodology.

5.2 TESTING & COMMISSIONING PROCEDURES

Testing will also take place during the Mobilisation Period, the completed works will be subject to appropriate commissioning and testing as part of the C&O Activities and also at the end of Operating Period, before the handover, as per appendix 5 of the Concession Agreement.

The Company shall propose the testing and commissioning procedures in the Bidding Form T7 – Technical Project Methodology / Approach of Volume I – bidding procedure, according to the Concession Agreement and Good International Industry Practices.

After completion of process commissioning for the KWC, the Company (in addition to other testing requirements as set out in the Concession Agreement) shall prepare Test Procedures for the KWC to demonstrate (i) the operational integrity of the interfaces of the KWC with related facilities as well as the operational integrity of the KWC itself, and (ii) the ability of the Treatment Plant to treat water within the design envelope, technical limits & to deliver potable water which complies with the Output Water Quality Specifications without interruption.

The minimum commissioning and acceptance testing criteria are listed in the following table, though further details shall be found at Appendix 5 of the Concession Agreement:

Item	**Criteria**
Potable Water	Potable water quality is in accordance with the Output Water Quality Specifications.
Continuous Operation	Continuous operation of the KWC in automatic mode without interruption.
	Certain specified individual equipment items have been in continuous operation without interruption.
	Automatic changeover of duty / standby units in the event of failure of the duty unit during the continuous operation verified.
	Display of all the monitoring parameters at the KWC console and SCADA verified.
	Ability to react in the desired manner when fault conditions are detected or reported is verified.
	Main water treatment process systems operating in a stable way and providing compliant water quality in accordance with the requirement set forth in the RFP.
	Delivery of water at the Output Water Connection Point.
Non-Revenue Water	Percentage of NRW within the limits defined by the Company.

Annexure 1 – Due Diligence Relevant Information

Due Diligence document has been Attached as a Separate Document

Due Diligence Report

HY6602-RP-TYP—Due Diligence--D01

Karachi Water Supply Canal PPP

June 2021

IFC
International Finance Corporation
WORLD BANK GROUP

Quality control sheet

Document	Due Diligence Report	
Project	**HY6602 Karachi Water Canal PPP**	
Code	HY6602-RP-TYP-Final Due Diligence-D02-WITH_COMMENTS	
Authors:	Signed:	JEM; IGL; JST, AJA, GAM, LRT
	Date:	17/06/2021
Verified	Signed:	GDM
	Date:	18/06/2021
Recipient	TYPSA Group	
Notes	Due Diligence for the existing canal rehabilitation. Annexes included in separate files. Verification dates are limited to edition D02	

Contents

Executive Summary *1*

1. INTRODUCTION AND GOALS *9*

2. ANALYSIS OF THE AVAILABLE DATA *15*

2.1. TOPOGRAPHICAL SURVEY 16

2.2. WATER QUALITY TESTS 17

2.3. GEOTECHNICAL SURVEY 22

2.4. GEOPHYSICAL SURVEY 24

2.5. WATER RESOURCES ANALYSIS 25

2.6. PRELIMINARY NATURAL RISK ASSESSMENT 29

2.7. LAND REQUIREMENTS AND UTILITIES 34

3. FACILITY ASSESSMENT AND GAP ANALYSIS *39*

3.1. KARACHI CANAL 39

3.2. HUB PUMPING STATION 43

3.3. RISING MAINS 45

3.4. WATER TREATMENT PLANT (FILTRATION PLANT) 46

3.5. POWER SUPPLY FACILITIES 49

3.6. FACILITY ASSESSMENT CONCLUSIONS 50

4. ANALYSIS OF POTENTIAL ALTERNATIVES *51*

4.1. Set of Alternatives 1: Existing Canal Rehabilitation 52

4.2. Set of Alternatives 2: Hybrid Approach 56

4.3. Set of Alternatives 3: Pipeline Approach 60

4.4. Multicriteria Analysis and Selection of Alternatives 64

5. DEVELOPMENT OF THE SELECTED ALTERNATIVE *71*

5.1. Description of the Selected Alternative 71

5.2. Water Conveyance Infrastructure 72

5.3. K-III Connection to Hub Pumping Station 77

5.4. Pumping Station 79

5.5. Rising Mains 82

5.6. Water Treatment Plant 83

5.7. SCADA and Metering System 88

5.8. Power Supply 91

5.9. Capital Expenditure (CAPEX) 102
5.10. Operating Expenditure (OPEX) 104
5.11. Construction Schedule 108
6. OPERATION & MAINTENANCE BASIC REQUIREMENTS 111
6.1. BASIC OPERATION GOALS 111
6.2. BASIC MAINTENANCE GOALS 112
6.3. OPERATION AND MAINTENANCE GENERAL CRITERIA 112
6.4. HUB SYSTEM SECURITY SYSTEM 114
6.5. MAINTENANCE TASKS AND REQUIREMENTS 114
6.6. CONCESSIONAIRE PROJECT FACILITIES 116
7. KEY PERFORMANCE INDICATORS 118
ANNEXES 121
Annex 1. DRAWINGS OF THE EXISTING FACILITIES 122
Annex 2. STUDIES AND FIELD CAMPAIGNS 123
Annex 3. PROPOSED DESIGN DRAWINGS 124
Annex 4. UPDATED 100 MGD-ALTERNATIVE ANALYSIS FOR THE TSR 125
Annex 5. CAPEX AND OPEX FIGURES 126

TABLES

Table 1. Risk allocation 8
Table 2: Locations for the Hub Canal cross section study carried out on site. 16
Table 3: Summary of water quality results shared by KWSB personnel at the filtration plant. 18
Table 4: Results from Samples taken on 18th of September. 20
Table 5: Results from Samples taken on 1st of Oct 2020. 21
Table 6: Available information about the WTP (Source: Operators from Hub WTP) 48
Table 7: Estimation of the existing power demand 49
Table 8: Facility Assessment conclusions 50
Table 9: Results of the Multicriteria analysis 70
Table 10: Items necessary for the WTP Rehabilitation 84
Table 11: PV Solar Plant Coordinates 92
Table 12: General characteristics 96
Table 13: Estimated energetic production 98
Table 14: Estimated monthly production profile 100
Table 15: Budget of the project 101
Table 16. Main KPIs proposed to be used at the KWC PPP 119
Table 17. Additional KPIs that could complement and enhance the KWC PPP follow-up 120

FIGURES

Figure 1. General layout of the Karachi Water Canal 10
Figure 2. Existing Bulk Water Supply System. Source: JICA Masterplan (2008) 11
Figure 3. Excerpt from the topographical survey report 17
Figure 4. Example of a figure layout from the generated Google KMz file 17
Figure 5. Head Regulator 18
Figure 6. Distribution Chamber 18
Figure 7. Geological mapping 24
Figure 8. Resistivity Test point at the Pumping Station 24
Figure 9. Resistivity Test point at the Pumping Station 24
Figure 10. Electrical Resistivity Tomography 25
Figure 11: Analysis of the historical Karachi Canal average monthly flow data 26
Figure 12: Analysis of the historical Karachi Canal average daily flow data 28
Figure 13 Karachi canal topographic map. Source: https://en-ca.topographic-map.com 30
Figure 14. Erosion problems along the canal embankment. 31
Figure 15. N-S axis. Altimetry for PS. Source: Google Earth. 31
Figure 16. W-E axis. Altimetry Source: Google Earth. 32
Figure 17. PS watershed. Source: https://en-ca.topographic-map.com 32
Figure 18. KWSB owned land around the PS and WTP (to be confirmed) 35
Figure 19. Example of a typical pipeline construction right-of-way. 36
Figure 20. General view of the facility system 39
Figure 21. Plan of Hub Canal 39
Figure 22. Head Regulator 40

Figure 23. Structural deterioration of KWSB canal 40
Figure 24. Hydraulic profile obtained as result of the calculations made. 42
Figure 25. Excessive slope in several sections of the Hub Canal 42
Figure 26. Schematic description of one of the potential canal rehabilitation alternatives 43
Figure 27. Old Pump House 44
Figure 28. Pumps installed inside the Old Pump House 44
Figure 29. General view of the New Pump Station 44
Figure 30. Surge vessels at the New Pumping Station 44
Figure 31. Rising mains 45
Figure 32. Plan view of the Water Treatment Plant 46
Figure 33. Description of Baseline alternative "0". 52
Figure 34. Proposed location for the new FV Plant 53
Figure 35. Longitudinal profile of the Karachi Canal 56
Figure 36. Alternative 2 Hybrid approach. Description 56
Figure 37. Alternative 3. Cases A and B. 60
Figure 38. Alternative 3. Cases A and B & new pump station at Head Regulator 61
Figure 39. Selected alternative description. 71
Figure 40. Longitudinal profile for the selected alternative 71
Figure 41. Typical Canal rehabilitation section. 73
Figure 42. Example of eroded and collapsed Hub Canal sections 73
Figure 43. Condition of the canal roadway after rainfall 73
Figure 44. WAPDA canal rehabilitation, earth storage 74
Figure 45. WAPDA canal rehabilitation, cofferdam detail. 74
Figure 46. Xúquer-Turia Canal Rehabilitation (Spain) 74
Figure 47. Xúquer-Turia Canal (Spain). Option for a Partial Rehabilitation 75
Figure 48. Options for Canal Rehabilitation 75
Figure 49. Damages in bridges and aqueducts 75
Figure 50. Pumping station scheme 77
Figure 51. Pumping stations scheme 80
Figure 52. Submersible booster pump set option 81
Figure 53. New Hub Water Canal System 82
Figure 54: Layout of WTP Update 85
Figure 55: Flow Diagram for WTP Update 85
Figure 56. Software architecture 91
Figure 57. Location of boreholes (Geotechnical Survey) 93
Figure 58. Seismicity of the area (Geotechnical survey) 93
Figure 59. PV Plant site proposal 94
Figure 60. PV Plant distribution 96
Figure 61. Single line diagram PV Plant 97
Figure 62. Estimated daily production profile. 99

ABBREVIATIONS

Alum	Iron free Aluminum Sulphate
BoQ	Bill of Quantities
DDR	Due Diligence Report
E&S	Environment and Social
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
ESMS	Environmental and Social Management System
GoS	Government of Sindh
GRP	Fiber Glass Reinforced Pipeline
IEE	Initial Environmental Evaluation
IFC	International Finance Corporation
KE	K-Electric, formerly known as Karachi Electric Supply Company
KOM	Kick-off meeting
km	Kilometers
KWC	Karachi or Hub water canal
KWSB	Karachi Water and Sewerage Board
m	Meters
MGD	Millions of Gallons per Day
MW	Mega Watts
Nullah	It is an open, usually concrete-lined, channel designed to allow rapid drainage of storm precipitation or industrial wastewater from high ground
O&M	Operation and Maintenance
PPP	Public Private Partnership
PS	Pumping station
ROT	Rehabilitation, Operation and Transfer
s	Seconds
SCADA	Supervisory control and data acquisition
SEQS	Sindh Environmental Quality Standards
USP	Unsolicited Proposal
USP Developer	EA consulting private limited, Capstone construction private limited JV and SMC
WAPDA	Pakistan Water & Power Development Authority
WTP	Water treatment plant

Executive Summary

Government of Sindh, through KWSB, aims to competitively procure private party to design, build, finance, operate and maintain the brownfield 100 MGD water canal from Hub Dam. The water canal system was developed in 1982. Project objective is to undertake major rehabilitation of existing infrastructure of Karachi Hub Canal and associated facilities (nearing completion of lifespan) to ensure long term water supply of 100 MGD to the city of Karachi.

The Hub Canal is a 22.4 km canal that conveys water from Hub Reservoir to the KWSB water treatment plant (WTP) located in Manghopir-Karachi, providing drinking water to District West in Karachi, a city with a total population of over 16.5 million people in 2021 (22 million according to other sources). The system was originally designed to treat 100 MGD (5.26 m^3/s) of water coming from Hub Reservoir, but the canal capacity is currently limited to around 75 MGD (3.94 m^3/s) The successful implementation of the project will enhance the existing condition to reach the total expected capacity of 100 MGD (5.26 m^3/s)

The Project scope involves the rehabilitation of a 22.4km canal from downstream of Hub Dam, pumping stations, water treatment plant and rising mains. The project also includes installation of a solar plant to serve as an alternative source of power to the national grid.

IFC PPP Transaction Advisory has been appointed by KWSB as Lead Transaction Advisor in March 2020 to review the unsolicited proposal, conduct detailed due diligence, structure the transaction, prepare the tender documents and bid the Project for private sector participation.

IFC has appointed Haidermota Advocate & Co as legal advisors, and TYPSA as technical and environmental advisor.

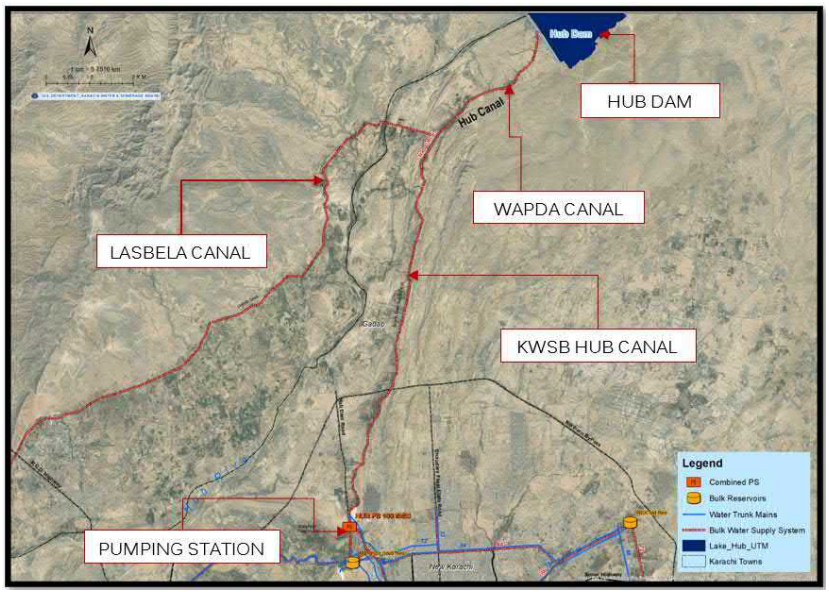
This project also considers the K-III connection, with up to 80 MGD (4.31 m^3/s), which is combined with the Canal when necessary, but no rehabilitation works are envisaged for K-III. This K-III connection encompasses a reinforced concrete pipeline (RCC) with an 80" (2,032 mm) diameter that is conveying water from the Indus River, through the Dhabeji Pump Station, and connecting with the Hub Pumping Station. This K-III connection is only used when there are maintenance works at Hub Canal or when Hub Reservoir does not have enough water resources to yield the design outflow; in particular, K-III completely takes over Hub Canal when Hub reservoir levels are below 278 ft (84.73 m above sea level).

This way, the project entails the following works:

- Rehabilitation of the existing Hub canal from the Head Regulator, along 11,700 m

- Construction of a new pipeline for 9,765 m; until the Hub Pumping Station.
- Upgrade of the Hub Pumping Station to achieve 100 MGD (5.26 m^3/s) and connect with K-III.
- Upgrade of the Rising Mains with 2 new GRP pipelines for 1,842 m
- Rehabilitation and capacity enhancement of the water treatment plant, as its capacity is limited to 80 MGD.
- SCADA and metering system.
- In addition, the project includes a solar PV generation solution to optimize energy requirements.

The **aim of the Due Diligence Report (DDR)** is to provide a basic engineering design and assess the risks. In order to achieve these objectives, the technical Consultant has carried out several studies, field visits and campaigns that are included in **Annex nº 2** of this due diligence report. In particular, the following tasks can be highlighted:



- data gathering and review,
- site visits,
- flow measurements surveys,
- hydrological study and water resources analysis,
- preliminary risk assessment including flooding,
- hydraulic calculations including transient analysis,
- water quality tests,
- topographical survey including drone flights and videos,
- geotechnical surveys,
- geophysical surveys,
- geological mapping of the Hub system alignment,
- seismic study and geotag maps,
- solar photovoltaic plant feasibility study,
- facility assessment and gap analysis,
- proposal of feasible alternatives,
- preliminary engineering design,
- and CAPEX-OPEX figures.

Karachi is Pakistan's economic and financial hub, generating 12-15% of the GDP, plus contributing with 53% of the overall federal tax collection and 5.5% to total domestic employment. With a population of over 16 million people and area covering 3 780 km^2 Karachi is the 12th biggest city in the world by population. The city

has witnessed a significant reduction in poverty with 9 of the population living below the poverty line in 2015 compared to 23 in 2005. Per capital income is approximately USD 6 000, making it the richest city in Sindh and the third richest city in Pakistan.

With regard to water supply, the Karachi Water and Sewerage Board (KWSB) estimates the total demand for the 16-million people city as 1,200 MGD (63.14 m^3/s). The bulk water sources for Karachi are Keenjhar Lake with 480 MGD (29.73 m^3/s) supply capacity, Hub Dam with 100 MGD (5.26 m^3/s) and other minor sources. Thus, there is an inherent shortfall of around 535 MGD in the Karachi water supply.

Furthermore, out of the total water supplied, 210 MGD (11.05 m^3/s) are not filtered. This, in addition to bacterial contamination from sewerage discharge flowing in pipelines laid parallel to water supply pipelines has significantly degraded the quality of water supplied. A study conducted by the Pakistan Council of Research in Water Resources (PCRWR) found that almost 86% of water supplied to Karachi is unfit for drink due to presence of E-coli.

In addition, the city is getting less water resources from the Keenjhar Lake due to non-desilting of its water channel. The Hub Dam source is also affected by the seasonal and annual water level fluctuations in the dam, and this situation is further aggravated due to losses attributed to leakages and water theft, and according to some estimates, 40% of the water supply in Karachi is being lost on this account.

The water stress gets worse with hot weather, and people in many areas (Lyari, Baldia, Orangi, Keamari, Shershah and parts of Gulistan-e-Johar) are compelled to drink contaminated water. A tanker of 1000 gallons (4.55 m^3) with slightly brackish water sells in city for Rs 1,000 and better water sells for up to Rs 2,000 for 1000 gallons, whereas citizens in many areas purchase canned and bottled water.

Based on the field visits and onsite surveys carried out, **a facility assessment and gap analysis** with a description of the current condition of the infrastructure have been made. After the assessment of the infrastructures that make up the Hub canal system, the main conclusions are the following:

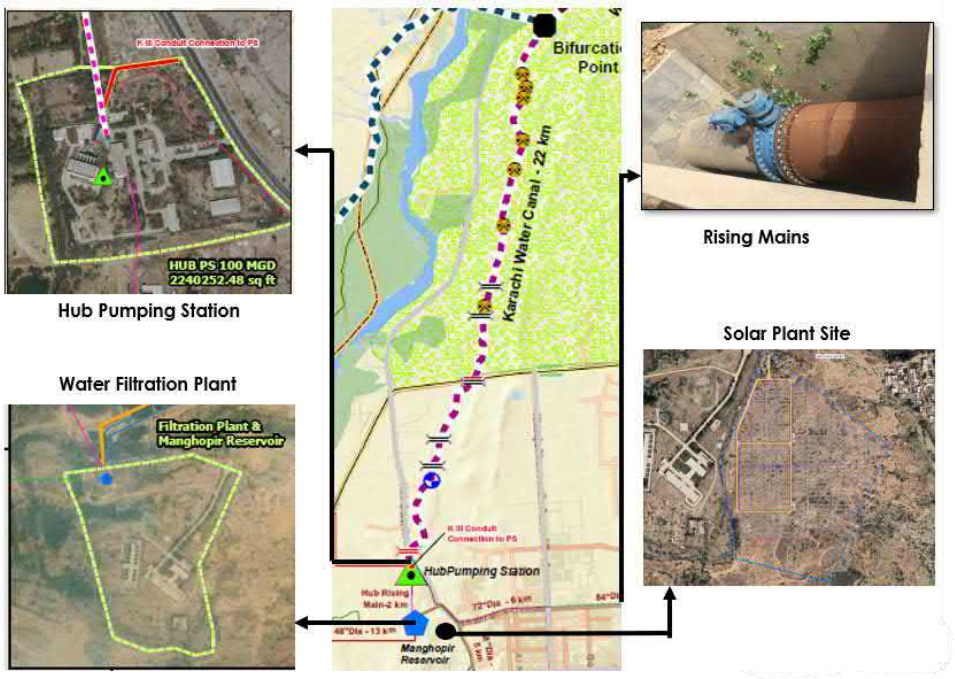
- No flow rate measurement devices are installed or implemented, so it is not possible to know or quantify the real amount of water conveyed by the system.
- The structure of the canal is old and undergoes a lot of deterioration. Its lifespan is almost finished and there is a significant loss of water throughout the alignment due to seepage. Based on the NED University of Engineering and Technology measurement carried out in November 2019, nearly 26% of the water is lost between the Head Regulator and the Hub Pumping Station. Some illegal offtakes from the canal have also been reported.
- The roadway along the canal also needs repair works because it does not have proper drainage and thus is bumpy, irregular, and missing at various locations on each side.
- The bottom lining of the aqueducts is highly deteriorated and has resulted in permanent wetlands around their location areas. Aqueduct structures are deteriorated, whereas seepage and leakages at joints / abutments were also observed during the site visits. At some locations, reinforcement bars are massively exposed due to concrete deterioration.

- The old pumping station, installed in 1982, surpassed its design life many years ago. There is no flow measuring device to confirm the current flow from the pumps and their efficiency cannot be calculated.

- The new pumping station was commissioned in 2006, and it is also near the end of its design life. Out of 6 pumps in the new pump house, 2 pumps are non-functional due to electromechanical faults.

- The rising mains are 38 years old, and according to the comments shared by KWSB their operation is not adequate, there are leakages along their alignment and bursts when used along with the new pump house. In any case, no additional information is available, and it has not been possible to carry out field surveys over the rising mains pipelines.

- The existing Hub Water Treatment Plant (WTP) was built 20 years ago for a design flow of 80 MGD, and it has currently several issues that should be solved to ensure that proper quality water is delivered to the population downstream:
    - The existing inlet screen gets constantly blocked because there is not a tank to store the waste.
    - Sulphur acid is not dosed, whereas backwashing pumps and blowers of the sand filters have been maintained but not replaced since their installation, and one of the blowers is not working.
    - Except for the chlorine, all chemical dosing is done manually.
    - In the sludge line, the scrapers and submerged sludge pumps have never been replaced since their installation.
    - The automatization system of the WTP (SCADA) is not working, and all process units are controlled manually.
    - According to the water quality tests, the WTP is not treating the water conveyed from the pumping station properly.



- The information provided by KWSB on power and consumption of the complex considers that demand remains steady 24/7 and, currently, a total and constant power demand of 6.1 MW could be considered as the base load for the complex.

A water resource assessment has been carried out to make an **estimation of the past performance of the system**. Historically, the average flow in the canal has been 70.5 MGD (3.71 m^3/s) with 100 MGD (5.26 m^3/s) being conveyed only 10% of the time. Only 50% of the days, the flow has been 80 MGD (4.21 m^3/s) or smaller and the median flow has been of 82 MGD (4.31 m^3/s). The resilience of the flow to return to 100 MGD (5.26 m^3/s) is only 1%. It has been decided by KWSB and the GoS that the rehabilitation of the Hub canal system should be able to convey and treat up to 100 MGD (5.26 m^3/s), especially with KIII as an additional source.

Currently, there are two legal offtakes that are metered, in particular, one from Hamdard University and another managed by the Public Health Department for a small population area. Other illegal offtakes and utilities have been identified.

For the **definition of the alternatives,** and after the analysis of the current capacity of the involved infrastructures, the following objectives have been pursued:

- Ensure there is minimal water supply disruption during the construction period.
- Minimize project lifecycle costs.
- Minimize construction period.
- Minimize operating and maintenance risks due to erosion and theft.
- Minimize land acquisition.

The following table summarizes the alternatives analyzed in this due diligence stage:

Alternative 1.1 (Canal rehabilitation with 80 MGD) ▪ Existing Canal rehabilitation including the 2.28 km pipeline in the high slope stretch for 80-100 MGD. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 80 MGD ▪ Connection with existing RM ▪ Solar PV Plant (3.3 MW)	Alternative 1.2 (Canal rehabilitation with 100 MGD) ▪ Existing Canal rehabilitation including the 2.28 km pipeline in the high slope stretch for 80-100 MGD. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 100 MGD ▪ Connection with existing RM ▪ Solar PV Plant (5.3 MW)
Alternative 2.1 (Hybrid with 80 MGD) ▪ Existing Canal rehabilitation in the first 11 km ▪ New GRP pipeline DN1900 for 9.2 km (80 MGD) with a pressure chamber at its beginning ▪ Decommissioning of the existing canal in the last 9.2 km ▪ Mitigation measures for the pipeline stretch. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 80 MGD ▪ Replacement of the existing RM ▪ Solar PV Plant (3.3 MW)	Alternative 2.2 (Hybrid with 100 MGD) ▪ Existing Canal rehabilitation in the first 11 km ▪ New GRP pipeline DN1900 for 9.2 km (100 MGD) with a pressure chamber at its beginning ▪ Decommissioning of the existing canal in the last 9.2 km ▪ Mitigation measures for the pipeline stretch. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 100 MGD ▪ Replacement of the existing RM ▪ Solar PV Plant (4.4 MW)

Alternative 3.1 (Pipeline with 80 MGD)	Alternative 3.2 (Pipeline with 100 MGD)
▪ Decommissioning of the existing canal and PS ▪ New GRP pipeline DN1900 (80 MDG) within existing RoW ▪ Mitigation measures for the new pipeline ▪ New Pumping Station at the Head Regulator, H=51.75m 2760 kW ▪ Water Treatment Plant (WTP) with 80 MGD ▪ Connection with existing RM ▪ Solar PV Plant (4.5 MW) ▪ New power distribution line (15 km)	▪ Decommissioning of the existing canal and PS ▪ New GRP pipeline DN1900 (100 MGD) within existing RoW ▪ Mitigation measures for the new pipeline ▪ New Pumping Station at the Head Regulator, Head and Power to be defined. ▪ Water Treatment Plant (WTP) with 100 MGD ▪ Connection with existing RM ▪ Solar PV Plant (6.3 MW) ▪ New power distribution line (15 km)

From a technical point of view, the hybrid solution that combines the partial rehabilitation of the existing canal between the Head Regulator and PK 11-+700, with a new pipeline in the last stretch until the Hub Pumping Station, plus an upgrade of the existing PS and WTP would be optimal. KWSB intends to proceed with Alternative 2.2 considering the optimal technical and environmental solution, with no land acquisition, and also respecting the original 100 MGD (5.26 m^3/s) once that K-III is included in the project as a back-up source.

All elements and equipment included in this due diligence report are for information purposes, the Concessionaire shall be entailed to come up with a definitive solution, complete the detailed design and utilize components and systems which are of new manufacture and proven design. All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

The risk allocation for this project is a follow, considering that GoS and KWSB are still deciding the coverages offered by each of them:

Risk	Description	KWSB/GoS	Private Party
Land Purchase and Site	The risk of acquiring title to the land required for the project. The land may be encumbered or have no access rights. In principle, it is not encroached.	X	
Site Security	The risk of safeguarding the project site and existing facilities for smooth implementation of the project		X
Water Resources	Seasonal or annual flow rate variations can reduce the volume of water supply from Hub dam due to unreliable rainfall.	X	
Water Rights License	The risk that KWSB does not have right of access to water from Hub Dam required for the implementation of the project.	X	
Permits and Consents	Regulatory permits required for project implementation including environmental approvals, electricity, culture department and any consents required have not been obtained.		X
Construction	Construction works do not meet the construction performance standards, suffer from defects or commissioning damage and involve labor, subcontractor disputes. Risk also includes construction is not completed on time and on budget resulting in time and cost overruns. Cost escalation/overruns due to changes		X

Risk	Description	KWSB/GoS	Private Party
	in interest rates and exchange rate have been considered separately		
Financial Close	Private sector fails to arrange the financing (both debt and equity) required for project implementation. Failure to achieve financial close due to conditions precedent related to KWSB) not being fulfilled is covered under agency performance risk		X
Design	Risk that the project has not been designed adequately for the purpose required and results in higher than expected maintenance costs or other performance failures or the risk of latent defects arising in the project facilities.		X
Existing Condition	Existing condition of the site and facilities may deteriorate during the project development phase		X
Environmental	Risk that implementation of the project would result in environmental degradation which would damage the latent environmental conditions and subsequently put local communities and other species at risk	X	X
Demand	Risk that the demand for water supply is less than the facility design capacity	X	
Operating and Maintenance	Operation and maintenance of the project does not comply with the operating performance standards resulting in increased operating costs, water unavailability, poor water quality, theft and seepage. This risk also includes an inability to measure the operating performance of the project through flow meters and automated systems		X
Interest Rate (Construction Period)	An increase in interest rates during the construction period may lead to cost overruns		X
Interest Rate (Operating Period)	An increase in interest rates during the operating period may lead to increased debt servicing costs and reduce profitability for equity holders	X	
Inflation	An increase in inflation rate may cause operating costs that are linked to inflation (wages, regular maintenance, fuel) to increase reducing profitability for equity holders. It would also decrease the monetary value of local currency-based annuity payments	X	
Exchange Rate	A depreciation of the local currency may render the local currency-based annuity payments insufficient to cover foreign debt servicing costs after conversion. Similarly, foreign equity holders would suffer a decrease in equity IRR	X	
Regulatory	Also known as the Change in Law risk, this risk includes any change in federal or provincial law, regulation (such as tax laws) that adversely affects the performance or economics of the project	X	

Risk	Description	KWSB/GoS	Private Party
Force Majeure	Risk that unexpected events occur which are outside the control of both parties (including temporary and expected drought in Hub Dam) that delay or prohibit the performance of the project.	X	X
Agency Performance	Risk that KWSB is unable to fulfill its obligations under the Concession Agreement including the obligation to pay annuity payments, secure funds required to be injected as viability gap funding, implement the required tariff indexations, payment of termination payments, payment of compensation in case of relief events, payment of additional cost incurred by the private sector on the account of KWSB etc	X	

Table 1. Risk allocation

1. INTRODUCTION AND GOALS

This Due Diligence Report for the Karachi Water Canal PPP Project is presented by TYPSA to IFC, and it encompasses a facility assessment that describes the current condition of the Karachi Hub Water Canal and its appurtenant infrastructures, namely the pumping station (PS), the "rising mains" (RM) pipeline that connects the PS with the water treatment plant (WTP), and the power supply analysis. Furthermore, within this document it is possible to find a preliminary engineering design and its cost estimate, namely for the canal rehabilitation, PS, RM, and WTP. Finally. this document also includes a review of all the documents and information gathered since May 2020, along with annexes that portray the technical campaigns executed for the development of the project.s

The aim of this Due Diligence Report (DDR) is to provide a basic engineering design, assess the risks, and pursue the following objectives:

- Technical and environmental support to develop the Karachi Canal PPP.
- The original aim is to rehabilitate, upgrade, operate and maintain the Canal with a PPP transaction that considers the participation of the private sector for the next decades.
- Assessment of the current situation and needs.
- Definition of an engineering solution.
- Ensure the environmental and social feasibility of the project.
- CAPEX-OPEX estimation.
- Support for the transaction definition and bidding process.

In order to achieve these objectives, many tasks and campaigns have been carried out by the Consultant, including the following:

- Review of existing information
- Site visits
- Flow measurements surveys
- Hydrological study and water resources analysis
- Flood risk assessment
- Hydraulic calculations, including transient analysis
- Water quality tests
- Geotechnical surveys
- Geophysical surveys
- Geological mapping of the Hub system alignment
- Seismic study
- Geotag maps
- Solar photovoltaic plant feasibility study

This project started off when a private sector entity, the USP Developer, approached the Government of Sindh (GoS) and Karachi Water and Sewerage Board (KWSB) via an unsolicited proposal (USP) that tried to involve the private sector for the rehabilitation of the canal that stems from Hub dam and is part of the Karachi water supply system. GoS appointed IFC as its Lead Transaction Advisor to support on the USP evaluation, prepare and undertake the structuring and tendering of the Project on a Public Private Partnership (PPP) basis. In

turn, Haidermota Advocates & Co was appointed as legal consultant and TYPSA as the technical and environmental consultant. The objective of the initial phase of the works was the study and analysis of both the existing documentation (USP and Response Letter) and the capabilities of the USP Developer, EPC Contractor & O&M Contractor. After the analysis of the USP unsolicited proposal, several gaps were found which led to it being turned down by KWSB. This led to a new stage, where the technical consultant was entitled to take on the responsibility of developing field campaigns, gather information and submit an engineering design to accomplish the PPP goals and make it bankable.

Along with all the field visits and onsite surveys, several weekly meetings have been held systematically with IFC, KWSB and both the technical and environmental teams. With respect to the Karachi Canal rehabilitation alternatives, KWSB brought up relevant issues that have driven the analysis and proposed design:

- The need to ensure that the canal remains operational and to prevent any major canal closure during the rehabilitation works.
- KWSB willingness to consider the construction of a new pipeline as an alternative to the canal rehabilitation, given the difficulties and expenses involved in a canal rehabilitation with absolutely no closure days.

This document focuses on the facility assessment and gap analysis, proposal of feasible alternatives and engineering design for the selected alternative (both CAPEX and preliminary OPEX), whereas the data gathering, onsite surveys and field visits are included as Annexes 1 and 2.

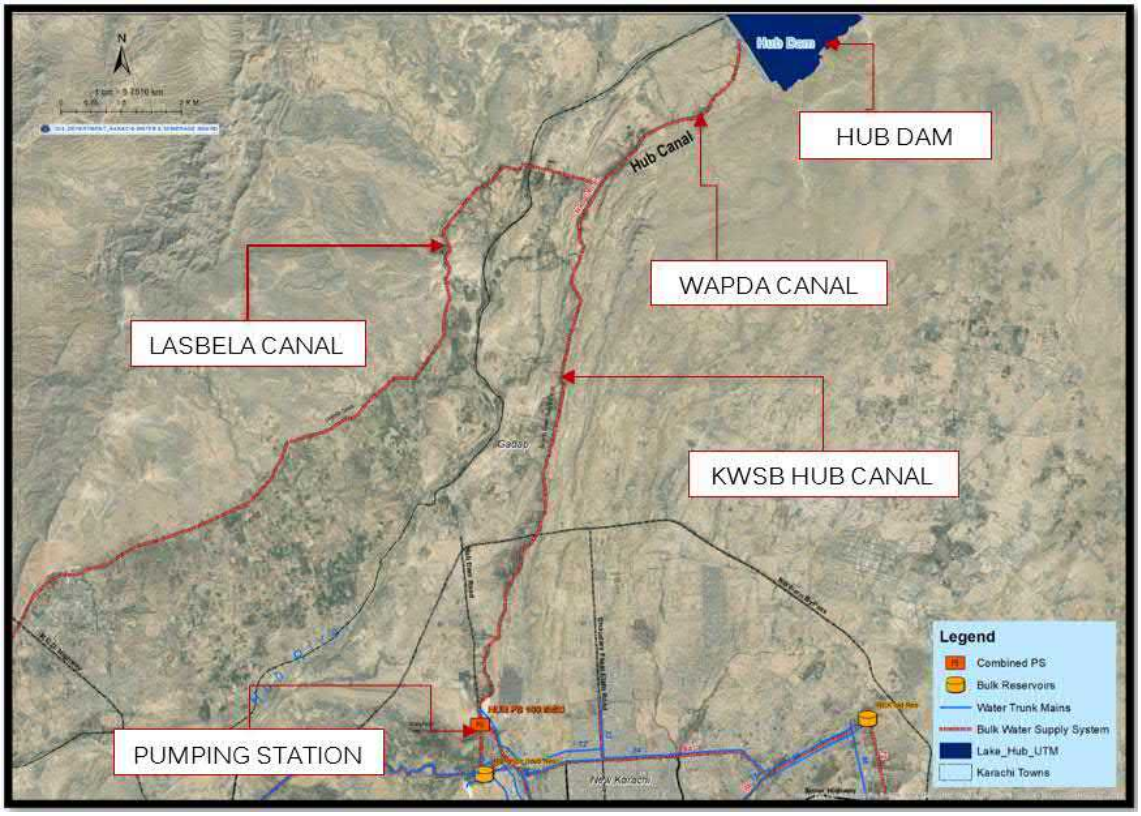


Figure 1. General layout of the Karachi Water Canal

Despite its limitations, this project is extremely important and strategic for the city of Karachi, and the consultants are aware of the responsibility that this work entails. Karachi is Pakistan's economic and financial hub, generating 12-15% of the GDP, plus contributing with 53% of the overall federal tax collection and 5.5% to total domestic employment. With a population of over 16 million people and area covering 3 780 km^2 Karachi is the 12th biggest city in the world by population.

The city has witnessed a significant reduction in poverty with 9 of the population living below the poverty line in 2015 compared to 23 in 2005. Per capital income is approximately USD 6 000, making it the richest city in Sindh and the third richest city in Pakistan. However, over the years, the economic activity in Karachi has stagnated due to poor governance, declining infrastructure, and inadequate development expenditure. In fact, Karachi ranked among the bottom 10 cities in the Global Livability Index.

According to a World Bank report, the infrastructure needs of Karachi are estimated at USD 10 Billion over the next 10 years, and the decaying infrastructure has led to a decline in labor productivity. Despite being a manufacturing powerhouse with an average GDP growth of 5.7% per annum between 2000 and 2012, labor productivity has only increased at 0.47% per annum. Administratively, the city is divided into 6 districts (excluding cantonments): South, East, Central, West, Malir and Korangi.

With regard to water supply, the Karachi Water and Sewerage Board (KWSB) estimates the total demand for the city as 1,200 MGD (62.51 m^3/s). The "Water supply and sewerage system in Karachi Report" (by JICA on 2008) proposed that 40 gallons per capita per day (GPCD) could be adopted for bulk water demand for the year 2025, that is the same as the 2008 demand, whereas water availability for domestic consumption will increase because of the reduction of water losses and the water-saving efforts of non-domestic consumers.

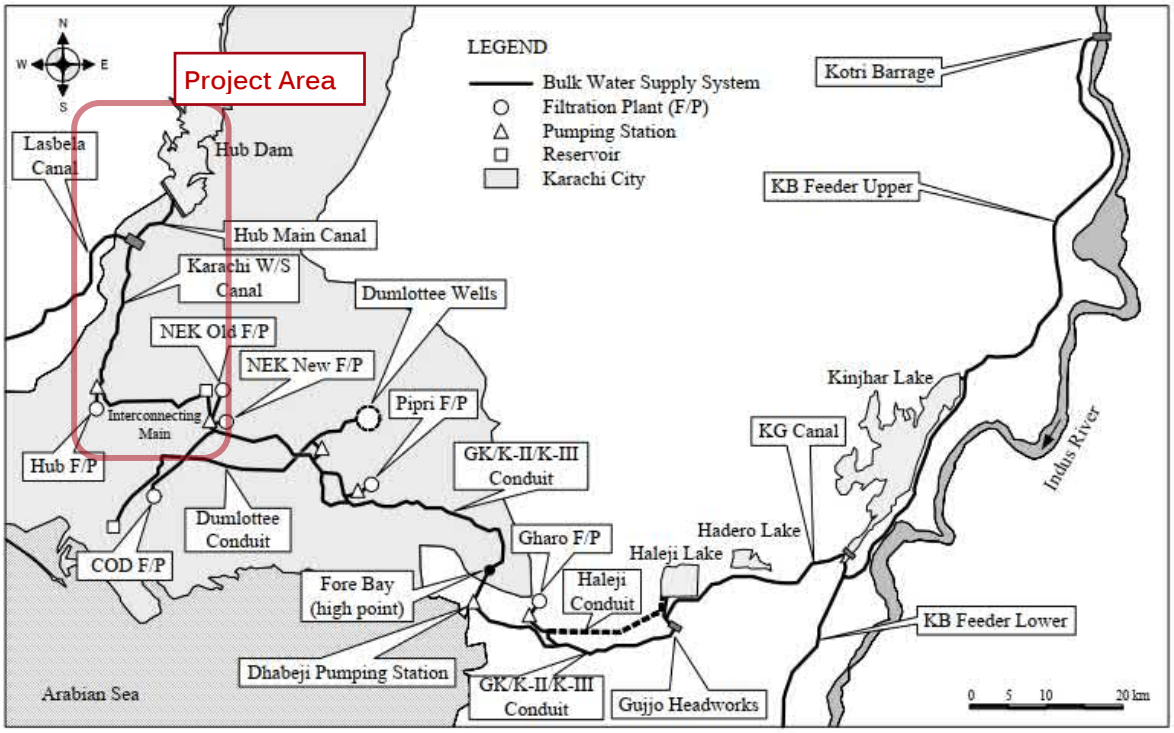


Figure 2. Existing Bulk Water Supply System. Source: JICA Masterplan (2008)

The bulk water sources for Karachi are Keenjhar Lake with 550 MGD (28.94 m^3/s) supply capacity, Hub Dam with 100 MGD (5.26 m^3/s) and 15 MGD from other minor sources. Thus, there is an inherent 45% shortfall in the Karachi water supply, that is an overall 535 MGD (28.15 m^3/s).

In addition, the city is getting less water resources from the Keenjhar Lake due to non-desilting of its water channel. The Hub Dam source is also affected by the seasonal and annual water level fluctuations in the dam, and this situation is further aggravated due to losses attributed to leakages and water theft, and according to some estimates, 35-40% of the water supply in Karachi is being lost on this account.

". Furthermore, out of the total water supplied, 210 MGD (11.05 m^3/s) are not filtered, and this fact, in addition to bacterial contamination from sewerage discharge flowing in pipelines laid parallel to water supply pipelines has significantly degraded the quality of water supplied. Another study conducted by PCRWR found that almost 86% of water supplied to Karachi is unfit for drink due to presence of E coli.

The water supply infrastructure is almost 40-45 years old, and poor maintenance and inadequate rehabilitation leads to the aforementioned water losses in the distribution system. Namely, out of the 665 MGD (34.99 m^3/s) supplied, 232 MGD (12.21 m^3/s) are lost due to leakages. This way, access to water through pipes, tube wells and pumps in Karachi has declined over the past 10 years, moving from a 90% coverage in 2006-07 to an 86% in 2014-15. In poor neighborhoods and informal settlements, water shortages are severe with availability ranging from two hours every two days to four hours per day. The lack of alternatives has given rise to unregulated hydrants propping across the city and sale of water through private commercial tankers.

The water stress gets worse with hot weather, and people in many areas (Lyari, Baldia, Orangi, Keamari, Shershah and parts of Gulistan-e-Johar) are compelled to drink contaminated water. A tanker of 1000 gallons (4.55 m^3) with slightly brackish water sells in city for Rs 1,000 and water with better quality can be sold for up to Rs 2,000 for 1000 gallons, whereas citizens in many areas purchase canned and bottled water.

In particular, the Hub Reservoir supplies water to Sindh (Karachi) and Balochistan, in a proportion determined by the Executive Committee of National Economic Council (ECNEC), which is the highest decision-making body for approval of public development schemes and projects. It is headed by the Prime Minister/Finance Minister and has representation from all development and economic ministries, and provinces at the minister level. As per ECNEC decision in 1990 s, water from Hub Dam is shared between Sindh and Balochistan provinces according to a proportion of 63.3% and 34.7% respectively.

In Sindh, the 100 MGD (5.26 m^3/s) water from Hub Dam is mainly supplied to district West of Karachi, and every year, a meeting is convened by the Water and Power Development Authority (owner of the Hub Dam) with GoS and Government of Balochistan to review the availability of water in Hub Dam for the next year. Any excesses and losses are shared by both governments according to the same ratio. The dead level at Hub Dam is around 276 feet. In the past, when water has fallen below the dead level, GoS has allowed GoB to continue pumping water directly from the Hub Reservoir dead storage to manage agricultural areas in Balochistan, while GoS fulfilles its own needs from Keenjhar Lake, through the K-III connection with Hub Pumping Station.

KWSB is responsible for the planning, development, management and revenue collection related to water and sanitation services in Karachi. In 1996, KWSB Act was passed to provide the legal framework for KWSB

operations, including the production, transmission, distribution, cost recovery of potable water and development of schemes to cover shortfalls in services. Despite being an independent autonomous board under the Local Government Department of GoS, KWSB enjoys very little autonomy, and all key functions, including approval of budgets, regulations, tariffs and others, lie within the GoS.

2. ANALYSIS OF THE AVAILABLE DATA

Given the nature of this project, the task of gathering information has been a challenge from the onset. Apart from the written information, IFC considered additional onsite surveys to fill data gaps and aiming at having detailed and quality information.

The efforts made by the KWSB personnel involved in this project, along with the PPP Unit team, IFC staff in Pakistan, WAPDA stakeholders, and local collaborators are noteworthy. The Karachi Water canal was designed and constructed around 4 decades ago and it has been in operation ever since. Many of the original design documents are not available anymore, and unfortunately, the canal system does not have a technical archive of its own.

As stated above, during the development of the project, numerous site visits have been carried out, some of them were associated with the Environmental and Social scoping, whereas others were focused on technical issues. Apart from the field visits, the technical consultant team in Karachi (from HPK) has held several meetings with KWSB and the regional PPP Unit, and they have also gathered information at KWSB headquarters office in Karachi. Within **Annexes 1 and 2**, it is possible to find further details on the data collected and the information generated during the visits and surveys performed.

By way of summary, the studies that have been carried out in addition to the field visits are included below, and more details can be found both in this same chapter and **Annex 2**:

- **Topographical study**: The topographical surveys carried out, both for the baseline and the pipeline alternative, thus covering a wider buffer from the existing canal axis, will allow the bidders to better analyze their alternatives, though they are entitled to remain in the existing RoW.
- **Flow measurement**: Two flow measurement campaigns have been carried out to serve as a starting point for hydrological analyses and flow estimation, and to make decisions on the optimum design flow.
- **Hydrological Study**: This study has been developed to clarify the design flow that best matches the actual water conveyed by the KWSB. Considering that this is a brownfield project for an infrastructure that has been in operation for almost 4 decades, and also the information available, this study has focused on the analysis of the historical inflows to Hub canal and the Hub Reservoir storage levels. The study has also been used to assess the possibility of flooding in the project areas.
- **Water quality analysis**: In addition to KWSB's historical documentation of water quality data, 2 test campaigns have been carried out in the canal, which serve as a basis for establishing the degree of compliance with the water quality standards currently provided by the treatment plant. Furthermore, a water quality test for the K-III inflows was required to assess the best option to include the K-III inflows in the design.
- **Geological, Geotechnical and Geophysical surveys**: Given the limited information available, a vast variety of surveys has been developed for this due diligence report, including boreholes, laboratory tests, electrical soil resistivity tests, ferro scanning of RCC structures and tomographies. The soil resistivity tests have allowed the Consultant to confirm the corrosion potential of the soils, which combined with the Hub waters, have a high corrosion potential for iron or steel pipes. The ferro scanning, UPV and impact hammer have allowed to assess the condition of reinforced concrete structures and buildings, whereas the tomography along the canal has clearly identified the seepage

the canal is undergoing, and how it feeds the groundwater. Finally, the geological mapping has allowed the determination of the percentage of soil and rock excavation in the pipeline stretch and has also defined with accuracy the type of materials that lay underneath the canal sections.

- Seismic analysis: During the on-site visual inspections, it was noticed that the structural members are sufficiently sized; these structures were built around 40 years ago and have withstood past earthquakes. In addition, the seismic zone for Karachi is 2B according to the local regulations, so it can be concluded that the structures can perform adequately in case of an earthquake event.
- Solar PV plant Feasibility study: A study have been developed to identify the site of the solar plant that better fits the project. This site results to be right next the water treatment plant, covering a total area of 11.83 ha. Estimated global irradiation is 1,944 kWh/m^2 and diffuse irradiation is estimated at 900.4 kWh/m^2 (46%) which makes the site suitable for solar power generation.

Apart from **Annex 2**, some additional details about the surveys and field campaigns are included in the following subchapters.

2.1. TOPOGRAPHICAL SURVEY

The scope of the surveying work carried out for the rehabilitation of the Karachi Canal at this due diligence stage have included the following items:

- Topographical survey of the Karachi Water Supply Hub Canal from the Head Regulator (about 8km downstream of Hub Reservoir) to Karachi City, where the filtration plant is located.
- Verification of existing canal cross sections at different locations. In particular:

Nº	P.K. (approx.)	Position	Nº	P.K. (approx.)	Position
1	0 + 350	Before 1st aqueduct	16	5 + 550	8th aqueduct
2	0 + 400	1st aqueduct	17	6 + 200	Between 8th and 9th aqueducts
3	0 + 500	Between 1st and 2nd aqueducts	18	7 + 550	9th aqueduct
4	0 + 550	2nd aqueduct	19	8 +100	Between 9th and 10th aqueducts
5	0 + 630	Between 2nd and 3rd aqueducts	20	10 + 550	10th aqueduct
6	0 + 710	3rd aqueduct	21	10 + 900	Between 10th aqueduct and 1st fall
7	1 + 200	Between 3rd and 4th aqueducts	22	11 + 820	1st fall
8	1 + 850	4th aqueduct	23	11 +850	Right after 1st fall
9	2 + 250	Between 4th and 5th aqueducts	24	12 + 810	Right before 2nd fall
10	2 + 400	5th aqueduct	25	12 + 820	2nd fall
11	2 + 600	Between 5th and 6th aqueducts	26	12 + 850	Right after 2nd fall
12	2 + 770	6th aqueduct	27	16 + 850	Between 2nd fall and 11th aqueduct
13	3 + 330	Between 6th and 7th aqueducts	28	17 +450	11th aqueduct
14	4 + 370	7th aqueduct	29	17 + 600	Singular point
15	4 + 450	Between 7th and 8th aqueducts	30	20 + 950	Right at the end of the canal

Table 2: Locations for the Hub Canal cross section study carried out on site.

- Topographical survey at the Pumping Station Facility (16 Acres) and Rising Mains.
- Topographical Survey at the Filtration Plant Facility (52 Acres)

- Apart from the plan views and cad files, "kmz" files have been generated for all facilities.

This Topographical report was developed during September, October, and November of 2020, and then further expanded in January 2021 to address the possibility of substituting part of the existing canal with a pipeline.

The project starts off at the Head Regulator, which is the hydraulic structure that separates the flows coming from the Hub reservoir and diverts them to the Lasbela Canal and the Hub Canal (or Karachi Water Canal). For the first 12 kilometers, the canal is located on a relatively flat platform at the foot of the hills that run parallel to the Hub River valley, which unfolds its alluvial terraces to the right of the existing canal. At this point, there is an old landslide, and the terrain descends with a steeper slope for about 2.5 kilometers. After that section, the existing canal again runs with a very gentle slope (in the order of the ten thousandths) until it reaches the Hub pumping station, which is located in a relatively flat area, although surrounded by gentle hills. From the pumping station, the rising mains continue up to the water treatment plant, located a couple of kilometers downstream. The rising mains run through gentle terrain that gradually increases in elevation until the last few meters before the hill where the WTP is located. Up there, the water treatment plant is developed in a big area, with relatively flat terrain, where the solar PV plant is also proposed.

For the full Topographical report, see **Annex 1 and Annex 3.**

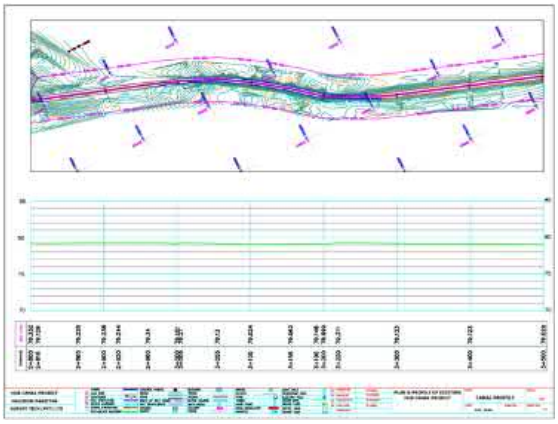


Figure 3. Excerpt from the topographical survey report

Figure 4. Example of a figure layout from the generated Google KMz file

2.2. WATER QUALITY TESTS

In order to assess the water quality in the Hub system, two different field works were consulted; the first one carried out by KWSB personnel and the second, more specific, carried out for this due diligence report.

During one site visit in September 2020, the WTP operators gave effluent water quality results analysed in their laboratory. Those samples were taken at the WTP reservoir and are summarized in the table below.

Parameters	Reservoir 07/04	Reservoir 19/04	Reservoir 29/06	Reservoir 30/06	Reservoir 02/08	WHO Limits	Pakistan Standards
pH	7,00	7,00	7,20	7,01	7,00	6,50-8,50	6,50-8,50
Colour (Hazen unit)	8	8	6	6	7	≤5	≤5
Turbidity (NTU)	9,5	7	4,8	9	32,7	≤5	≤5

Table 3: Summary of water quality results shared by KWSB personnel at the filtration plant.

Almost the totality of these samples **did not comply** with turbidity and colour according to the WHO Limits and Drinking Water **Standards** in Pakistan.

Figure 5. Head Regulator

To contrast the quality water data generated in the Hub WTP Lab, a water quality sampling campaign was envisaged for this DDR. Thus, two water sampling campaigns with three spot samples in each sampling campaign were carried out (see **Annex 2** for the Water Quality Analysis results).

During the field visits, it was ensured that samples were collected according to the standard operating procedure and preserved properly to acquire the accurate results during testing. Thus, water quality samples were taken on two days at three separate points:

- Before the head regulator at the Main Canal
- Inlet of the Water Treatment Plant (WTP)
- Outlet of the Water Treatment Plant

Figure 6. Distribution Chamber

The results of the samples were compared against WHO and Pakistan drinking water standards, and these are the main findings:

- Only two parameters do not comply with the water quality standards (WHO and Pakistan); turbidity and aluminum. In theory, this could be resolved with standard treatment processes like chemical dosing and sand filtration.
- Higher concentrations of aluminum inside the WTP seem reasonable because the treatment plant is not dosing for chemicals like aluminum. On the other hand, there are aluminum concentrations in the water source outside the WTP, which might be related with aluminum silicates in the earth.
- The concentration values of the three samples on both days are very similar for each parameter. This indicates that **raw water coming through the inlet is not being properly treated inside the WTP** either due to non-functional equipment, non-availability of chemicals or KWSB technical issues.
- Temperature is quite high in both sets of samples (higher than 30ºC). As result, the presence of organic matter could be envisaged in the reservoir, because it has not been cleaned up since 2004. However, BOD5 is very low in the three locations (less than 0,02 mg/l).

- The original KWSB samples taken in September 2020 did not show the presence of faecal coliforms, and that is why another sampling campaign was order in October 2020, where coliforms were finally found in the collected samples.

The following tables show the water quality parameters analyzed in those 2 campaigns against the limit values set by the WHO and the Pakistani Standards):

Parameters	Head Regulator	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
pH	7,01	7,00	6,96	6,50-8,50	6,50-8,50
Odour	Odorless	Odorless	Odorless		
Taste	Sweet	Sweet	Sweet		
Colour (Pt-Co)	<5	<5	<5	≤15	≤15
Turbidity (NTU)	9	6	7,5	≤5	≤5
Total dissolved solids (TDS – mg/l))	200	292	262	<1000	<1000
Total Hardness (mg/l)	109,86	135,73	130,26		<500
Fluoride (mg/l)	0,12	0,10	0,12	1,5	≤1,50
Nitrate Nitrogen (NO_3 – mg/l)	0,31	0,33	0,3	50,0	≤0,50
Nitrite Nitrogen (NO_2 – mg/l)	0,006	0,025	0,004	3,00	≤3,00
Aluminium (mg/l)	0,25	0,33	0,63	0,20	≤0,20
Arsenic (mg/l)	<0,005	<0,005	<0,005	0,01	≤0,50
Boron (mg/l)	0,13	0,078	0,068	0,30	0,30
Barium (mg/l)	0,057	0,057	0,077	0,70	0,70
Cadmium (mg/l)	<0,0030	<0,0030	<0,0030	0,003	0,01
Chromium (mg/l)	<0,005	0,012	0,010	0,5	≤0,50
Copper (mg/l)	<0,0050	<0,0050	<0,0050	2,00	2,00
Manganese (mg/l)	0,014	0,023	0,014	0,5	≤0,50
Nickel (mg/l)	<0,0050	<0,0050	<0,0050	0,020	≤0,020
Lead (mg/l)	<0,0050	<0,0050	0,027	0,01	≤0,050
Antimony (mg/l)	<0,0050	<0,0050	<0,0050	0,02	≤0,0050
Selenium (mg/l)	<0,0050	<0,0050	<0,0050	0,01	0,01
Zinc (mg/l)	<0,0050	0,008	<0,0050	3,00	5,00
Mercury (mg/l)	≤0,0010	≤0,0010	≤0,0010	0,0010	≤0,0010
Chloride (mg/l)	27,47	58,38	54,95	250,0	<250,0
Chlorine residual (mg/l)	<0,02	<0,02	<0,02	<0,02	0,2-0,5
Cyanide (mg/l)	<0,01	<0,01	<0,01	0,07	≤0,05
Total Phenols (mg/l)	<0,002	<0,002	<0,002	≤0,002	
Chloro Pesticides (µm/l)	<1,00	<1,00	<1,00		
Total PAH (mg/l)	<0,5	<0,5	<0,5	10,00	
Total Alkalinity (mg/l)	74,24	77,72	74,24		
Acidity as $CaCO_3$	<5,00	<5,00	<5,00		
BOD_5	<2,00	<2,00	<2,00		

Parameters	Head Regulator	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
T[a]	32,00	32,40	32,00		
Faecal Coliform (E. Coli – cfu/100ml)	Absent	Absent	Absent	Absent	Absent
Total Coliforms (cfu/100ml)	12	16	Absent	Absent	Absent

Table 4: Results from Samples taken on 18th of September.

Parameters	Before Pumping St.	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
pH	7,045	7,47	7,50	6,50-8,50	6,50-8,50
Odour	Odorless	Odorless	Odorless		
Taste	Sweet	Sweet	Sweet		
Colour (Pt-Co)	12	**15**	12,5	≤15	≤15
Turbidity (NTU)	7	**5**	12	≤5	≤5
Total dissolved solids (TDS – mg/l))	184	196	204	<1000	<1000
Total Hardness (mg/l)	114,18	113,81	115,27		<500
Fluoride (mg/l)	0,10	0,10	0,12	1,5	≤1,50
Nitrate Nitrogen (NO_3 – mg/l)	0,14	0,16	0,15	50,0	≤0,50
Nitrite Nitrogen (NO_2 – mg/l)	<0,003	<0,003	<0,003	3,00	≤3,00
Aluminium (mg/l)	0,43	0,095	0,27	0,20	≤0,20
Arsenic (mg/l)	<0,005	<0,005	<0,005	0,01	≤0,50
Boron (mg/l)	0,16	0,012	0,098	0,30	0,30
Barium (mg/l)	0,12	0,064	0,084	0,70	0,70
Cadmium (mg/l)	<0,0030	<0,0030	<0,0030	0,003	0,01
Chromium (mg/l)	0,007	<0,0050	0,006	0,5	≤0,50
Copper (mg/l)	<0,0050	<0,0050	<0,0050	2,00	2,00
Manganese (mg/l)	0,015	0,009	0,017	0,5	≤0,50
Nickel (mg/l)	<0,0050	<0,0050	<0,0050	0,020	≤0,020
Lead (mg/l)	<0,0012	<0,0050	<0,0050	0,01	≤0,050
Antimony (mg/l)	<0,0050	<0,0050	<0,0050	0,02	≤0,0050
Selenium (mg/l)	<0,0050	<0,0050	<0,0050	0,01	0,01
Zinc (mg/l)	0,021	<0,0050	0,007	3,00	5,00
Mercury (mg/l)	≤0,0010	≤0,0010	≤0,0010	0,0010	≤0,0010
Chloride (mg/l)	30,61	27,21	29,76	250,0	<250,0
Chlorine residual (mg/l)	<0,02	<0,02	<0,02	<0,02	0,2-0,5
Cyanide (mg/l)	<0,01	<0,01	<0,01	0,07	≤0,05
Total Phenols (mg/l)	<0,002	<0,002	<0,002	≤0,002	
Chloro Pesticides (µm/l)	<1,00	<1,00	<1,00		
Total PAH (mg/l)	<0,5	<0,5	<0,5	10,00	
Total Alkalinity (mg/l)	89,83	85,11	81,56		

Parameters	Before Pumping St.	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
Acidity as $CaCO_3$	<5,00	<5,00	<5,00		
BOD_5	<2,00	<2,00	<2,00		
T^a	31,20	32,40	32,00		
Faecal Coliform (E. Coli – cfu/100ml)	9	10	Absent	Absent	Absent
Total Coliforms (cfu/100ml)	15	30	Absent	Absent	Absent

Table 5: Results from Samples taken on 1st of Oct 2020.

Apart from the Hub Water Canal (KWC), the K-III waters were also analyzed by KWSB in April 2021, upon request due to the implications that those waters could have for both the water treatment plant and the pumping station (PS). The main conclusion is that, based on these water quality tests, the integration of K-III waters to the Hub system should not have a significant impact on the KWC facilities, equipment, or the processes implemented at the water treatment plant (WTP).

K-III does not carry brackish water, because it has around 500 mg/l of total dissolved solids (brackish waters would include more than 2,500 mg/l). In any case, "hard water" is found, with values between 182 and 190 mg/l. These figures are higher than the KWC waters, but neither one seems to be corrosive water. The K-III water does not have a high concentration of aluminium or heavy metals.

Finally, the following overall comments and suggestions can be made:

- Microbial contamination is to be expected in these waters, and the coliform analyses at KWC gave low values because these waters, either in a lake or a reservoir, are subjected to natural processes such as the incidence of ultraviolet light from the sun, predation by other bacteria, etc. However, this does not mean that these waters cannot include other microorganisms in the form of cysts, helminth eggs or viruses (which are more resistant to natural processes). In any case, the coagulation-flocculation and disinfection treatment carried out in the filtration plant should account for this issue.
- The excess of aluminium we found in the KWC waters could be fixed in the final process of the filtration plant, by means of adding NaOH, something that apparently is foreseen by KWSB personnel (according to the field visits).
- Finally, the existence of chloroform in the K-III water analysis, prior to being processed in the plant, is surprising. It does not seem to be dangerous (<100 µg/l), although it could indicate the presence of an industrial discharge at some point upstream.
- In any case, all these conclusions are based on a few samples, and it is advisable that regular water quality tests (other than the ones carried out at the WTP laboratory) are carried out as validation and comparison tests, including WHO typical parameters.

2.3. GEOTECHNICAL SURVEY

To carry out the rehabilitation of the canal system or an alternative solution, it was essential to carry out Geotechnical studies of the project. This chapter summarizes the recommendations and remedial measures. Whereas the information on the geotechnical activities carried out at the site, the characteristics of subsurface materials and the particulars of field and laboratory tests can be found in the **Annex 2.**

The geotechnical investigations were undertaken to meet the following objectives:

- To delineate the major subsoil types spread over the site area.
- To evaluate the geotechnical design parameters for project works.
- To spell-out the geotechnical evaluation of the foundations.

GEOLOGY OF THE AREA

The project lies in an area of slight undulating with a range of low cliffs in the vicinity. The topsoil mainly consists of windblown deposit in the form of silty, fine to coarse sand/clayey silt.

The main geological unit around the site is Miocene to Pliocene age Gaj/Manchhar/Nari Formation comprising mainly of marine shale and friable to hard limestone with sandstone, shale, clay beds & conglomerates in the topmost part. The rocks dominantly comprise interbedded sandstone, siltstone, mudstone and shale. Thin beds of limestone are also present in a small stretch. In addition, thin veins of secondary gypsum are also present within the rocks. The overburden layer is made of silty sand with thin layers of slightly consolidated gravel.

FIELD INVESTIGATIONS

The following geotechnical investigation program was developed in this due diligence stage to fulfil the above-mentioned objectives:

1. Drilling of sixteen (16) boreholes varying from 5 to 15 m depth, through straight rotary drilling.
2. Carrying out Standard Penetration Tests (SPTs) or CPT in the boreholes at 1.0 m intervals generally up to maximum drilled depth of 15 m.
3. Collection of undisturbed soil samples from the boreholes.
4. Collection of water samples from boreholes, if encountered.
5. Laboratory testing of selected soil samples for the evaluation of:
    a. Classification Tests and Atterberg Limits
    b. Specific Gravity
    c. Strength Tests on Soil Samples
    d. Strength Tests on Rock Samples
    e. Chemical Tests of Soil

Following the field campaigns and the laboratory tests, the following conclusions can be highlighted:

a. **Lithology and Stratigraphy**: The subsurface materials as identified are mostly intermixed at various depths. However, the geotechnical investigations have revealed the presence of the following main lithological units at project areas:

b. **In-Situ Compactness**: The in-situ compactness as inferred from SPT "N" values indicate a loose to medium dense / dense material. The N values are ranging from 1 to 41 However, the in-situ compactness is highly variable vertically and, also, location wise.
c. **Shear Strength**: This strength data shows that the soil consistency is medium. The angle of internal friction of sandy samples is in the range of 32 to 34 degrees which appears to be adequate for medium dense inorganic silt / silty sand.
d. **Settlement Potential**: The soils at site are medium compressible and expected to undergo moderate settlements under the expected structural loads at most of the locations. The compressibility of the ground is variable, vertically as well as laterally.
e. **Groundwater:** Groundwater table was not encountered in the boreholes except at one discrete location

Apart from that, **Annex 2** of this due diligence report includes the detailed compilation of the design criteria in a Geotechnical Investigation Evaluation report, with the following main recommendations:

a. **Design Criteria**: The foundations of all the structures should meet the following minimum design criteria.
    I. These should be safe against shear failure of the supporting ground.
    II. These should not settle excessively under the service loads. A limit of 25mm has been put on the total settlement of any individual square/strip type spread foundation. The total settlement of mats should be considered as 50mm.
    III. The angular distortion between two adjacent foundations should not exceed 1/500.
    IV. The foundations of various structures must stay safe under tensile, lateral moment and vibrational loadings.
b. **Excavations/Earth Work:** Generally, excavations for shallow work would be made in the firm silty/sandy stratum. It is estimated that steep temporary excavations with light equipment would be possible, probably without any support system. For guidance, the temporary excavation lines may be kept close to vertical, or as determined by trials at site.
c. **Coefficients of Lateral Earth Pressure:** It is recommended to use granular material as the backfill material behind the retaining structures wherever required. The backfill material should be compacted to at least 90% Modified Proctor density.
   The static lateral earth pressure coefficients for active (Ka), at rest (Ko) and passive (Kp) conditions, using granular material as backfill having ø = 30° are recommended as Ka = 0.33, Ko = 0.50, Kp = 3.00 and the coefficient of friction between concrete and soil should be 0.35.
d. **Type of Cement:** The subsoils at the site contain soluble sulphates in lower quantities, therefore, it is recommended to use Ordinary Portland Cement (OPC) or other suitable type in concrete construction work according to requirement.
e. **Fill Placement and Compaction:** For the placement and compaction of engineered fill, granular material should be used. The material should be well graded and should not have fraction greater than 3 inches. The maximum fine fractions should not exceed from 8% and compaction control tests should be performed frequently.

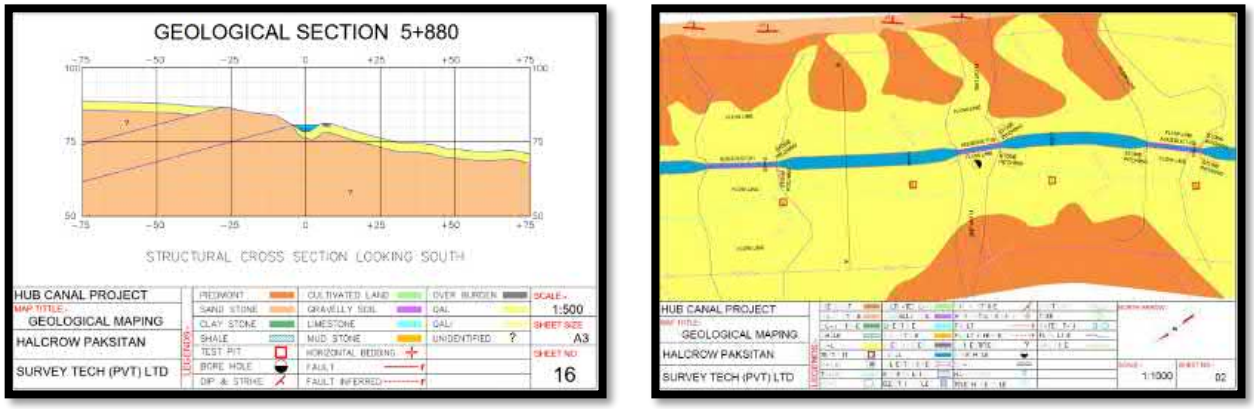


Figure 7. Geological mapping

Finally, the **geological mapping** has been carried out to determine the geological units falls along the Karachi route canal of the project site. The total length of the route corridor is 22 km in length and the width is 70 meters at both sides of the canal alignment, left and right respectively, to prepare the geological map at the required scale. The topographical sheets have been prepared at 1: 1000 scale and the whole area split into 56 sheets for detailed geological mapping. They can also be found in **Annex 2** of this due diligence report.

2.4. GEOPHYSICAL SURVEY

Electrical Soil Resistivity Tests have been conducted at two locations (Pump Station & Filtration Plant). The purpose of this survey was to determine the electrical resistivity of the subsurface material which could be used for the design of the earthing system and assess the corrosion potential por metals pipelines. The survey was conducted up to the maximum depth of 10 meters.

The coordinates of each resistivity point that were recorded with GPS are given in the next figures:

Figure 8. Resistivity Test point at the Pumping Station

Figure 9. Resistivity Test point at the Pumping Station

The electrical resistivity sounding points are designated as S-01 to S-04 at Site no. 1 (Pump Station) and S-01 to S-06 at Site no. 2 (Filtration Plant). The field resistivity data of all the sounding points along with their apparent resistivity (ohm-m) VS electrode spacing (m) curves can be consulted in the **Annex 2**.

The soil resistivity tests have allowed TYPSA to confirm the corrosion potential of the soils, which combined with the Hub waters, have a **high corrosion potential for iron or steel pipes.**

In addition, **ferro scanning of RCC structure** for steel reinforcement details, ultrasonic pulse velocity for uniformity and relative quality and Schmidt hammer or impact hammer test for the estimation of the concrete strength of concrete of RCC structure of Pump House Buildings and Karachi Canal were conducted.

The ferro scanning, UPV and impact hammer have allowed to assess the **condition of reinforced concrete structures and buildings.** The estimation of the concrete strength could be consulted in Annex 2.

As the extent of seepage from canal system depends on the permeability of neighbouring and encompassing surface/subsurface material therefore, **Electrical Resistivity Tomography** lines were conducted along permeable strata after detailed inspection of the surface material and canal lining conditions. The acquisitions were made with different spread length varying from 87 – 145 m as per local site conditions.

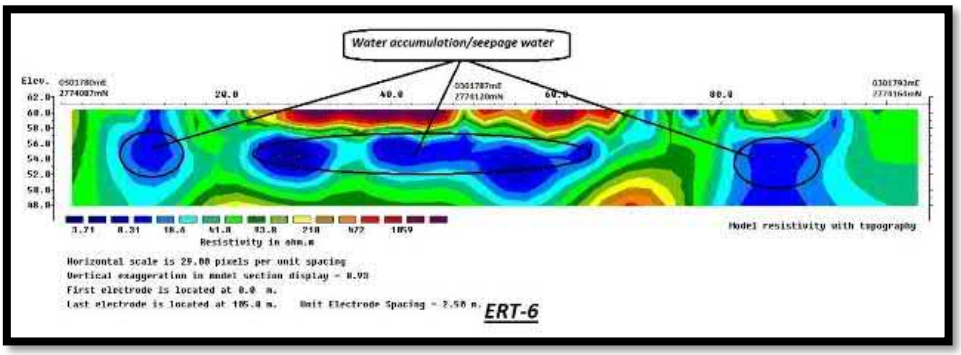


Figure 10. Electrical Resistivity Tomography

The tomography along the canal has **clearly identified the seepage** the canal is undergoing, and how it feeds the groundwater.

2.5. WATER RESOURCES ANALYSIS

One of the most critical aspects to be considered when analyzing the possible project alternatives is to identify the water availability in the Hub Dam Reservoir and its ability to be delivered to Karachi. This input strongly conditions the proposed solutions.

The analysis of the available water resources for the Hub Canal has been highlighted as one of the key objectives of the due diligence process. The data set is considered as reasonably representative of historic hydrological trends and sufficient to draw sound conclusions with regards to historical flows in the Hub Canal. Calculations and studies have been conducted to assess the available water resources provided by the Hub Dam watershed (refer to **Annex Nº 2**). A review of the available data has concluded that historical Hub Reservoir storage values along with the Karachi Hub Canal outflows managed by WAPDA are the most robust and reliable data to assess the availability of water resources to the Hub Canal system. The following figure presents monthly data from the 20-year data series.

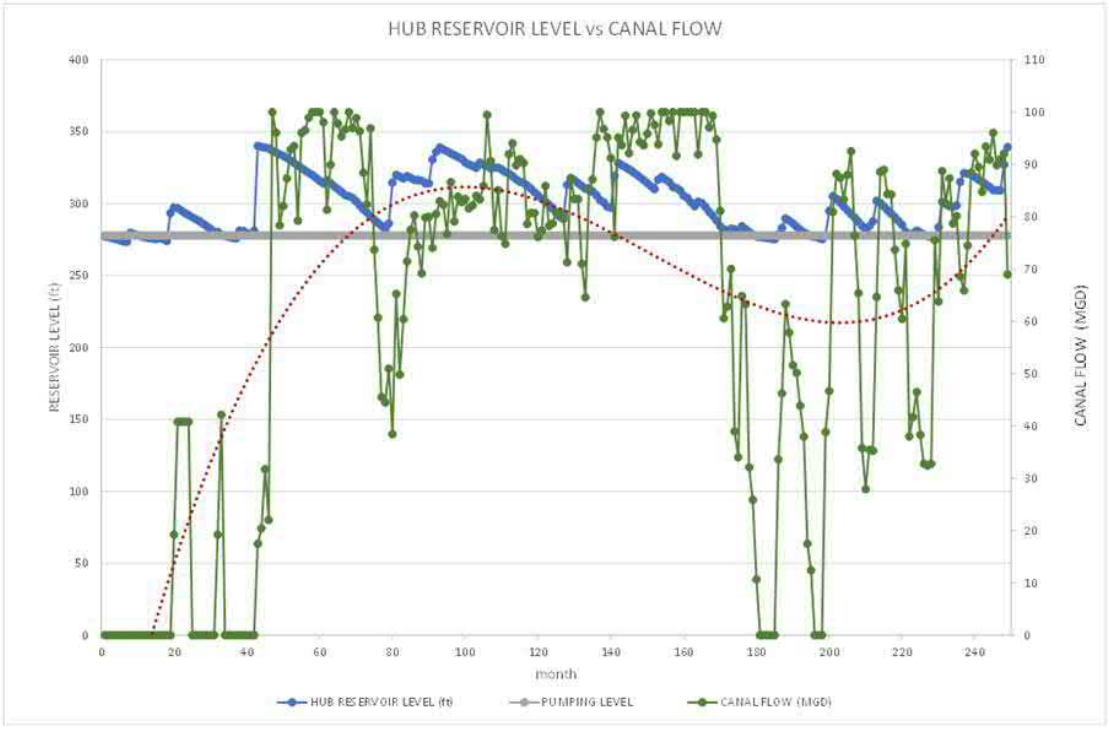


Figure 11: Analysis of the historical Karachi Canal average monthly flow data

Based on the available data, both the median and the mean values have been estimated to characterize the data sets, in this case, the KWC daily, monthly, and yearly inflows. The median has the advantage of being less influenced by extreme outliers than the mean. In this case, dealing with inflows that range from zero to theoretically 100 MGD (5.26 m^3/s), the median is deemed better than the mean to describe the data.

In simple terms, the median is the value that is greater or equal to half of the other values and less than or equal to the other half of the values in the data set. The median thus describes the location or central tendency of the distribution of inflows to the Hub Canal, assuming that is a random variable, and in the continuous case, any daily inflow is equally likely to be above as below the median. According to the historical daily data, 82 MGD (4.31 m^3/s) is the median inflow at Hub Canal.

In addition, the resilience and reliability concepts have been used to analyze the available data. In this regard, the reliability of any time series is the number of data in a satisfactory state divided by the total number of data in the time series. Assuming satisfactory values in the time series X_t containing n values are those equal to or greater than some threshold X^T, then:

Reliability [X] = [number of time periods t such that Xt ≥ XT] / n

In this case, several threshold values have been used, and the most important one is obviously having 100 MGD (5.26 m^3/s) flowing in the Hub Canal. So, you can see that the reliability is essentially the percentage of days where the inflows from Hub Reservoir into KWC were greater or equal to that defined threshold X^T. All thresholds for 100 MGD, 90 MGD, 80 MGD and down to no flow have been analyzed. This concept has also been applied to some Hub Reservoir water levels.

On the other hand, the resilience is the probability that if in an unsatisfactory state, the next state will be satisfactory. It is the probability of having a satisfactory value in time period (t + 1) given an unsatisfactory value in any time period t. It can be calculated as the following:

> *Resilience[X] = [number of times a satisfactory value follows an unsatisfactory value] / [number of times an unsatisfactory value occurred]*

In this case, those thresholds X^T have been chosen for 100 MGD, 90 MGD, 80 MGD, etc. and, for each of them, the daily data has been used to make the analysis. Namely, every day that Hub canal had inflows lower than the threshold that is considered as an unsatisfactory value, and a satisfactory value is assumed as the day when the inflows became equal or greater to the threshold again. The resilience tells how quickly the KWC system recovers and returns to a satisfactory inflow value in the historical daily time series. This concept has also been applied to some Hub Reservoir water levels.

The main conclusions obtained from the studies show the following results.

Hub Reservoir Water Levels:

- The Hub Reservoir storage values appear to depend on rainfall. The water cycle processes within a water basin are highly non-linear and time dependant, with big inertia and having many parameters involved (rainfall, soil conditions, evaporation, infiltration parameters, etc.) Therefore, the correlation coefficients are significant between rainfall data from nearby meteorological stations and the Reservoir level data.
- From the 20-yr period of record for monthly Reservoir level data, the following results can be drawn:
    - Average monthly reservoir level: 301.56 ft (average daily reservoir level: 298.51 ft)
    - Median monthly reservoir level: 300.53 ft (median daily reservoir level: 303.40 ft)
- The probability of having reservoir levels above the elevation of the sill of the intake (i.e. 278 ft) that feeds the WAPDA Main Canal is the following:
    - 89.6% of the time (based on daily reservoir level data)
    - Below the Reservoir level of 278 ft, water needs to be pumped to the WAPDA Main Canal and no outflows are allocated for the Karachi Water Canal.
- The resilience of the reservoir is determined as follows based on the daily data:
    - 82.8% of the time, the reservoir recovers from levels below 278 ft[1] (on the next day)
    - 91.3% of the time, the reservoir recovers from levels below 283 ft[2] (on the next day)

[1] 278 ft is the elevation below which no flow can be diverted to the Karachi Canal (sill of intake).
[2] 283 ft is the reservoir level below which restrictions on flows to the Karachi Hub Canal are triggered.

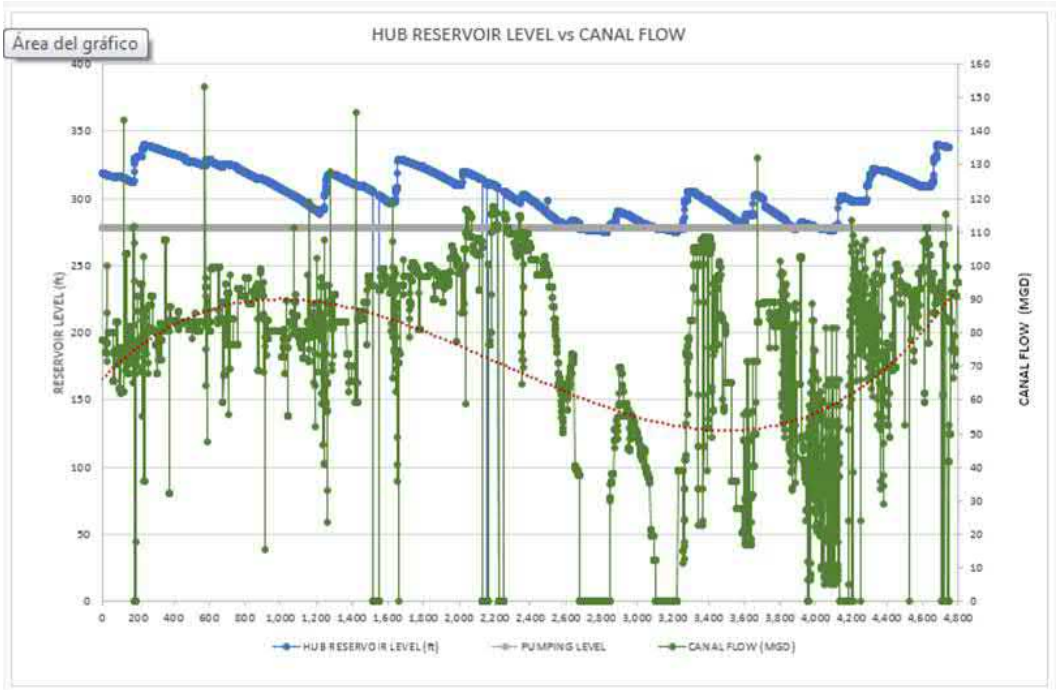


Figure 12: Analysis of the historical Karachi Canal average daily flow data

KWSB Canal Flows:

- Depending on whether daily of average monthly data is used, the Karachi Water Canal has conveyed a median of 81.8 MGD (4.3 m^3/s) or 78.3 MGD over the 20-yr period of record. The average value is 70.5 MGD (3.7 m^3/s).
- 90% of the time, the Karachi Water Canal has conveyed water. 10% of the historical daily data shows no flow in the canal (see figures above).
- Based on the existing data, the amount of time the canal has guaranteed the maximum canal capacity flow (100 MGD) is approximately 10% of the time.
- The Reliability of the Karachi Water Canal is defined by the following probabilities for these flow rates:
    - For 80 MGD it has been 56%
    - For 100 MGD it has been only 12%
- The resilience of the KWC to recover from outflows below a threshold is very small on a daily basis:
    - 6% of the time the KWC recovers back to 80 MGD (one day after the discharge drops below 80 MGD)
    - 1% of the time the KWC recovers back to 100 MGD (one day after the discharge drops below 100 MGD)
- Significant periods with the KWC out of service (without flows) are observed in the data.

Based on the historical data, 80 MGD is a flow that is more coherent with the actual water conveyed by the KWC, based on the water resources availability at the Hub Reservoir. However, around 10% of the time the KWC has historically conveyed 100 MGD.

According to the data received, losses in the canal due to seepage and other causes could represent over 25% of the outflows from the Hub Reservoir. Because of these losses, it is estimated that currently, only around 70 to 80 MGD would be reaching the pumping station.

While the pumping station could convey a total of 120 to 140 MGD (combining the Hub and "Karachi-III" Canals), the theoretical capacity of the pumping station is currently only 120 MGD, so an upgrade would be needed to increase the daily flows in the future.

The Water Treatment Plant currently has a capacity of 80 MGD, which is lower than the potential volume of water that could be conveyed to it from both the Hub and K-III Canals. Several long-term water supply scenarios could be considered, depending on KWSB's planning.

In any case, after sharing the available data with KWSB and the GoS, it has been decided that the rehabilitation of the KWSB Canal should ensure it has a conveyance capacity of 100 MGD, which is the capacity of the original canal design. Due to the water stress situation in Karachi, KWSB and the GoS have determined that whenever 100 MGD are available at the Hub Reservoir, that the Karachi Canal System must be capable of supplying those outflows to the population, in conjunction with the K-III connection if necessary.

Regarding the **groundwater table,** during the geotechnical investigations, water was encountered in only one borehole (BH-4) during the investigations in October 2020. The average depth in the borehole was 1.6 mbgl. Because the water level was inconsistent with other boreholes, it was concluded that this could not be actual depth of the groundwater table at that location. Further studies during the detailed design stage should be carried out to determine groundwater levels at that stage, mainly for potential implications during the rehabilitation works and the future operation.

2.6. PRELIMINARY NATURAL RISK ASSESSMENT

This section is a preliminary study of the main natural risks that could affect the project. It has been found that, a priori, the area is not vulnerable to the effects of the main agents (earthquakes and floods). In addition, there appears to be an area, around 12 km downstream of the Head Regulator of the Hub canal, where landslides are possible.

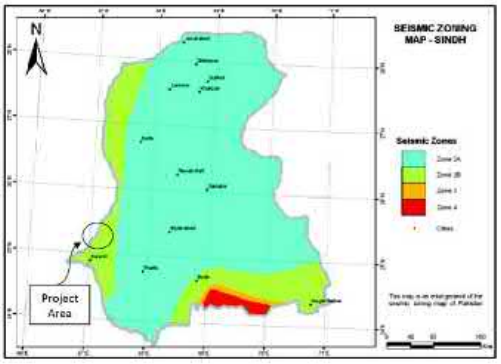
SEISMIC STUDY

The Seismic features of this area have been analyzed in both the geotechnical and the geophysical reports, included in **Annex 2**. Both reports include parameters that show that this area is not prone to strong earthquake generating sources in the proximity, but distant seismic sources are strong and active, as frequent moderate levels of shakings were felt from earthquakes occurring in far flung areas like Hindukush region.

The project area lies in Zone 2B, according to the earthquake zoning of Pakistan. The probability of earthquake is low with an intensity range of V to VI according to MMI scale. The corresponding PGA is 0.16g to 0.24g.

Seismic Parameters for Karachi:

- Magnitude (Richter) 5.5 – 6.5
- Intensity – I (MM) VI-VIII
- Peak Ground Acceleration (PGA) % 28 %
- Zone (UBC) 2B
- Description of EQ Hazard Upper **Moderate**



During the on-site visual inspections, it was noticed that the structural members in the canal and appurtenant facilities are sufficiently sized, and the rebar detected in the structural members also seems adequate. Additionally, no major cracks indicating seismic damage were observed on the structures. These structures were built around 40 years ago and have withstood past earthquakes. Also keeping in mind, the seismic zone 2B for Karachi, it can be concluded that the structures can perform adequately in case of an earthquake event.

FLOOD **RISK** ASSESSMENT

Based on the existing information at local data bases and flood management viewers as SUPARCO, a preliminary study of the possible flood risks along the project infrastructures has been conducted. The main conclusions are the following:

- **Karachi Canal** runs in a parallel manner along a crest situated North-South at right side of the Canal, perpendicular to the slope lines, in an east-west direction. In that section (Hub Dam to Pump Station), the risks of serious impacts due to floods are considered, a priori, relatively low.

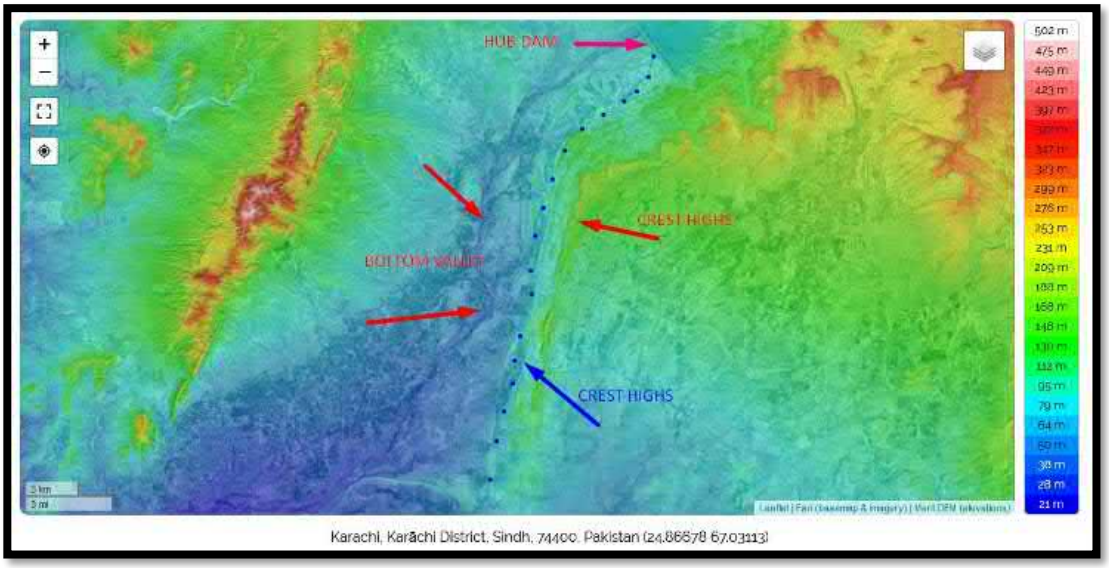


Figure 13 Karachi canal topographic map. Source: https://en-ca.topographic-map.com

Additionally, there are already constructed 11 aqueducts, to allow the normal drainage to the west.

However, some localised impacts on the canal embankment are registered due to the characteristics of the surrounding terrain (high proportion of sands) and the low maintenance of the transversal drainage along the canal. It is considered that the improvement of the two service roads along the

canal and the provision of adequate drainage should minimize (or even eliminate) those localized problems. With this regard, the maintenance of the service roads will be of paramount importance.

Figure 14. Erosion problems along the canal embankment.

- **The Pumping station** is located at a lower site, surrounded by:
  - At the north: a small change of slope and watershed, located about 300 m upstream, situated at level 65 m (+4 m related to the PS).
  - At the South: a flat valley and the mounting escarpment towards the Water Treatment Plant

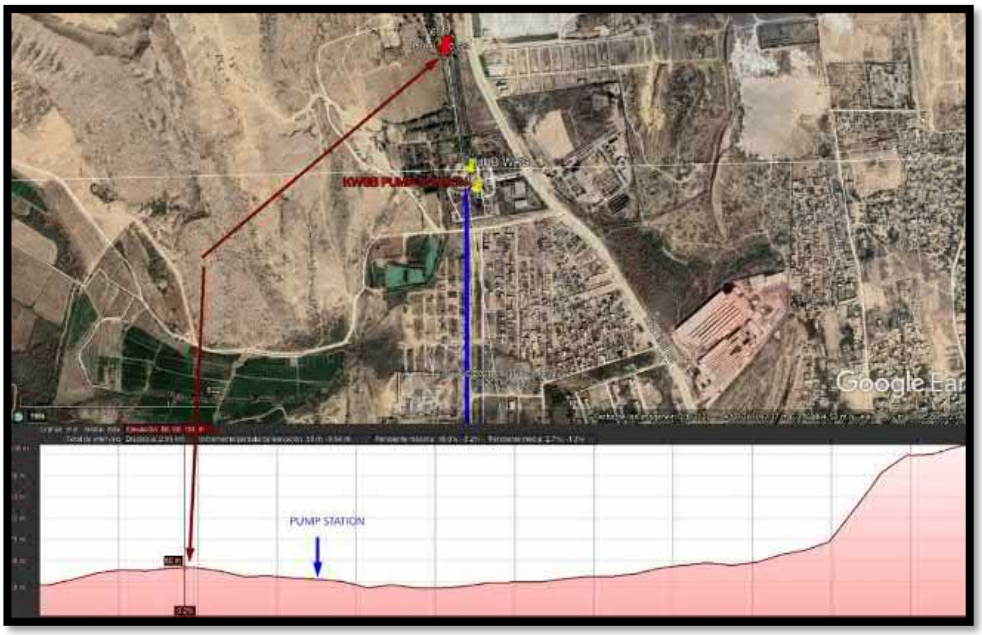


Figure 15. N-S axis. Altimetry for PS. Source: Google Earth.

  - At the East: a tender slope mounting from the Pump Station towards Hub Dam Road and Karachi city.

- At the West: a high and steppe slope to a hill (about level 78 m).

Figure 16. W-E axis. Altimetry Source: Google Earth.

Considering the existing topography, a preliminary assessment of the watershed that could impact the pumping station area indicates that it appears to be less than 1 km^2.

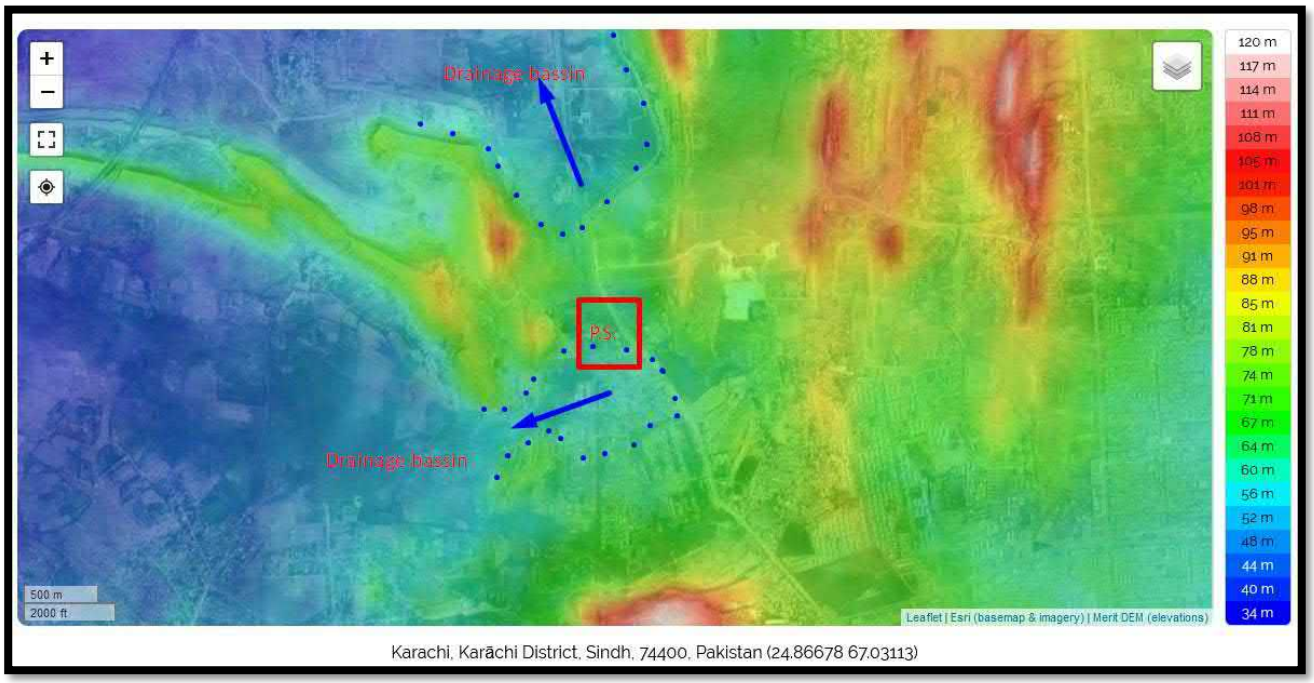
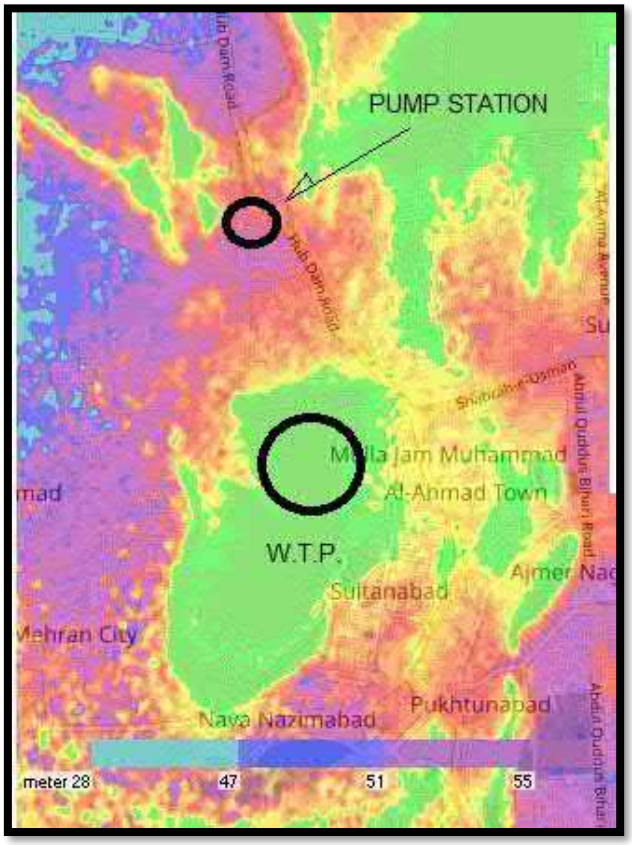
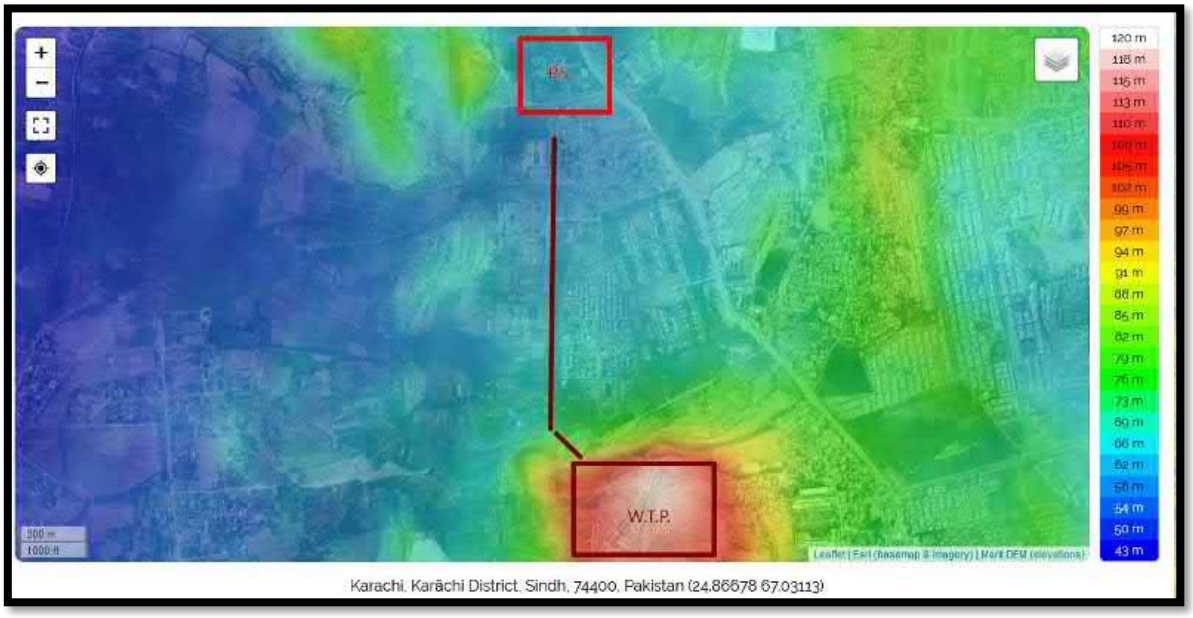


Figure 17. PS watershed. Source: https://en-ca.topographic-map.com



Source: https://www.floodmap.net

- The **Water Treatment Plant** is located at the top of a flat surface, at an elevation of 105-108 m. The flood risk is, therefore, very low or inexistent.



Therefore, it is the Hub Pumping Station where most of the flood risks could be concentrated. However, according to KWSB, during the last flood events of September 2020, the PS did not undergo any relevant issues, even though the surface drainage at the PS site should be improved to allow a faster drainage and

reduce the surface waterlogging during periods of very heavy rainfalls. According to KSWB, water puddles have never affected the equipment or the correct operation of the Pumping Station.

In summary, the flood risks at the Hub Pumping Station are considered of low magnitude, and the drainage sub-basin that can generate flows into the perimeter where the PS is located is small. In addition, drainage system elements are identified all around the site.

In any case, the Concessionaire shall verify the flood risks in the detailed design stage, conduct an in-depth impact and risks assessment and, finally, design and construct the required works to mitigate the potential impacts (if need be). Those studies shall be conducted according to the national regulations and/or state of the art engineering practice.

2.7. LAND REQUIREMENTS AND UTILITIES

According to the collected documentation, the implementation of the proposed solutions should not require new **Land Acquisition** or an Involuntary resettlement process (LARAP), because all areas involved would be owned by KWSB, namely:

- **Canal rehabilitation**: It will remain within the existing KWSB Right-of-Way (RoW), which encompasses 30 m (100 ft) to each side of the canal axis.
    - Length of 12,100 m and an area of 363,000 m^2 (89.70 acres)
- **New pipeline**: It can be aligned over the existing roadway of the canal or next to the canal embankment, within the existing RoW.
    - Length of 9,765 m and an area of 292,950 m^2 (72.39 acres)
- **Pumping Station**: All rehabilitation works shall take place within the existing KWSB perimeter.
    - Perimeter of around 1,050 m and area of 62,990 m^2 (15.6 acres)
- **Rising Mains and Power Transmission Line**: It is assumed that the same canal RoW of 30 m to each side of the axis is in force.
    - Length of around 1,842 m and an area of 55,260 m^2 (13.65 acres)
- **Water Treatment Plant**: All rehabilitation works shall take place within the existing KWSB perimeter.
    - Perimeter of around 1,928 m and an area of 206,355 m^2 (50.99 acres)
- **Solar PV Plant**: This due diligence proposes that the new solar plant is located next to the existing water treatment plant, in an area which has no current uses and should be available.
    - Fenced perimeter of 1,380 m with an area of 118,300 m^2 (29.23 acres)

This way, until the final Detailed Design is developed by the Concessionaire, this due diligence report is recommending and considering that all construction activities are kept within the existing RoW, and the proposed design also stays within the existing RoW. Based on the preliminary findings, any use beyond the

existing RoW during the construction stage should be temporary and would have low impact. All these issues should be considered both in the detailed design and ESIA put forward by the Developer/Concessionaire.

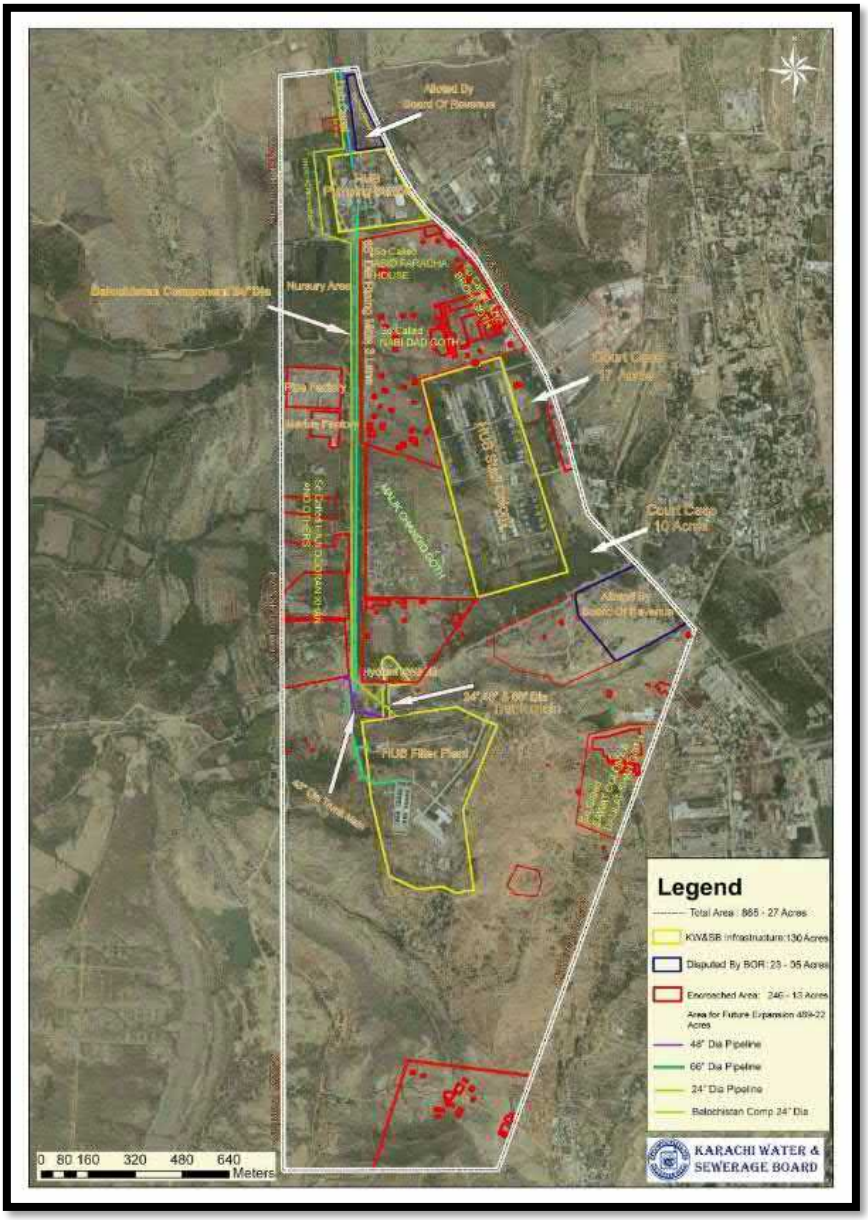


Figure 18. KWSB owned land around the PS and WTP (to be confirmed)

Among the aforementioned components of this project, we could highlight the new pipeline stretch, but in general all construction works should take place within 15 to 20 meters, that is 50 to 60 ft. In any case, prior to being issued for construction, the detailed alignment drawings should be defined by the Developer/Concessionaire and revised as necessary to incorporate any changes to the route, right-of-way width, or any other changes that may impact the construction of the pipeline stretches. The revised drawings should be issued for construction, and the site crew shall use these drawings to stake the location of the centerline of the pipeline and other features such as right-of-way width, temporary construction areas, property lines, locations for construction bores, and other items that the contractor will need for construction

purposes. These stakes should be used by the contractor to install the pipeline in the correct location and to limit the work area to where right-of-way stands.

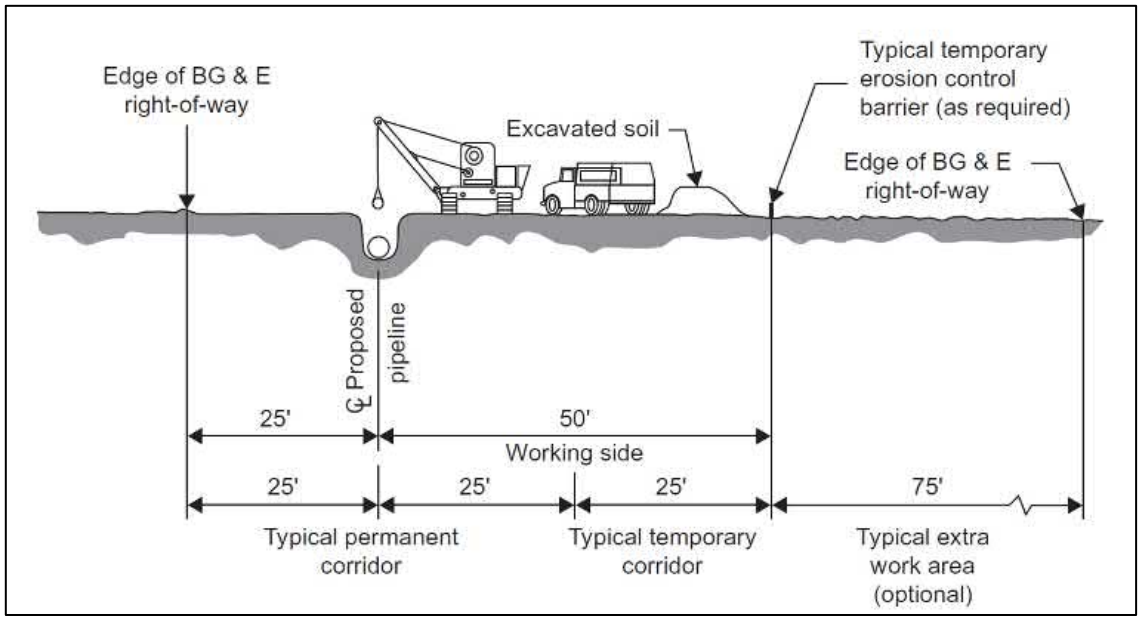


Figure 19. Example of a typical pipeline construction right-of-way.

The ownership of all land occupied by the canal and auxiliary infrastructures by KWSB is confirmed, and KWSB is completing legal ownership formalities; all associated infrastructure ownership is in the name of KWSB now.. Originally, the canal was implemented by WAPDA in the early 80's of the last century and it was later handed over to KWSB.

If the Developer needs additional temporary land, it would be necessary to carry out a study about the ownership and assess the need to resort to procedures in accordance with the Pakistani regulations as well as the procedures set out in IFC's Performance Standard 5 "Land Acquisition and Involuntary Resettlement".

Although the impact on the overall cost of the project is likely to be negligible, if any additional temporary land should be used, the Developer is entitled to develop a plot or cadastral plan identifying the ownership of the plots, the band of occupation of the canal (current Right of way estimated at 30 m from the canal axis) as well as the detailed definition of the plan view of temporary occupation of the works, including the rising mains and the solar PV plant. This should be properly addressed at the detailed design, and any definitive impacts shall be studied in more detail in the ESIA associated with final detailed design carried out by the Private Sector (Developer/Concessionaire).

With regard to the utilities, it should be noted that there are different **offtakes along the existing canal**, which are detailed below:

- **Hamdard University legal connection**: This is a pumping station and an 8" diameter pipe. This connection is used by the university without planning, depending on the needs of the university´s reverse osmosis plant and laboratories. KWSB claims that this is a legal connection for which they invoice, and it seems that it is not possible to change this connection to a new one from the WTP (it requires 5 km of new pipes and a pumping station).

- **Legal connection to an informal settlement looked after by the Sindh Public Health Department**: This is the other legal connection, along with Hamdard University, which is metered and does not have a cap on the amount of water that can be drawn from the system.
- These legal connections are metered, and the average water drawn by each of them does not exceed 0.5 MGD (0.026 m^3/s)

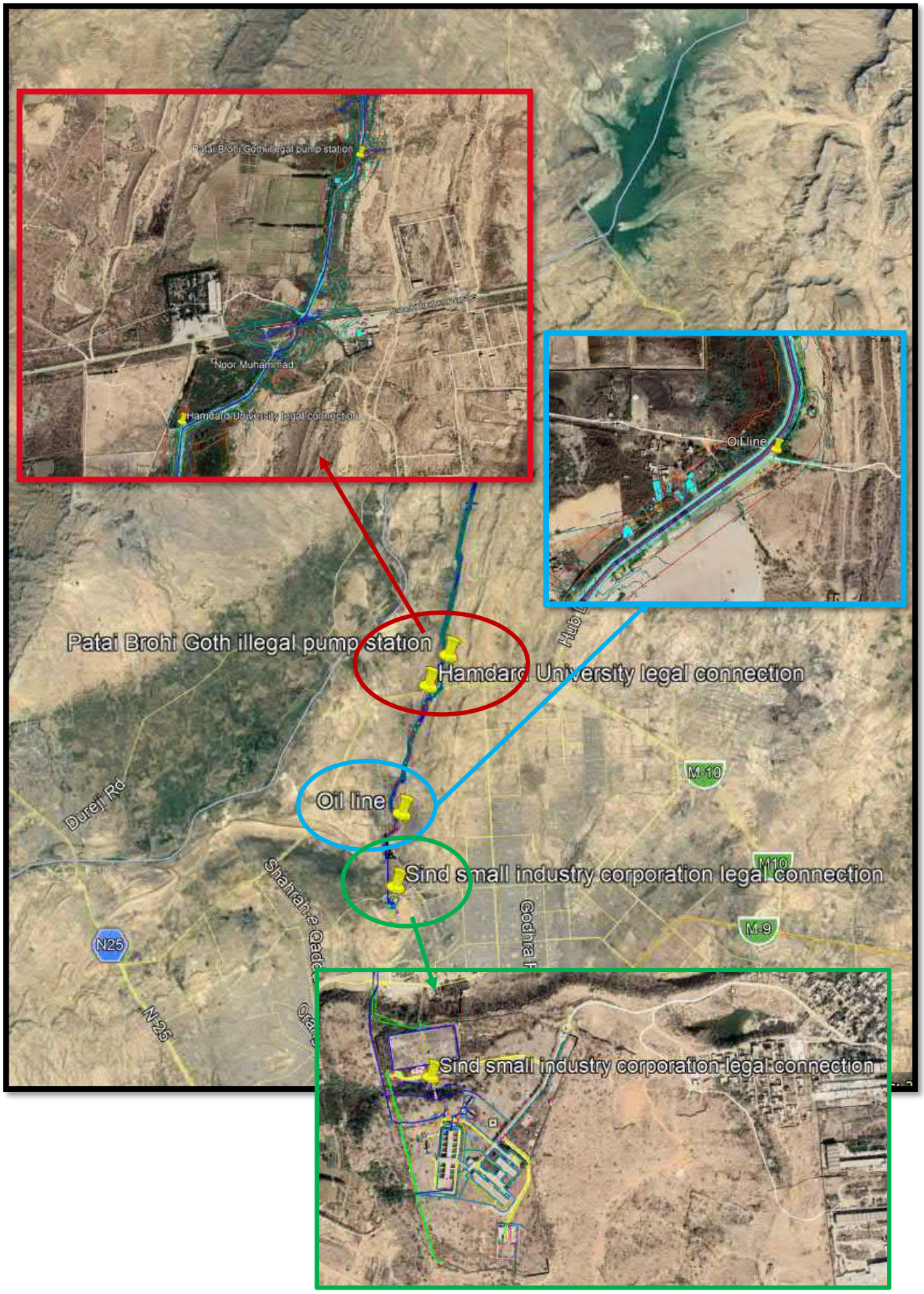
In addition to the legal and metered connections, the following have also been identified:

- **Sindh Small Industry Corporation connection**: This is a 12" diameter pipe that aims at using 15 MGD, although it is not in operation because the area is still under development and the company has not yet applied for this connection. It will stem directly from the water treatment plant.
- **Other water connections from the canal that are illegal**. These offtakes are gathered in the E&S report and can be listed as follow:
    - Tanker trucks takes water from the canal to the village of Haji Ibrahim Goth for domestic use.
    - M. Murad Brohi Village uses the canal for washing cloths and drinking by the use of jerry cans.
    - Maharaj Goth village uses the canal for washing cloths and drinking by the use of jerry cans.
    - Patai Brohi Goth village uses pumps to take water from the canal for domestic uses.
    - These small villages have sent a letter to KWSB in order to ask for a legal connection.

Finally, there are the following additional **utilities** going across or over the canal:

- There are transformers, heavy transmission lines and electric 132 kV high tension lines and electricity poles situated within 200 m at both sides of the canal (particularly in the area adjacent to the Northern bypass road). It is considered that these infrastructures do not interfere with the project.
- There is a 11 kV line of 1 km thar runs parallel to the canal. This line will need to be protected during the construction works. Although not expected, it is possible that this line may have to be relocated, something which will require consultation with K-Electric.
- There are two gas pipelines of 20" and 18" diameter crossing the canal. Both lines, one to Sharshah and the other to Attock refinery at Hub Chowky, belong to the Sui Southern Gas Company Limited (SSGCL). Construction works around these gas lines will have to be properly scheduled and done coordinated with the Gas company. Should relocation of the pipes be finally needed, it shall be done by the Gas company and paid for by the Concessionaire.
- There is an underground crude oil line owned by HUBCO/SUPARCO of 12" to 18" diameter. Should the relocation of this infrastructure be finally deemed necessary, it should also be analyzed with HUBCO/SUPARCO.

It is important to highlight these existing utilities should not put at risk the construction works envisaged by this project. According to the proposed design in this due diligence report, these utilities lay in the new pipeline alignment, and temporary construction works necessary to deal with these utilities or even permanent design measures (such as locating the water pipeline underneath other existing lines) do not imply technical challenges or a significant impact on the investment budget. In any case, it is necessary that all proper arrangements are accounted for by the Developer when the detailed design, and eventually the construction stage are reached.


Patai Brohi Goth illegal pump station
Hamdard University legal connection
Oil line
Sind small industry corporation legal connection
Durej Rd
M-10
M-9
N25
N-25

3. FACILITY ASSESSMENT AND GAP ANALYSIS

Based on the field visits and onsite surveys carried out, a facility assessment with a description of the current condition of the infrastructure is included in this chapter.

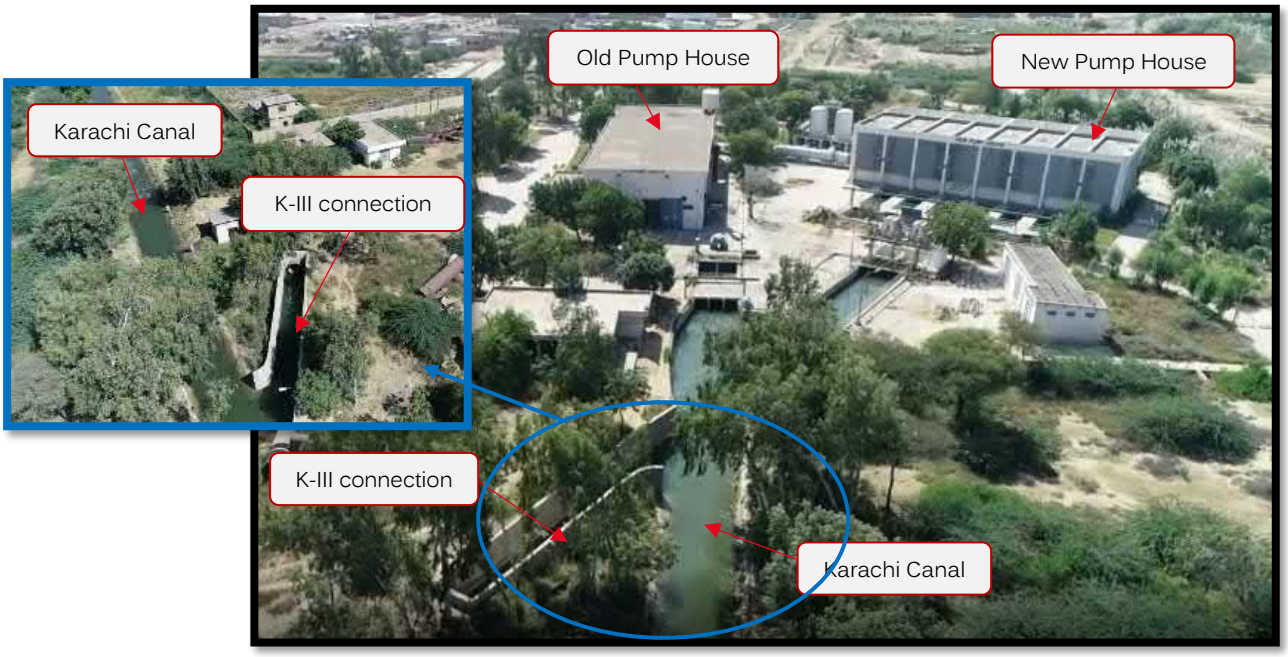


Figure 20. General view of the facility system

3.1. KARACHI CANAL

To be able to make a good characterization of the current state of the canal, different field visits have been developed, going through its entire layout, and obtaining all the relevant information that is included in **Annexes 1 and 2**.

There is a Main Canal that starts off at Hub Reservoir and reaches the Head Regulator 8.3 km downstream, and this canal is operated by WAPDA. After the first 8.3 km, there is a head regulator which bifurcates into two separate canals:

- The first one, is the Hub canal/Karachi canal (total length of 21,141 m, eleven aqueducts, fifteen culverts and a gas pipe crossing).
- The second one is the Lasbela canal (out of the scope)

The **typical cross sections** of canal and aqueducts are essential in analysing the design and existing condition of the canal for establishing the required measures for its

Figure 21. Plan of Hub Canal

rehabilitation. **Annex 1** shows the main geometry data of the canal. In any case, the Hub/Karachi section is trapezoidal and open. It is made of block masonry, and at some places, CC lining is also observed.

Figure 22. Head Regulator

The **head regulator** has one scale for flow measuring; therefore, the flow transmitted to Hub canal (towards Karachi) is of a maximum of 6.5 ft height as explained by the WAPDA operator. Empirical discharge curves defined in the original project are used to operate the gates and no calibration has been carried out with field campaigns.

There is an **inspection path** to move around the canal. This path also needed repairs as it is bumpy, irregular in bad shape and missing at various location form each side.

The figure below shows that the **canal infrastructure** is old, undergoes a lot of deterioration and the service life of this structure has almost finished. The loss is already evident by the flow measurement analysis developed by NED University.

Figure 23. Structural deterioration of KWSB canal

The current state of the canal shows that structural repair is highly necessary to stop transport losses. As a first estimate, these water losses could be reduced (and so increasing the total water flow to the pumping station) by almost 25 percent.

There is also a connection taken for Hamdard university from the canal of which the available information may be consulted in previous section. Some **illegal connections** from the canal were also witnessed.

A total of eleven aqueducts are located along the Hub/Karachi canal. In general, the bottom lining is completely deteriorated and, as a result, there are leaks around the canal area. In addition, the condition of aqueducts is poor, and seepages that are clearly visible have resulted in permanent wetlands around the area. Aqueducts are surrounded by thick vegetation, shrubs, and grass mix.

The deteriorated structure of the aqueducts shows seepage and leakages at joints and abutments. At some locations, due to concrete deterioration, rebar is exposed. During the site visits, cross drainage structures were also found in poor condition.

For a better assessment of the current situation of these structures, technical tests were conducted on selected aqueducts, on the basis of which, it could be concluded that:

- Aqueducts 01, 06 & 09 need retrofitting.
- Aqueduct 10 apparently seems better in comparison to the other aqueducts. However, test results show some columns have already been retrofitted. It needs further investigation before second time retrofitting.
- Aqueduct 11 is apparently in the worst condition, i.e. significant cracking, concrete spalling, leakages, etc. Ferro scanning test also could not detect rebar existence in one column and one wall. Therefore, it is recommended to demolish this Aqueduct, though it lies within the canal stretch that shall be substituted by a pipeline.
- Based on our findings after detailed survey, it is recommended to rehabilitate all the Aqueducts (except Aqueduct 11) that are structurally stable. This can be done by properly cleaning and removing any damaged concrete from inside of the aqueduct. All the seepage holes must be grouted with crystalline cement mortar or epoxy grout. Afterwards all the inside walls and slab should be coated with crystalline cement or epoxy-based water proofing material, the number of coats will depend upon the recommendation from the manufacturer of approved product. In order to increase the life of water proofing, it should be covered with CC plaster in the thickness of at least 20mm.
- After repairing aqueducts and closing all the leakages, the retrofitting work should be done from the outside. Based on the condition of aqueducts, this can be done by plastering with waterproof mortar and/or by jacketing the structure if there is considerable damage at concrete and steel. The jacketing work should also be carried out on the columns wherever required.
- Regarding the bridges, these are found to be in a fair to good condition. However, retrofitting/repair could be required.
- The RCC fall structure in the canal is in good condition.

In order to estimate the work required for the rehabilitation of the KWSB channel, a simulation of its operation and load-bearing capacity was carried out, based on its current geometry. The HEC-RAC software was used, and the results obtained are shown in **Annex 2.**

The aim of the analysis is to know whether the flow of 100 MGD can be conveyed through the repaired canal. The study carried out shows the existence of a group of sections with excessive flow velocities, located between sections corresponding to p.k. 6-903 to p.k. 9+200, (PK 0 is located at the pumping station in the model).

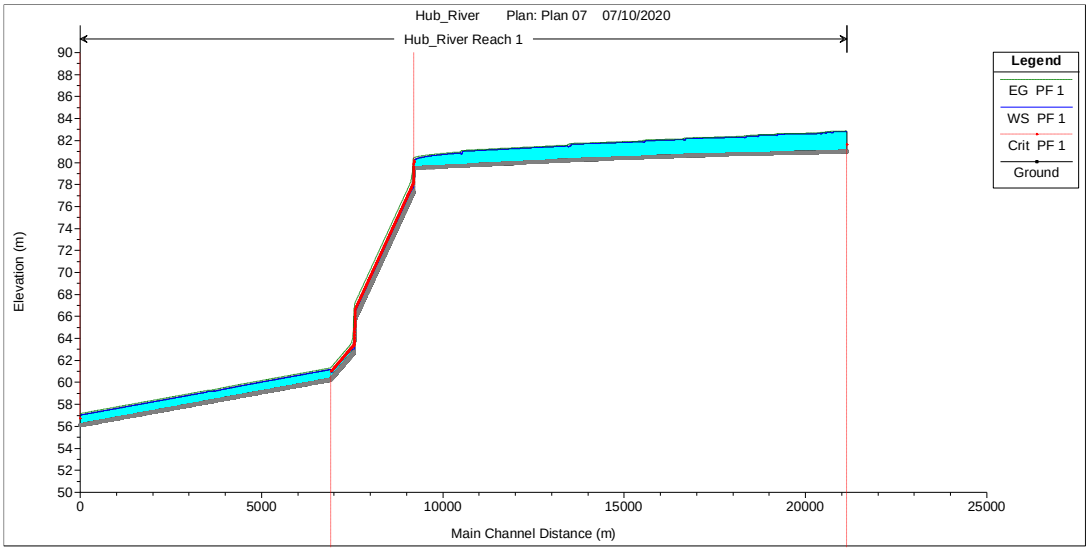


Figure 24. Hydraulic profile obtained as result of the calculations made.

At these sections, the excessive velocities are generated due to a significant slope, close to an average 1%, which is an extreme value for a free-surface flow canal. The figure shows how the excessive slope derives in high velocities that undermine the canal and generate erosion. In addition, it could be a reason for the increased water leakage measured in the Canal.

Figure 25. Excessive slope in several sections of the Hub Canal.

However, if these high-velocity sections were to be replaced by a pressure-flow pipeline, the existing gradient (estimated at 19 m) could allow the construction of a small hydroelectric plant, with an estimated capacity (on the basis of existing data) of around 500 kW. The estimated cost of this new hydroelectric plant would be around 1,785,000USD, with a ratio of 3,570 USD/kW. However, this hydropower scheme would only make sense if a free-surface flow were envisaged in the last stretch of the canal prior to Hub Pumping Station. This hydropower plant is not feasible if the last stretch of the existing KWSB is substituted by a new pipeline.

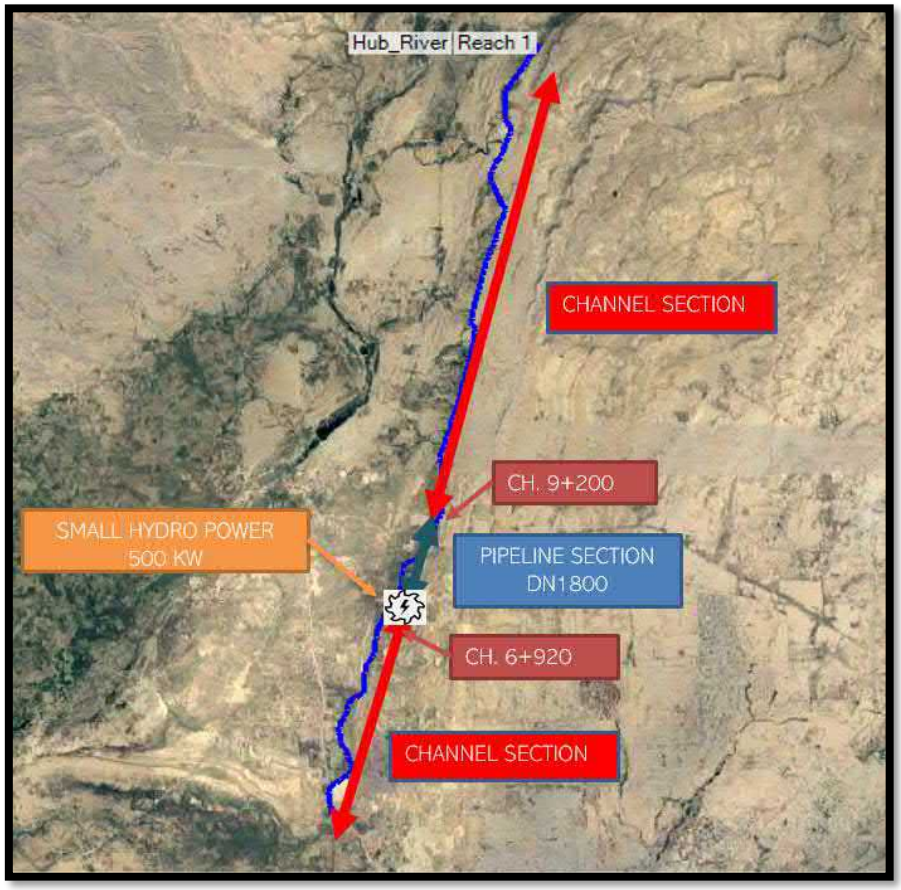


Figure 26. Schematic description of one of the potential canal rehabilitation alternatives

3.2. HUB PUMPING STATION

There are **two pump houses** placed in the Hub Pumping Station, at the end of the existing canal. The first one is called the **Old Pump House** and the other is called the **New Pump House**. Both pumping stations are currently in a poor condition.

As mentioned before, there are 2 water sources for these pump houses:

- Hub/Karachi Canal, which currently contributes with a median 82 MGD throughout the seven days of week. It should be noted that values of up to 100 MGD are achieved around 10% of the time.
- K-III connection, an alternate bulk water source scheme which is adding around 50 MGD for 3 days a week and may be used during the rehabilitation period of the Karachi water canal. Although there is no information available, it has been verbally indicated that KWSB has used up to 80 MGD from KIII during drought seasons.

In any case, the site visits and the available design documents show that total capacity of the existing Hub pumping station is around **120 MGD.**

The pumps in the Old Pump House have surpassed their design service life, which is roughly 20 years, since the pumps were installed in 1982. There is no flow measuring device to confirm the current flow from the

pumps so that their efficiency could be calculated. Since they have far surpassed their design life, it is time to replace all the pumps with new setup or discard them definitively..

Figure 27. Old Pump House

Figure 28. Pumps installed inside the Old Pump House

The **New Pump House** was implemented in 2006, along with the K-III connection, and though it was constructed approximately 25 years after the Old Pump House, it is also near the end of its design life. Out of 6 pumps in the new pump house, 4 pumps (66%) are functional while 2 pumps (33%) are non-functional due to electromechanical faults.

Within **Annex 1** it is possible to find a compilation of drawings of the New Pump House.

Figure 29. General view of the New Pump Station

The intake before the location of the pumps has two duty continuous chain raked screens (15 mm) and three travelling band screens (2 mm), one in standby. **The chain raked system and the band screens are out of order, so repair works are required.**

Finally, on the rising mains from the new pump house, two surge vessels are placed to counter transient effects. The volume of the surge vessels is of 2x35 m^3.

Figure 30. Surge vessels at the New Pumping Station

3.3. RISING MAINS

There are three rising mains that are fed by the pumping station and convey water to the existing filtration plant, all three are 66" in diameter and are made up of steel. Two of them transfer water to the filtration plant whereas the one left is redundant, but according to KWSB personnel it has never carried any water. In any case, the rising mains are 38 years old, and they will surpass their normal lifespan if a 20-year concession period were considered for the operation of the system.

No written or significant oral information about the rising mains has been gathered, other than the pictures taken at the exit point where the 72" pipe is followed by the two 66" pipes that connect the PS with the WTP.

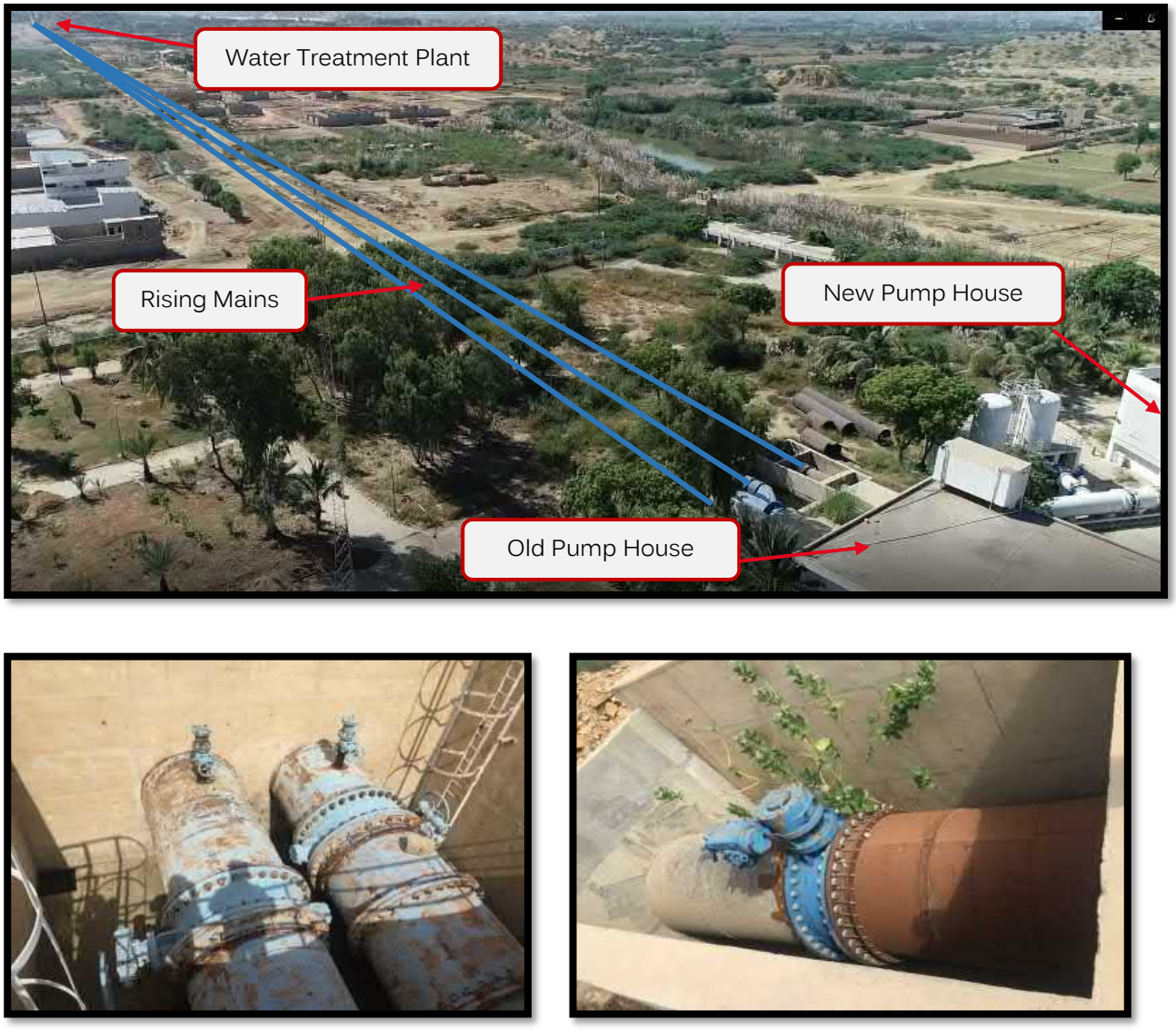


Figure 31. Rising mains

Different studies have been proposed to recognise the state of these 3 pipelines, test pits and ultrasound test among others, but KWSB has decided not to carry them out. In any case, KWSB management and on-site personnel have reported a deficient performance of the rising mains when water is pumped to the existing filtration plant. In addition, during the field visits the rising mains alignment has been inspected, and leakage from the pipeline is apparent, whereas air vent valves and other visible elements are in a very poor condition.

Apparently, there is no corrosion system implemented and both the waters conveyed, and the soil resistivity tests carried out during this due diligence stage have shown the high corrosion potential in the system. Steel pipes like the ones implemented in the rising mains typically need a guaranteed corrosion protection with Impressed Current Cathodic Protection (ICCP) systems.

Despite the lack of information, at the request of KWSB, a complete replacement of the Rising Mains has been considered, with 2 GRP DN1900 mm pipes, and thus included in the CAPEX and OPEX.

3.4. WATER TREATMENT PLANT (FILTRATION PLANT)

The existing Hub Water Treatment Plant (WTP) is the end point of the whole system, and it receives waters conveyed through the canal, pumping station and rising mains. This filtration plant is close to Swat Colony and Moon City area, and it was built 20 years ago for a design flow of 80 MGD (4.21 m^3/s).

Like the pumping station, the water source to the WTP is mainly Hub Dam, but it can also get water from the K-III connection.

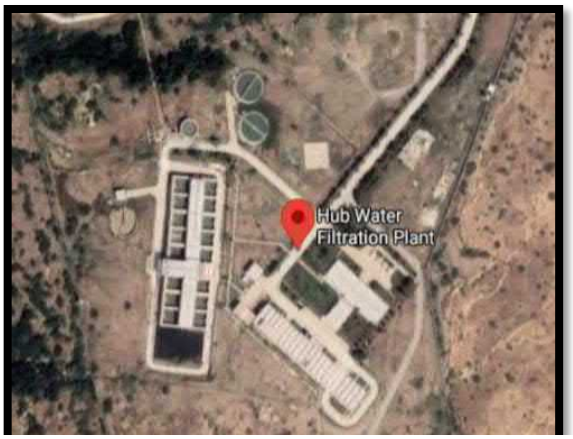


Figure 32. Plan view of the Water Treatment Plant

The main treatment processes which are implemented at the WTP are summarized in the following table, along with the key operation features, an assessment of the current condition, and the proposed actions.

WATER LINE	
Inlet + Raw water Distribution Chamber	**EXISTING INFORMATION** ▪ There is not any inlet flow meter to measure the flow to the plant. ▪ There is a manual screen. No available information about space bar. ▪ One unit which distributes the raw water to the two lines of sand filters. ▪ No information provided related to dimensions. ▪ Estimated SA:122,72 m^2 (Diameter of 12,5 m source Google Earth) ▪ The following chemicals can be dosed in this chamber: Alum, Chlorine and Sulphur Acid.
	OPERATION INFORMATION ▪ The existing inlet screen get constantly blocked. There is a lot of waste around the screen due to there is not any tank to store the waste. ▪ Currently sulphur acid is not dosed. ▪ Only Alum and Chlorine are dosed in this tank.
	PROPOSED IMPROVEMENTS An inlet flow meter and instrumentation would be introduced to automatize the pre-chemical dosing. The existing dosing pipelines would have to be replaced due to their poor condition. Replace the existing screen for an automatic one and introduce a waste tank

Sand Filters + Backwashing pumps + Blowers	**EXISTING INFORMATION** ▪ There are 2 lines of sand filters, each one with 8 filters. ▪ Estimated dimensions of each filter: 47,58 m2 and 21,89 m^3 ▪ Flow capacity of each filter: 22.730, 45 m^3/d (5MGD) ▪ Backwashing pumps = 3 (2 Duty+1 Standby) - unitary installed power of 65 kW ▪ Turbo Blowers = 3 (2D+1S) – unitary installed power of 62,5 kW
	OPERATION INFORMATION ▪ Media (sand) was replaced from 8 filters last year. Nonetheless, all filters seem blocked. ▪ Backwashing pumps and bowers have been maintenance but not replaced since installation. ▪ One of the blowers is not working.
	PROPOSED IMPROVEMENTS To improve the current performance, it would be necessary to replace the media, blowers, backwashing pumps, all pipelines, and valves. In addition, instrumentation and flow meters would be introduced to automatize this process
Pre and Post chemical dosing	**EXISTING INFORMATION** ▪ Sulfuric Acid: o 4 storage tanks with a unitary capacity of 1800 litres o 3 (2D+1S) – no available information about these pumps ▪ Alum: o 7 dosing pumps – 4(2D+2S) of 0,012kW each one; and 3(2D+1S) of 0,5 kW each one o 4 mixing tanks. No available information about the existing mixers and tanks dimensions ▪ Lime: o 4 transfer with unitary power of 5kW. These pumps are out of service. o 4 batch tanks with mixers. No available information about tank dimensions and mixers ▪ Chlorine water pumps: o 3(2D+1S) with a unitary power of 15 kW o No available information about chlorination system
	OPERATION INFORMATION All chemical dosing is done manually, except for the chlorine.
	PROPOSED IMPROVEMENTS To improve the current performance, it would be necessary to replace all chemical pumps, mixers, storage tanks, chlorination system, pipelines, and valves. In addition, it would be necessary to introduce flow meters and instrumentation to automatize the pre and post chemical dosing.

SLUDGE LINE	
Washwater Balance Tank	**EXISTING INFORMATION** ▪ One unit which collects the backwashing from the filters. ▪ No information provided related to dimensions. ▪ Estimated SA:346,36 m2 (Diameter of 21 m source Google Earth) ▪ The scraper has never been replaced
Thickener Feed Pumps	**EXISTING INFORMATION** ▪ Submerged thickener pumps = 3 (2 Duty+1 Standby) - unitary installed power of 18 kW. These pumps have never been replaced since installation
Sludge Thickener Gravity Tanks	**EXISTING INFORMATION** ▪ Two units which collects the sludge from the washwater balance tank. ▪ No information provided related to dimensions. ▪ Estimated SA:397,61 m2 (Diameter of 22,5 m source Google Earth) ▪ The scrapers have never been replaced
Washwater Balance Tank + Thickener Feed Pumps + Sludge Thickener Gravity Tanks	**OPERATION INFORMATION** The scrapers and submerged sludge pumps have never been replaced since their installation **PROPOSED IMPROVEMENTS** To improve the current performance, it would be necessary to replace the scrapers, sludge thickener pumps, pipelines, and valves. In addition, it would be necessary to introduce flow meters and instrumentation to automatize the unit process.
CCMs & GENERATOR	
CCMs	**EXISTING & OPERATION INFORMATION** ▪ There are 3 central control modules CCMs. ▪ CCM-1 – Admin Building. ▪ CCM-2 – Submerged thickened sludge pumps + backwashing pumps. ▪ CCM-3 – Rest of the equipment (like blowers, all chemical pumps, etc). ▪ There is not spare space available in the CCMs. **PROPOSED IMPROVEMENTS** All CCMs should be replaced by new equipment.
Generator	**EXISTING & OPERATION INFORMATION** ▪ Diesel Generator – FG Wilson; 1500 RPM; 800 KVA. ▪ The existing generator has never been replaced since the installation. **PROPOSED IMPROVEMENTS** The existing generator would have to be replaced.
AUTOMATION & SCADA	
	EXISTING & OPERATION INFORMATION The automatization system of the WFT is not working and all process units are controlled manually. **PROPOSED IMPROVEMENTS** All process units would have to be controlled automatically through PLCs and SCADA system.

Table 6: Available information about the WTP (Source: Operators from Hub WTP)

All mechanical, electrical and automatization equipment has not been replaced in the last 20 years, their condition is deficient, and it would be necessary to replace all equipment to improve the performance of the existing WTP.

3.5. POWER SUPPLY FACILITIES

Presently, the whole complex is connected to the distribution grid at 11 kV from the K-Electricity (K-E) (Walika Grid) company. The point of interconnection with the grid is the so-called **K-electric room** that belongs to the K-E company, with the main 11 kV busbar. It is located beside the pumping station building and has two main 11 kV feeders. One, called "HUB DAM", is the main power source, while the second one is called "MUMTAZ" and serves as a standby power source.

The **filtration plant substation** is connected to the existing (Old) Pump House through a 11kV feeder, and at the entrance of this substation there is an isolator switch (11kV) and an MT/LV 800 kVA transformer. It also has installed a DG set of 800 kVA as backup.

The **Old Pump House HT Panel** is directly connected to the K-Electric substation line, having each pump fed through a dedicated electrical panel. It also has installed a DG set (11 kV) of a capacity of 3,600 kW and an 11 kV power exchanger to the New Pump House. The **New Pump House HT panel** is connected to the K-Electric substation line, having each pump fed through a dedicated electrical panel, with a provision of establishing a second standby line. There is also a 11 kV power exchanger to the Old House.

As part of an environmental strategy, a **solar photovoltaic plant** to partially cover the large energy demand is being considered. This solution has the ultimate purpose of reducing the electricity charges the system bears every year. For a proper solar plant assessment, meteorological data have been gathered. It is seemed, from this data, that the location shows high irradiation values, which makes the proposed site quite optimal for the installation of a photovoltaic solar plant. The diffuse component is also high and the average temperature throughout the year is 26.3ºC while the maximum operating temperature obtained, with a GHI > 35 W/m² is 41.5 ºC. This temperature will be the design temperature. All the information regarding the Solar Plan is developed in **Annex 2**.

Finally, the information provided by KWSB on power and consumption of the complex is illustrated in the following table. It shows an estimate of the power demand of the facilities based on the existing capacity:

Power Demand	
Water Pumping Station	~ 4,800 kW
Water Treatment Plant	~ 500 kW
Ancillary equipment	~ 800 kW

Table 7: Estimation of the existing power demand

The provided information also considers that demand remains steady 24/7 and, then a total and constant power demand of 6.1 MW could be considered as the base load for the complex in the existing conditions.

3.6. FACILITY ASSESSMENT CONCLUSIONS

Based on all the field campaigns, the on-site inspections and the assessment carried out by the Consultant team on the Hub water supply system, the main conclusions are summarized in the following table:

1.- KARACHI CANAL
▪ No flow rate measurement devices are installed or implemented, so it is not possible to know or quantify the real amount of water conveyed. ▪ The structure of the canal is old and undergoes a lot of deterioration. Its lifespan is almost finished and there is a significant loss of water throughout the canal alignment due to seepage. ▪ Nearly 25% of the water is lost between the Head Regulator and the Hub Pumping Station. Some illegal offtakes from the canal have also been reported.
AUXILIARY INFRASTRUCTURES ASSOCIATED TO KARACHI CANAL
▪ The roadway along the canal also needs repair works because it is bumpy, irregular and is missing at various locations on each side. ▪ The bottom lining in the aqueducts is highly deteriorated, whereas seepage and leakages at joints/abutments were also observed during the site visits. At some locations, reinforcement bars are massively exposed due to concrete deterioration.
2.- PUMPING STATION
▪ The old pump house, installed in 1982, has surpassed its design life; therefore, it is time to replace all the pumps with a new setup or discard them for good. ▪ There is no flow measuring device to confirm the current flow from the pumps and their efficiency cannot be calculated. ▪ The new pump house was implemented in 2006, and it is also near the end of its design life. Out of 6 pumps, 4 pumps are functional while 2 pumps are non-functional due to electromechanical faults.
3.- RISING MAINS
▪ The rising mains are 38 years old, and they may surpass their normal lifespan if a 30-year concession period is considered for the operation of the system. ▪ Based on the field visits carried out, there is apparent seepage along the rising mains alignment and no corrosion protection system was ever implemented. ▪ Despite the lack of information, KWSB has asked for the complete upgrade and substitution of the rising mains with 2 new pipelines.
4.- WATER TREATMENT PLANT (FILTRATION PLANT)
▪ The existing Hub Water Treatment Plant (WTP) was built 20 years ago for a design flow of 80 MGD. ▪ The inlet screen gets constantly blocked because there is not a tank to store the waste. ▪ Sulphur acid is not dosed, whereas backwashing pumps and blowers of the sand filters have been maintained, but not replaced since their installation, plus one of the blowers is not working. ▪ Except for the chlorine, all chemical dosing is done manually. ▪ In the sludge line, the scrapers and submerged sludge pumps have never been replaced. ▪ The automatization system of the WTP (SCADA) is not working. ▪ According to the water quality tests, the WTP is not treating the water properly.

Table 8: Facility Assessment conclusions

4. ANALYSIS OF POTENTIAL ALTERNATIVES

This due diligence report focuses on the PPP project, aimed at rehabilitating the Hub Canal System from the Head Regulator (distributor) to the Water Treatment Plant. The 8,32 km section that goes from the Hub Reservoir to the Head Regulator is operated by WAPDA and could have an influence on the reliability of the KWSB Hub water system. However, this canal is out of the scope of this project due to its better condition.

Due to the water-stress condition in Karachi, it is necessary to ensure that the canal remains operational almost all days and to limit any canal closure during the rehabilitation works. At this due diligence stage, **during the month of January 2021, the following 6 alternatives were considered in the analysis**:

Alternative 1.1 (Canal rehabilitation with 80 MGD) ▪ Existing Canal rehabilitation including a 2.28 km pipeline in the high slope stretch. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 80 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (3.3 MW)	Alternative 1.2 (Canal rehabilitation with 100 MGD) ▪ Existing Canal rehabilitation including a 2.28 km pipeline in the high slope stretch. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 100 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (5.3 MW)
Alternative 2.1 (Hybrid with 80 MGD) ▪ Existing Canal rehabilitation in the first 11 km ▪ New GRP pipeline DN1900 for 9.2 km (80 MGD) with a pressure chamber at its beginning ▪ Decommissioning of the existing canal in the last 9.2 km ▪ Mitigation measures for the pipeline stretch. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 80 MGD ▪ Replacement of the existing RM ▪ Downscaling the Solar PV Plant (3.3 MW)	Alternative 2.2 (Hybrid with 100 MGD) ▪ Existing Canal rehabilitation in the first 11 km ▪ New GRP pipeline DN1900 for 9.2 km (100 MGD) with a pressure chamber at its beginning ▪ Decommissioning of the existing canal in the last 9.2 km ▪ Mitigation measures for the pipeline stretch. ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 100 MGD ▪ Replacement of the existing RM ▪ Downscaling the Solar PV Plant (4.4 MW)
Alternative 3.1 (Pipeline with 80 MGD) ▪ Decommissioning of the existing canal and PS ▪ New GRP pipeline DN1900 within existing RoW ▪ Mitigation measures for the new pipeline ▪ New Pumping Station at the Head Regulator, H=51.75m 2760 kW ▪ Water Treatment Plant (WTP) with 80 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (4.5 MW) ▪ New power distribution line (15 km)	Alternative 3.2 (Pipeline with 100 MGD) ▪ Decommissioning of the existing canal and PS ▪ New GRP pipeline DN1900 within existing RoW ▪ Mitigation measures for the new pipeline ▪ New Pumping Station at the Head Regulator, Head and Power to be defined. ▪ Water Treatment Plant (WTP) with 100 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (being defined) ▪ New power distribution line (15 km)

It is important to highlight that during the alternative analysis carried out in January 2021, the Consultant was asked to leave the rising mains rehabilitation out of the scope of the project, and a simple hydraulic connection with the pumping station works was considered. The K-III connection was also left out of the analysis, following the request from KWSB. In any case, all these alternatives are coherent with each other and serve the purpose of comparing the different options in a homogeneous way.

During the month of May 2021, both KWSB and the GoS asked the Consultant to include the K-III connection in the scope of the project due to the water-stress condition in Karachi. In the coming years, the objective will be to provide the population served by the Hub system with 100 MGD (5.26 m^3/s) whenever possible, and that implies resorting to the K-III connection very often. In fact, the historical performance of the system shows that only 10% of the days the Hub Reservoir can yield that design flow, and median values reveal that 50% of the time the system may combine 82 MGD (4.31 m^3/s) from Hub Reservoir with 18 MGD (0.95 m^3/s) coming from the K-III connection.

Based on these developments and after including KIII , rising mains and refinements, the transaction structure document (TSR) prepared in June 2021 has included an updated analysis of the alternatives, but only focusing on the 100 MGD (5.26 m^3/s) options. These updated figures include the costs associated with the K-III connection, the complete rehabilitation of the rising mains and the corresponding power supply and chemical costs. This updated analysis that focuses on the three 100 MGD alternatives and has been prepared for the TSR is included in **Annex 4** of this due diligence report.

Following, the descriptions developed for the six original alternatives are included along with the analysis carried out in January 2021, before the K-III and the rising mains were included within the project scope.

4.1. Set of Alternatives 1: Existing Canal Rehabilitation

This first set of alternatives focuses on the rehabilitation of the KWSB canal to convey both 100 MGD and 80 MGD, including the following features:

- The rehabilitation of all aqueducts and the demolition (including the construction of a new one) for Aqueduct nº 11 due to its condition.
- The installation of a pipe at the high-speed area (CH 6+940 to CH 9+200, considering the beginning at the PS and moving upstream). In that section, a solution based on the construction of steps, after study, was finally rejected.
- The pumping station and its intake will be designed for 80 MGD and 100 MGD, respectively.
- The old pump house is proposed to be shut down and demolished since a newer station with a pre-treatment system is available and maintaining two pumping stations is not considered economical.

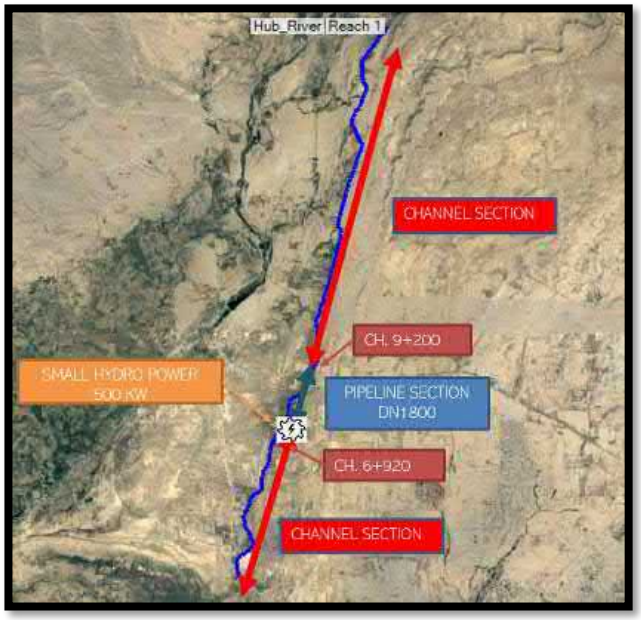


Figure 33. Description of Baseline alternative "0".

- At the new pump house, the replacement of all mechanical equipment and associated valves is proposed. With the information available, there is no reason to modify the current proposed unit flow rates for each pump, and replacing old pumps with new ones has the following advantages:

  - Lower energy consumption by considering high energy efficiency pumps. Efficiency above 85%.
  - Use of engines with the latest efficiency technology.
- Also, chain raked screens and travelling band screens shall be replaced.
- The implementation of a photovoltaic plant.
  - Based on the obtained requirements, this new PV plant should cover an extension of about 14.50 ha.
  - The irradiation levels are high, maximizing the production of the PV generator.
  - The consumption is constant and most of the energy produced by the PV plant will be self-consumed.

Figure 34. Proposed location for the new FV Plant

  - The construction of the plant is feasible, due to the characteristics of the land.
  - The current local regulations support and encourage self-consumption facilities, improving the viability of this kind of facilities.
- Considers a lump sum for the connection to the existing risings mains.

Estimated Capex. Alternatives 1.1 and 1.2

Based on the design hypothesis, the cost for this Baseline approach solution is summarized in the following tables, Alternative 1.1 for 80 MGD (4.21 m^3/s) and Alternative 1.2 for 100 MGD (5.26 m^3/s).

ALTERNATIVE 1.1. (BASELINE) WITH 80 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)
Canal Rehabilitation (80 or 100 MGD) incl. 2.28 km Pipeline	USD 24,534,136	USD 294,410	50 years	USD 279,689	USD 14,720
SCADA and metering system (Canal, PS and RM incl. telecom.)	USD 2,000,000	USD 24,000	15 years	USD 24,000	USD 0
Pumping Station - PS (80 MGD) H=48m - 2,609 kW	USD 3,688,887	USD 1,473,035	25 years	USD 44,267	USD 1,428,769
Conection with Existing Rising Mains	USD 265,000	USD 0	30 years	USD 0	USD 0
Water Treatment Plant Upgrade - WTP (80 MGD)	USD 7,473,000	USD 398,374	25 years	USD 127,041	USD 271,333
Solar PV Plant (4.4 MW)	USD 4,170,887	USD 124,089	25 years	USD 99,271	USD 24,818
E&S Mitigation Measures (3%)	USD 1,263,957	-	-		
Contingencies (15%)	USD 6,319,787	-	-		
Overheads (15%)	USD 6,319,787	-	-		
Profit (7%)	USD 2,949,234	-	-		
TOTAL Construction Works	**USD 58,984,675**	**USD 2,313,908**	25 to 50 years	**USD 574,268**	**USD 1,739,640**

The following considerations have been taken in account:

- When the direct cost is available, CAPEX includes 6% of indirect costs. Both direct and indirect costs are combined to apply
- Overhead costs (13%), profit (6%) and contingencies.
- For technical coherence, the pumping station, rising mains and water treatment plant share the same design flow.
- For the pumping station a 48m manometric head is estimated (elevation between the PS and WTP) with a 120 MGD design flow
- The WTP includes a SCADA of its own.
- The rising mains OPEX is estimated at 0 USD because it is part of both the PS and WTP, and thus included in them.
- OPEX for the canal is estimated at 1.2% of CAPEX per year.
- OPEX for the pumping station is estimated at 1.2% of CAPEX per year.
- OPEX for the water treatment plant is estimated at 2% of CAPEX per year.
- For the power consumption, 0.08 USD/kwh is the current tariff for using the existing power grid, and 0.0285 USD/kWh is the tariff for the PV Solar Plant.
- The assumption is that the PV Solar Plant will provide 21% of the power consumption and the rest will come from the existing power grid.
- For the water treatment plant, the power consumption is not included (0.03 kWh/m³ can be used on a daily basis)
- 80 MGD (4.21 m³/s) yield 363,744 m³/day
- The rehabilitation of the raising mains was excluded when this study of alternatives was carried out (it has been included at the request of KWSB when developing the final solution), this fact has no effect on the comparison between the different alternatives.

ALTERNATIVE 1.2. (BASELINE) WITH 100 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)
Canal Rehabilitation (80 or 100 MGD) incl. 2.28 km Pipeline	USD 24,534,136	USD 294,410	50 years	USD 279,689	USD 14,720
SCADA and metering system (Canal, PS and RM incl. telecom.)	USD 2,000,000	USD 24,000	15 years	USD 24,000	USD 0
Pumping Station - PS (100 MGD) H=48m - 3,293 kW	USD 4,414,385	USD 1,856,266	25 years	USD 52,973	USD 1,803,293
Conection with Existing Rising Mains	USD 265,000	USD 0	30 years	USD 0	USD 0
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 14,840,000	USD 607,942	25 years	USD 252,280	USD 355,662
Solar PV Plant (5.3 MW)	USD 5,064,481	USD 151,360	25 years	USD 121,088	USD 30,272
E&S Mitigation Measures (3%)	USD 1,533,540	-	-		
Contingencies (15%)	USD 7,667,700	-	-		
Overheads (15%)	USD 7,667,700	-	-		
Profit (7%)	USD 3,578,260	-	-		
TOTAL Construction Works	**USD 71,565,202**	**USD 2,933,978**	25 to 50 years	**USD 730,030**	**USD 2,203,948**

The following considerations have been taken in account:

- When the direct cost is available, CAPEX includes 6% of indirect costs. Both direct and indirect costs are combined to apply
- overhead costs (13%), profit (6%) and contingencies.
- For technical coherence, the pumping station, rising mains and water treatment plant share the same design flow.
- For the pumping station a 48m manometric head is estimated (elevation between the PS and WTP) with a 120 MGD design flow
- The WTP includes a SCADA of its own.
- The rising mains OPEX is estimated at 0 USD because it is part of both the PS and WTP, and thus included in them.
- OPEX for the canal is estimated at 1.2% of CAPEX per year.
- OPEX for the pumping station is estimated at 1.2% of CAPEX per year.
- OPEX for the water treatment plant is estimated at 2% of CAPEX per year.
- For the power consumption, 0.08 USD/kwh is the current tariff for using the existing power grid, and 0.0285 USD/kWh is the tariff for the PV Solar Plant.
- The assumption is that the PV Solar Plant will provide 21% of the power consumption and the rest will come from the existing power grid.
- For the water treatment plant, the power consumption is not included (0.03 kWh/m³ can be used on a daily basis) 100 MGD (5.26 m³/s) yield 454,464 m³/day.
- The rehabilitation of the raising mains was excluded when this study of alternatives was carried out (it has been included afterwards at the request of KWSB), this fact has no effect on the comparison between the different alternatives.

4.2. Set of Alternatives 2: Hybrid Approach

This set of alternatives includes solutions based on the following assumptions:

- The partial rehabilitation of the canal, for 80 MGD (Alternative 2.1) and 100 MGD flow (Alternative 2.2).
- The substitution of the sloped section and the installation of a new pipeline from that section down to the Pump Station (CH 9,200 to CH 0+000 – considering the starting point at the PS and moving upstream, CH 9,200 is PK 13+390 if the starting point is at the Head Regulator and moving downstream) by means of a new pipe 9,200 m long and with a 1900 mm diameter.
- The upgrade of the pumping station and the water treatment plant.

The analysis of the basic longitudinal profile clearly shows the area with excessive flow velocities. At these sections, a supercritical flow is found (Froude numbers >1), reaching a maximum value for the Froude number of 5.52. The supercritical flow is generated due to the excessive slope of these sections, close to an average 1%, which is an extreme value for a free-surface flow canal.

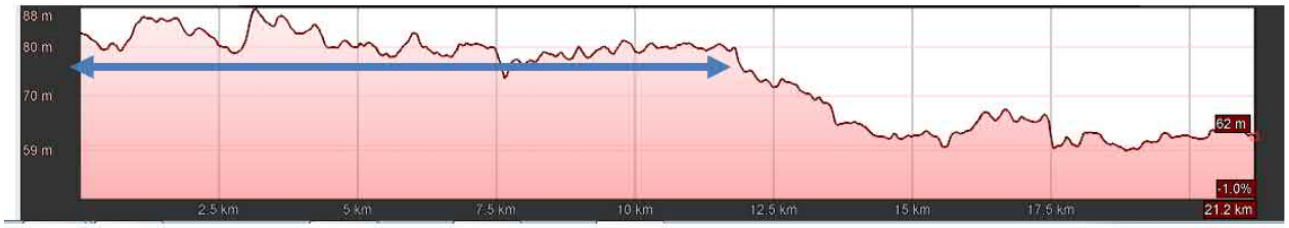


Figure 35. Longitudinal profile of the Karachi Canal

It has been observed that a pipeline starting off from the Head Regulator would thus require trench heights of about 10-20 m at that area located 11 km downstream. To avoid this issue, this set of potential alternatives would have to begin with a canal section from the Head Regulator, and then a pipeline would take over with an inlet or surge chamber that would connect with the existing PS. Finally, an intake chamber with proper rakes would be located at the end of the canal section, ensuring the transition from free surface to pressure flow.

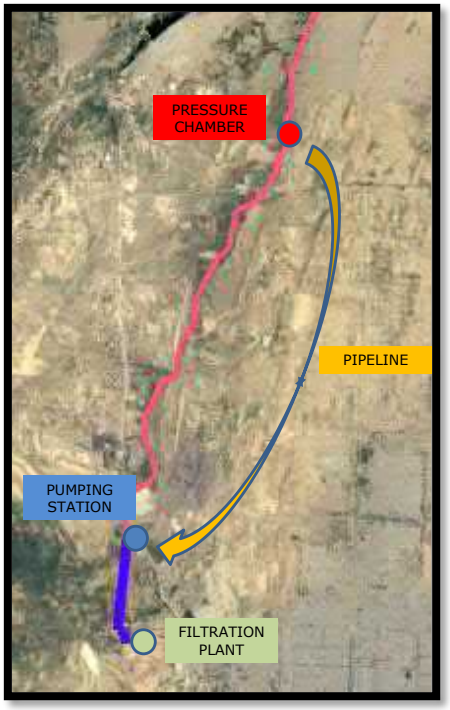


Figure 36. Alternative 2 Hybrid approach. Description

Thus, this alternative will consider the following:

- The first 11.39 kilometers from the Head Regulator, since they are very flat and do not present problems of excessive speed, would be repaired.
- The existing “New Pump House” would be used for the K-III outflows.
- A new pump house would be constructed to convey the waters from the Hub Canal, working as a booster.
- Pressure flow is ensured at the pumping station inlet to minimize head losses.
- Connection to the rising mains pipes from the pumping plant.
- Update of the current WTP facilities for 80 MGD and 100 MGD, respectively.

- Construction of a Photovoltaic plant and required transmission power line.

This solution minimizes the challenge of maintaining the water supply while the construction works are carried out.

Estimated Capex. Alternatives 2.1 and 2.2.

Based on the design hypothesis, the cost for this hybrid approach solutions are summarized in the following tables, Alternative 2.1 for 80 MGD (4.21 m^3/s) and Alternative 2.2 for 100 MGD (5.26 m^3/s).

ALTERNATIVE 2.1 (HYBRID APPROACH) WITH 80 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)
Karachi Canal Rehabilitation (11km) & Partial Decommissioning	USD 10,865,478	USD 130,386	50 years	USD 123,866	USD 6,519
New GRP Pipeline DN1900 (80 MGD) Length = 9.2 km	USD 12,272,372	USD 73,634		USD 62,589	USD 11,045
SCADA and metering system for the system, including telecom.	USD 2,000,000	USD 24,000	15 years	USD 24,000	USD 0
Pumping Station - PS (80 MGD) H=35.43m 1890 kW	USD 3,688,887	USD 1,079,106	25 years	USD 44,267	USD 1,034,840
Conection with Existing Rising Mains	USD 265,000	USD 0	30 years	USD 0	USD 0
Water Treatment Plant Upgrade - WTP (80 MGD)	USD 7,473,000	USD 398,374	25 years	USD 127,041	USD 271,333
Solar PV Plant (3.3 MW) + Distribution line (2.5 km)	USD 3,243,885	USD 95,361	25 years	USD 76,289	USD 19,072
E&S Mitigation Measures (3%)	USD 1,194,259	-	-		
Contingencies (10%)	USD 3,980,862	-	-		
Overheads (15%)	USD 5,971,293	-	-		
Profit (7%)	USD 2,786,604	-	-		
TOTAL Construction Works	**USD 53,741,640**	**USD 1,800,861**	25 to 50 years	**USD 458,052**	**USD 1,342,809**

The following considerations have been taken in account:

- When the direct cost is available, CAPEX includes 6% of indirect costs. Both direct and indirect costs are combined to apply
- overhead costs (13%), profit (6%) and contingencies.
- For technical coherence, the pumping station, rising mains and water treatment plant share the same design flow.
- For the pumping station a 48m manometric head is estimated (elevation between the PS and WTP) with an 80 MGD design flow
- The WTP includes a SCADA of its own.
- OPEX for the canal is estimated at 1.2% of CAPEX per year.
- OPEX for the pipeline is estimated at 0.6% of CAPEX per year.
- OPEX for the pumping station is estimated at 1.2% of CAPEX per year.
- OPEX for the water treatment plant is estimated at 2% of CAPEX per year.
- For the power consumption, 0.08 USD/kwh is the current tariff for using the existing power grid, and 0.0285 USD/kWh is the tariff for the PV Solar Plant.
- The assumption is that the PV Solar Plant will provide 21% of the power consumption and the rest will come from the existing power grid.
- For the water treatment plant, the power consumption is not included (0.03 kWh/m³ can be used on a daily basis)
- 80 MGD (4.21 m³/s) yield 363,744 m³/day.
- The rehabilitation of the raising mains was excluded when this study of alternatives was carried out (it has been included a posteriori at the request of KWSB), this fact has no effect on the comparison between the different alternatives.

ALTERNATIVE 2.2 (HYBRID APPROACH) WITH 100 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)
Karachi Canal Rehabilitation (11km) & Partial Decommissioning	USD 10,865,478	USD 130,386	50 years	USD 123,866	USD 6,519
New GRP Pipeline DN1900 (100 MGD) Length = 9.2 km	USD 12,272,372	USD 73,634		USD 62,589	USD 11,045
SCADA and metering system for the system, including telecom.	USD 2,000,000	USD 24,000	15 years	USD 24,000	USD 0
Pumping Station - PS (100 MGD) H=39.4m 2625 kW	USD 4,414,385	USD 1,490,250	25 years	USD 52,973	USD 1,437,277
Conection with Existing Rising Mains	USD 265,000	USD 0	30 years	USD 0	USD 0
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 14,840,000	USD 607,942	25 years	USD 252,280	USD 355,662
Solar PV Plant (4.4 MW) + Distribution line (2.5 km)	USD 4,204,808	USD 124,687	25 years	USD 99,750	USD 24,937
E&S Mitigation Measures (3%)	USD 1,465,861	-	-		
Contingencies (10%)	USD 4,886,204	-	-		
Overheads (15%)	USD 7,329,306	-	-		
Profit (7%)	USD 3,420,343	-	-		
TOTAL Construction Works	**USD 65,963,758**	**USD 2,450,900**	25 to 50 years	**USD 615,458**	**USD 1,835,442**

The following considerations have been taken in account:

- When the direct cost is available, CAPEX includes 6% of indirect costs. Both direct and indirect costs are combined to apply
- overhead costs (13%), profit (6%) and contingencies.
- For technical coherence, the pumping station, rising mains and water treatment plant share the same design flow.
- For the pumping station a 48m manometric head is estimated (elevation between the PS and WTP) with a 100 MGD design flow
- The WTP includes a SCADA of its own.
- OPEX for the canal is estimated at 1.2% of CAPEX per year.
- OPEX for the pipeline is estimated at 0.6% of CAPEX per year.
- OPEX for the pumping station is estimated at 1.2% of CAPEX per year.
- OPEX for the water treatment plant is estimated at 2% of CAPEX per year.
- For the power consumption, 0.08 USD/kwh is the current tariff for using the existing power grid, and 0.0285 USD/kWh is the tariff for the PV Solar Plant.
- The assumption is that the PV Solar Plant will provide 21% of the power consumption and the rest will come from the existing power grid.
- For the water treatment plant, the power consumption is not included (0.03 kWh/m³ can be used on a daily basis) 100 MGD (5.26 m³/s) yield 454,464 m³/day.
- The rehabilitation of the raising mains was excluded when this study of alternatives was carried out (it has been included a posteriori at the request of KWSB), this fact has no effect on the comparison between the different alternatives.

4.3. Set of Alternatives 3: Pipeline Approach

This last set of alternatives focuses on the implementation of a new pipeline from the Head Regulator, with a 1900 mm diameter and a total length of almost 22 km. To allow the comparison with the previous alternatives, the design flow considered is once more 80 MGD (Alternative 3.1) and 100 MGD (Alternative 3.2).

Considering the hydraulic profile, it is necessary to resort to external energy from the hydraulic system to reach the Water Treatment Plant with the considered flows. To this end, the following two cases have been identified:

Case A: The existing Old Pump House could be reshaped to act as a "booster", and the canal would be replaced by a new pipeline. With the existing profile, always considering pressure flow, this case requires enough energy gradient to convey the flow, and that implies a slope gradient along the pipeline alignment. The pipeline alignment cannot follow the existing canal and needs to depart from it to find lower ground and ensure that energy gradient, and this will require massive land acquisition (blue line in Figure 37. Alternative 3. Cases A and B.)

Case B: To avoid new land acquisition and remain in the existing RoW, if no additional energy is used other than the Hub Pumping Station, excavations of about 15-20 m deep will be required at the end of the flat section of the existing canal (11.39 km downstream of the Head Regulator), with higher costs and especially environmental impacts (red line at Figure 37. Alternative 3. Cases A and B.).

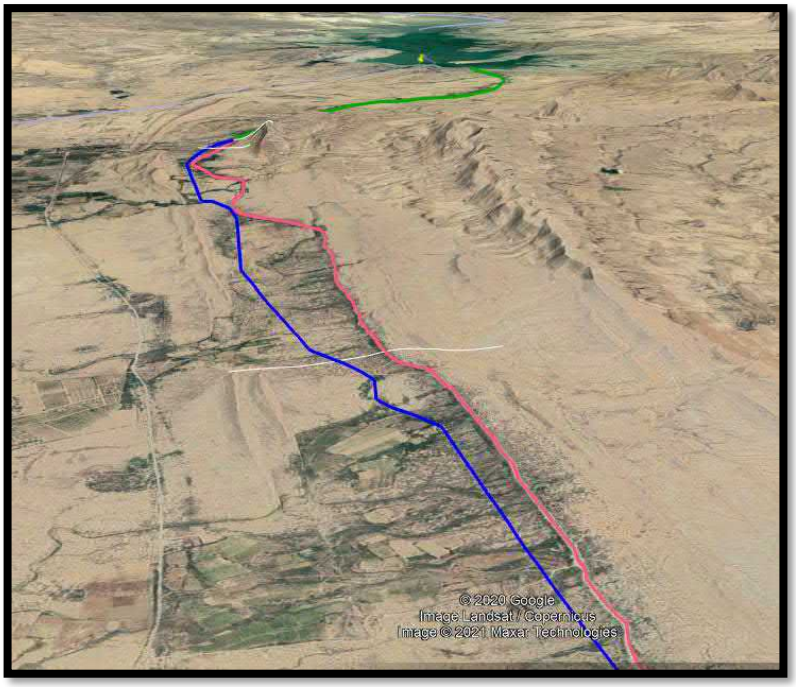


Figure 37. Alternative 3. Cases A and B.

Both cases result in alternatives that are not completely feasible, due to the land acquisition costs and timeline, or due to environmental impacts. To get around these issues, a new pump station could be implemented at the Head Regulator to add energy to the system and connect directly with the water treatment plant downstream.

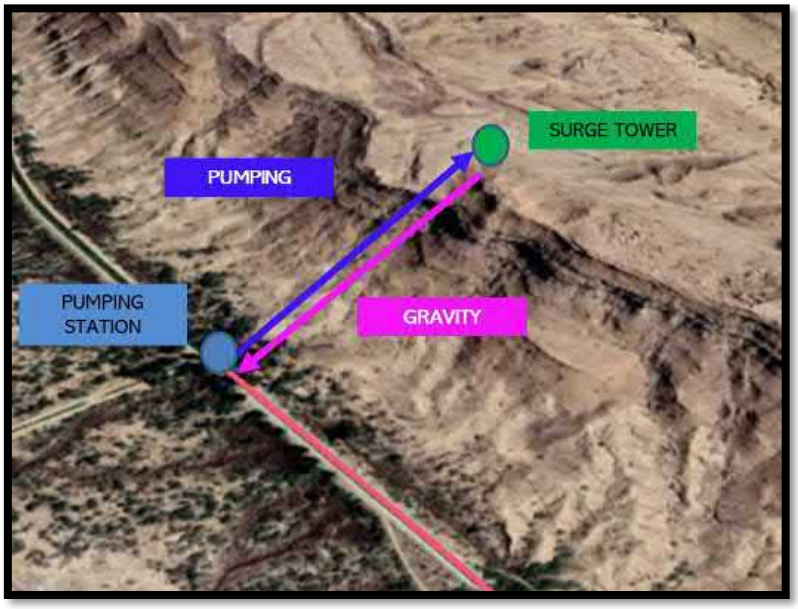


Figure 38. Alternative 3. Cases A and B & new pump station at Head Regulator

This way, due to the WTP elevation, a pumping station at the starting point would be needed to raise the flow to a small surge tower located at the top of the nearby hill. In addition, this set of alternatives would require the implementation of a new high voltage power line to supply energy to that new pump station. The field investigations conducted at the Hub Dam site show that the existing electric line does not have enough capacity to supply that pump unit (1890 to 4000 kW). In this case, it will require an upgrade and negotiations with the K-electric company. At the same time, this solution would also require a roadway to access the small nearby surge tower. Finally, the Solar PV Plant would also have to be relocated to the surroundings of the Head Regulator.

After the analysis of the combination of possible solutions for these Alternatives 3.1 and 3.2, **Case B** has been considered as the most appropriate, because the current alignment is used, and no land acquisition would be required.

Estimated Capex. Alternatives 3.1 and 3.2.

Based on the design hypothesis, the costs for this full pipeline approach solutions are summarized in the following tables, Alternative 3.1 for 80 MGD (4.21 m^3/s) and Alternative 3.2 for 100 MGD (5.26 m^3/s).

ALTERNATIVE 3.1 (PIPELINE WITH NEW PS AT HR) 800 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)
Karachi Canal & Existing PS Decommissioning	USD 2,120,000	USD 0	-	USD 0	USD 0
New GRP Pipeline DN1900 (80 MGD) within existing RoW	USD 29,293,618	USD 175,762	50 years	USD 149,397	USD 26,364
SCADA and metering system for the system, including telecom.	USD 2,000,000	USD 24,000	15 years	USD 24,000	USD 0
Pumping Station - PS (80 MGD) H=51.75m 2760 kW	USD 3,916,336	USD 1,558,191	25 years	USD 46,996	USD 1,511,194
New Dirt Road to access the new PS scheme (5 km)	USD 1,371,166	USD 41,135	10 years	USD 41,135	USD 0
Conection with Existing Rising Mains	USD 265,000	USD 0	30 years	USD 0	USD 0
Water Treatment Plant Upgrade - WTP (80 MGD)	USD 7,473,000	USD 398,374	25 years	USD 127,041	USD 271,333
Solar PV Plant (4.6 MW) + Distribution line (15 km)	USD 4,977,554	USD 130,074	25 years	USD 104,059	USD 26,015
E&S Mitigation Measures (3%)	USD 1,542,500	-	-		
Contingencies (10%)	USD 5,141,667	-	-		
Overheads (15%)	USD 7,712,501	-	-		
Profit (7%)	USD 3,599,167	-	-		
TOTAL Construction Works	**USD 69,412,511**	**USD 2,327,535**	25 to 50 years	**USD 492,628**	**USD 1,834,907**

The following considerations have been taken in account:

- When the direct cost is available, CAPEX includes 6% of indirect costs. Both direct and indirect costs are combined to apply
- overhead costs (13%), profit (6%) and contingencies.
- For technical coherence, the pumping station, rising mains and water treatment plant share the same design flow.
- For the pumping station at the Head Regulator a 51.75m manometric head is estimated with an 80 MGD design flow
- The WTP includes a SCADA of its own.
- OPEX for the canal is estimated at 1.2% of CAPEX per year.
- OPEX for the pipeline is estimated at 0.6% of CAPEX per year.
- OPEX for the pumping station is estimated at 1.2% of CAPEX per year.
- OPEX for the water treatment plant is estimated at 2% of CAPEX per year.
- For the power consumption, 0.08 USD/kwh is the current tariff for using the existing power grid, and 0.0285 USD/kWh is the tariff for the PV Solar Plant.
- The assumption is that the PV Solar Plant will provide 21% of the power consumption and the rest will come from the existing power grid.
- For the water treatment plant, the power consumption is not included (0.03 kWh/m³ can be used on a daily basis)
- 80 MGD (4.21 m³/s) yield 363,744 m³/day
- The rehabilitation of the raising mains was excluded when this study of alternatives was carried out (it has been included a posteriori at the request of KWSB), this fact has no effect on the comparison between the different alternatives.

ALTERNATIVE 3.2 (PIPELINE WITH NEW PS AT HR) 100 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)
Karachi Canal & Existing PS Decommissioning	USD 2,120,000	USD 0	-	USD 0	USD 0
New GRP Pipeline DN1900 (100 MGD) within existing RoW	USD 29,293,618	USD 175,762	50 years	USD 149,397	USD 26,364
SCADA and metering system for the system, including telecom.	USD 2,000,000	USD 24,000	15 years	USD 24,000	USD 0
Pumping Station - PS (100 MGD) H=60.7m 4,043 kW	USD 5,370,986	USD 2,278,133	25 years	USD 64,452	USD 2,213,681
New Dirt Road to access the new PS scheme (5 km)	USD 1,371,166	USD 41,135	10 years	USD 41,135	USD 0
Conection with Existing Rising Mains	USD 265,000	USD 0	30 years	USD 0	USD 0
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 14,840,000	USD 607,942	25 years	USD 252,280	USD 355,662
Solar PV Plant (6.4 MW) + Distribution line (15 km)	USD 6,654,921	USD 181,265	25 years	USD 145,012	USD 36,253
E&S Mitigation Measures (3%)	USD 1,857,471	-	-		
Contingencies (10%)	USD 6,191,569	-	-		
Overheads (15%)	USD 9,287,354	-	-		
Profit (7%)	USD 4,334,098	-	-		
TOTAL Construction Works	**USD 83,586,183**	**USD 3,308,237**	25 to 50 years	**USD 676,277**	**USD 2,631,961**

The following considerations have been taken in account:

- When the direct cost is available, CAPEX includes 6% of indirect costs. Both direct and indirect costs are combined to apply
- overhead costs (13%), profit (6%) and contingencies.
- For technical coherence, the pumping station, rising mains and water treatment plant share the same design flow.
- For the pumping station at the Head Regulator a 51.75m manometric head is estimated with an 80 MGD design flow
- The WTP includes a SCADA of its own.
- OPEX for the canal is estimated at 1.2% of CAPEX per year.
- OPEX for the pipeline is estimated at 0.6% of CAPEX per year.
- OPEX for the pumping station is estimated at 1.2% of CAPEX per year.
- OPEX for the water treatment plant is estimated at 2% of CAPEX per year.
- For the power consumption, 0.08 USD/kwh is the current tariff for using the existing power grid, and 0.0285 USD/kWh is the tariff for the PV Solar Plant.
- The assumption is that the PV Solar Plant will provide 21% of the power consumption and the rest will come from the existing power grid.
- For the water treatment plant, the power consumption is not included (0.03 kWh/m³ can be used on a daily basis) 100 MGD (5.26 m³/s) yield 454,464 m³/day
- The rehabilitation of the raising mains was excluded when this study of alternatives was carried out (it has been included a posteriori at the request of KWSB), this fact has no effect on the comparison between the different alternatives.

4.4. Multicriteria Analysis and Selection of Alternatives

The purpose of this analysis is to make a comparison of the different alternatives and to propose one which, according to the structure of criteria and weightings, is considered the most appropriate.

Methodology

To select the most suitable alternative a multicriteria analysis process has been conducted considering technical, economic, environmental, and social criteria. At the same time, the four criteria have been weighted considering its relative importance or value, and a multicriteria matrix has been obtained, getting a final weight for each of the alternatives.

The criteria set presents some quantitative criteria (indicated as "q") and also qualitative aspects of the alternatives (indicated as "Q"). The selection and how to weigh both types of criteria have been discussed considering the opinion of several technicians and water experts within the Consultant's team.

The First Level Weights considered are the following ones:

Criteria. Level 1.	TYPE	Relative Weight (W1)
Technical	Q	0.3
Economical	q	0.4
Environmental	Q	0.2
Social	Q	0.1

Within each 1st level criteria, some 2nd level criteria have been considered and given a relative weight (W2). The criteria finally considered are the following ones:

C1-Technical Criteria:

- Ease of construction works
- Duration of works
- Risks of unexpected events on schedule
- New energy supply requirements
- Ease of maintenance
- Management complexity (Technical staff required)
- Losses of water and efficiency

C2- Economical Criteria:

- Investment costs
- Operation and Maintenance costs
- Energy costs

C3- Environmental Criteria:

- Adequacy to water resources availability
- Affection to natural Vegetation and Wildlife
- Landscape and current status / modification

- Water quality protection (water delivered) / contamination risks

C4- Social Criteria:

- Impact on human life's losses
- LARAP requirements & Involuntary Resettlement
- Uncontrolled water use

The multicriteria analysis matrix is shown in the next table, along with the basic power consumption for each alternative (mainly at the PS and the WTP), and the overall timeline for construction works.

In the case of the yearly outflows and losses, a specific table is also included for these initial 6 alternatives. The analysis was carried out using the median available outflows from Hub Reservoir, that is 82 MGD (4.31 m^3/s)

The analysis is done over the initial six general alternatives put forward in January 2021.

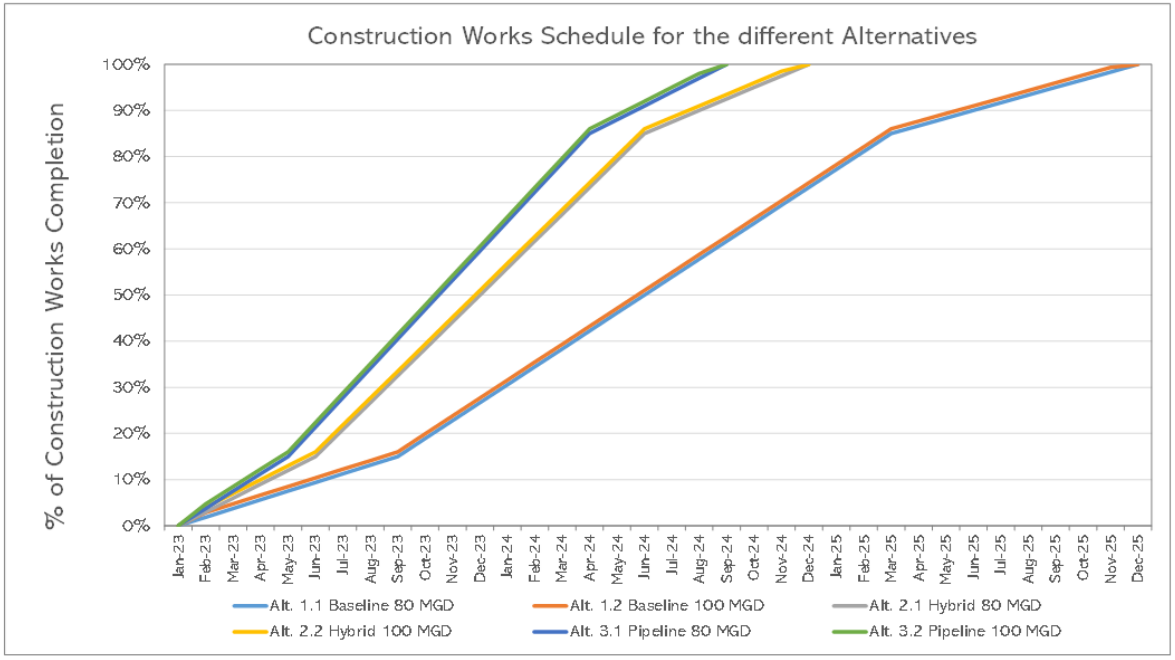
		1 st LEVEL CRITERIA	2nd LEVEL CRITERIA	Weight (W1)	Weight (W2)	Weight (W)	ALTERNATIVES PONDERATION						EVALUATION					
							ALT-1.1	ALT-1.2	ALT-2.1	ALT-2.2	ALT-3.1	ALT-3.2	ALT-1.1	ALT-1.2	ALT-2.1	ALT-2.2	ALT-3.1	ALT-3.2
1.-		**Technical**		22.0%	100.0%													
	1.1.-		Ease of construction works		15.0%	0.03	1	1	3	3	3	3	0.033	0.033	0.099	0.099	0.099	0.099
	1.2.-		Duration of works		15.0%	0.03	1	1	3	3	4	4	0.033	0.033	0.099	0.099	0.132	0.132
	1.3.-		Risks of unexpected events on schedule		25.0%	0.06	1	1	4	4	4	4	0.055	0.055	0.220	0.220	0.220	0.220
	1.4.-		New energy supply requirements		10.0%	0.02	3	3	5	3	3	1	0.066	0.066	0.110	0.066	0.066	0.022
	1.5.-		Ease of maintenance		15.0%	0.03	2	2	3	3	4	4	0.066	0.066	0.099	0.099	0.132	0.132
	1.6.-		Management complexity (Technical staff required)		5.0%	0.01	5	5	3	3	2	2	0.055	0.055	0.033	0.033	0.022	0.022
	1.7.-		Losses of water and efficiency		15.0%	0.03	2	2	4	4	5	5	0.066	0.066	0.132	0.132	0.165	0.165
2.-		**Economical**		34.0%	100.0%													
	2.1.-		Investment costs		50.0%	0.17	0.91	0.75	1.00	0.81	0.77	0.64	0.155	0.128	0.170	0.139	0.132	0.109
	2.2.-		Operation and Maintenance costs		30.0%	0.10	0.78	0.61	1.00	0.73	0.77	0.54	0.079	0.063	0.102	0.075	0.079	0.056
	2.3.-		Energy costs		20.0%	0.07	0.77	0.63	1.00	0.76	0.73	0.53	0.052	0.043	0.068	0.052	0.050	0.036
3.-		**Social**		22.0%	100.0%													
	3.1.-		Impact on human life's losses		50.0%	0.11	2.00	2.00	4.00	4.00	5.00	5.00	0.220	0.220	0.440	0.440	0.550	0.550
	3.2.-		LARAP requirements & Involuntary Resettlement		40.0%	0.09	5.00	5.00	4.00	4.00	1.00	1.00	0.440	0.440	0.352	0.352	0.088	0.088
	3.3.-		Uncontrolled water use (non-revenue water)		10.0%	0.02	1.00	1.00	4.00	4.00	5.00	5.00	0.022	0.022	0.088	0.088	0.110	0.110
4.-		**Environmental**		22.0%	100.0%													
	4.1.-		Adequacy to water resources availability		50.0%	0.11	5.00	3.00	5.00	3.00	5.00	3.00	0.550	0.330	0.550	0.330	0.550	0.330
	4.2.-		Impact on natural Vegetation and Wildlife		20.0%	0.04	5.00	5.00	4.00	4.00	2.00	2.00	0.220	0.220	0.176	0.176	0.088	0.088
	4.3.-		Landscape and current status / modification		10.0%	0.02	2.00	2.00	4.00	4.00	4.00	4.00	0.044	0.044	0.088	0.088	0.088	0.088
	4.4.-		Water quality protection (water delivered) / contamination risks		20.0%	0.04	2.00	2.00	4.00	4.00	4.00	4.00	0.088	0.088	0.176	0.176	0.176	0.176
			WEIGHTED SUM METHOD										**1.96**	**1.74**	**2.66**	**2.40**	**2.49**	**2.22**

BREAKDOWN OF POWER CONSUMPTION AND YEARLY COSTS FOR THE BASIC 6 INITIAL ALTERNATIVES (JANUARY 2021)

							0.08 USD/kWh
	Projected Water Flow (MGD)	Yearly Project Outflow (hm^3)	Key Facilities	Power Consumption (kWh/year)	Solar Plan Yield (kWh/year)	Power Provider Yield (kWh/year)	Power Provider Cost (USD/year)
Alt. 1.1 Baseline 80 MGD	75.7 MGD	125.55 hm^3	Pumping Station - PS (80 MGD) H=48m - 2,609 kW	22,858,870 kWh/year	7,765,843 kWh/year	15,093,027 kWh/year	1,207,442 USD/year
	75.7 MGD	125.55 hm^3	Water Treatment Plant Upgrade - WTP (80 MGD)	3,766,580 kWh/year	1,279,620 kWh/year	2,486,960 kWh/year	198,957 USD/year
Alt. 1.2 Baseline 100 MGD	75.7 MGD	125.55 hm^3	Pumping Station - PS (100 MGD) H=48m - 3,293 kW	28,850,885 kWh/year	9,801,510 kWh/year	19,049,375 kWh/year	1,523,950 USD/year
	75.7 MGD	125.55 hm^3	Water Treatment Plant Upgrade - WTP (100 MGD)	3,766,580 kWh/year	1,279,620 kWh/year	2,486,960 kWh/year	198,957 USD/year
Alt. 2.1 Hybrid 80 MGD	77.7 MGD	128.95 hm^3	Pumping Station - PS (80 MGD) H=35.43m 1890 kW	16,556,400 kWh/year	5,624,705 kWh/year	10,931,695 kWh/year	874,536 USD/year
	77.7 MGD	128.95 hm^3	Water Treatment Plant Upgrade - WTP (80 MGD)	3,868,379 kWh/year	1,314,204 kWh/year	2,554,175 kWh/year	204,334 USD/year
Alt. 2.2 Hybrid 100 MGD	77.7 MGD	128.95 hm^3	Pumping Station - PS (100 MGD) H=39.4m 2625 kW	22,995,000 kWh/year	7,812,090 kWh/year	15,182,910 kWh/year	1,214,633 USD/year
	77.7 MGD	128.95 hm^3	Water Treatment Plant Upgrade - WTP (100 MGD)	3,868,379 kWh/year	1,314,204 kWh/year	2,554,175 kWh/year	204,334 USD/year
Alt. 3.1 Pipeline 80 MGD	80.6 MGD	133.70 hm^3	Pumping Station - PS (80 MGD) H=51.75m 2760 kW	24,177,600 kWh/year	8,213,855 kWh/year	15,963,745 kWh/year	1,277,100 USD/year
	80.6 MGD	133.70 hm^3	Water Treatment Plant Upgrade - WTP (80 MGD)	4,010,899 kWh/year	1,362,622 kWh/year	2,648,276 kWh/year	211,862 USD/year
Alt. 3.2 Pipeline 100 MGD	80.6 MGD	133.70 hm^3	Pumping Station - PS (100 MGD) H=60.7m 4,043 kW	35,416,680 kWh/year	12,032,107 kWh/year	23,384,573 kWh/year	1,870,766 USD/year
	80.6 MGD	133.70 hm^3	Water Treatment Plant Upgrade - WTP (100 MGD)	4,010,899 kWh/year	1,362,622 kWh/year	2,648,276 kWh/year	211,862 USD/year

CONSTRUCTION DURATION FOR THE BASIC 6 INITIAL ALTERNATIVES (JANUARY 2021)

	ALT. 1.1 Baseline 80MGD	ALT. 1.2 Baseline 100MGD	ALT. 2.1 Hybrid 80MGD	ALT. 2.2 Hybrid 100MGD	ALT. 3.1 Pipeline 80MGD	ALT. 3.2 Pipeline 100MGD
Duration	3 years	3 years	2 years	2 years	1.75 years	1.75 years
Construction Technical Risk	VERY HIGH	VERY HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM
Land Acquisition & Power Supply Risks	VERY LOW	VERY LOW	LOW	LOW	HIGH or VERY HIGH	HIGH or VERY HIGH



PROJECTED WATER OUTFLOWS AND LOSSES FOR THE BASIC 6 INITIAL ALTERNATIVES (JANUARY 2021)

	Design Water Flow (MGD)	Median Water Resources (MGD)	Overall Losses (%)	Projected Water Flow (MGD)	Projected Water Flow (m^3/s)	Yearly Project Outflow (hm^3)	Yearly Project Outflow (Acre-foot)
Alt. 1.1 Baseline 80 MGD	80 MGD	81.8 MGD	7.5%	75.7 MGD	3.98 m^3/s	125.55 hm^3	101,787 A-F
Alt. 1.2 Baseline 100 MGD	100 MGD	81.8 MGD	7.5%	75.7 MGD	3.98 m^3/s	125.55 hm^3	101,787 A-F
Alt. 2.1 Hybrid 80 MGD	80 MGD	81.8 MGD	5.0%	77.7 MGD	4.09 m^3/s	128.95 hm^3	104,538 A-F
Alt. 2.2 Hybrid 100 MGD	100 MGD	81.8 MGD	5.0%	77.7 MGD	4.09 m^3/s	128.95 hm^3	104,538 A-F
Alt. 3.1 Pipeline 80 MGD	80 MGD	81.8 MGD	1.5%	80.6 MGD	4.24 m^3/s	133.70 hm^3	108,390 A-F
Alt. 3.2 Pipeline 100 MGD	100 MGD	81.8 MGD	1.5%	80.6 MGD	4.24 m^3/s	133.70 hm^3	108,390 A-F

CONCLUSIONS

From a technical point of view, the hybrid solution that combines the partial rehabilitation of the existing canal in the first stretch of the alignment (between the Head Regulator and PK 11+700) with a new pipeline in the last stretch (from that point until the Hub Pumping Station), plus an upgrade of the existing PS and WTP would be optimal.

The results of the multicriteria analysis also show that the Alternative 2.1 is the most suitable solution to be implemented. However, the GoS and KWSB consider of paramount importance the need to maximise the quantity of water available for Karachi at a given moment, combining Hub Reservoir with the water transferred through K-III. Therefore, the option of conveying 100 MGD to the water treatment plant whenever possible is highly prioritized by KWSB, and the selected alternative is 2.2.

Alternative 2.2 is ranked as the first alternative among the ones that include 100 MGD (5.26 m^3/s), and the water-stress condition that Karachi suffers in conjunction with the social impacts are higher order reasons that fully justify this choice.

ALTERNATIVES	RANKING
Alternative 2.1 (80 MGD)	2,66
Alternative 3.1 (80 MGD)	2,49
Alternative 2.2 (100 MGD)	**2,40**
Alternative 3.2 (100 MGD)	2,22
Alternative 1.1 (80 MGD)	1,96
Alternative 1.2 (100 MGD)	1,74

Table 9: Results of the Multicriteria analysis

5. DEVELOPMENT OF THE SELECTED ALTERNATIVE

This chapter aims at describing the engineering solution already selected as the one that best suits the purpose of this project. The design is based on the various studies and surveys (topographical and geotechnical mainly) carried out and already described in section 2.

All elements and equipment included in this due diligence report are a proposal for information purposes. At a later stage, the Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design. All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes, as well as the RfPs.

This proposed design is also considering the provision of fences along the canal alignment, pipeline section, Hub pumping station (PS), water treatment plant (WTP), and solar PV plant. The facilities will incorporate CCTV WIFI enabled cameras and the concessionaire will be responsible for ensuring the proper security.

5.1. Description of the Selected Alternative

The alternative finally considered is the hybrid one for 100 MGD (alternative 2.2). As explained in previous chapters, the analysis of the longitudinal profile shows a section with excessive flow velocities due to the slope. At the same time, it has been observed that the orography of the first 12 km from the Head Regulator is quite flat within the existing RoW, something that will require deep excavations to give a pipeline the proper energy gradient if the alignment remains within the existing RoW.

To avoid these issues, the selected alternative would begin with the existing canal from the Head Regulator, and they would be properly rehabilitated. After those first kilometers, a pressure chamber with proper rakes would be located at the end of the canal section and a pipeline would take over, connecting with the existing pumping station.

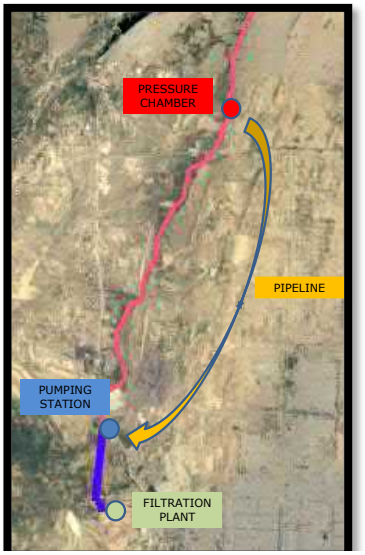


Figure 39. Selected alternative description.

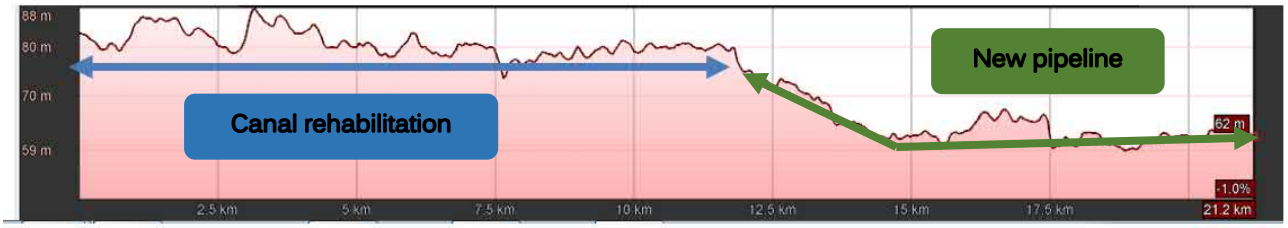


Figure 40. Longitudinal profile for the selected alternative

This solution considers:

- Rehabilitation of the first 11.7 km of the canal from the Head Regulator. This repair is considered because this part of the canal is very flat and does not present excessive velocity problems.
- Replacement of the canal sloping section by the installation of a new pipeline This new pipe will have a diameter of 1900 mm and a length of 9.8 km.

- Construction of a new pumping station by the replacement of elements and by the elimination of the pre-treatment system which will be placed it in the pressure chamber.
- Upgrade and rehabilitation of the water treatment plant.
- Replacement of the existing raising mains pipeline.
- Construction of a new Photovoltaic Solar Plant and the required transmission power line

5.2. Water Conveyance Infrastructure

The water conveyance infrastructure would integrate two different parts:

- From the Head Regulator to PK 11+700: Rehabilitation of the existing canal
- From PK 11+700 up to the Hub Pump Station: New pipeline for 9,800 m

Thus, the scope of works starts with the rehabilitation of the Karachi Water Canal from the Head Regulator (Lasbela Canal derivation) to PK 11+700 where an intake chamber shall be built to feed the 1900 mm diameter GRP pipeline that would run parallel to the existing channel, which will ultimately be decommissioned in this last stretch. The existing RoW shall also be fenced to ensure the proper security and several water offtakes for the utilities mentioned in a previous chapter shall be implemented.

REHABILITATION OF THE EXISTING CANAL:

For the rehabilitation of the existing canal, a standard section is proposed with the following structure:

- Conditioning of the embankment by clearing and shaping the slopes.
- Conditioning of the canal lining by means of a 0.10 m layer of concrete (fc 3000 psi/ 20 MPa).
- Waterproofing of the sections by means of 3 layers of geotextile sheets of 300 S/cm² and 2 layers of PVC waterproofing sheets of 1.5 mm thickness.

- Upgrade of the service roads, 3.0 m wide, on a 20 cm thick granular base, with a 2% slope, a curb on the sides of the canal, and longitudinal drainage.
- Transversal drainage works (culverts) according to needs.

The following typical section for the channel section is proposed.

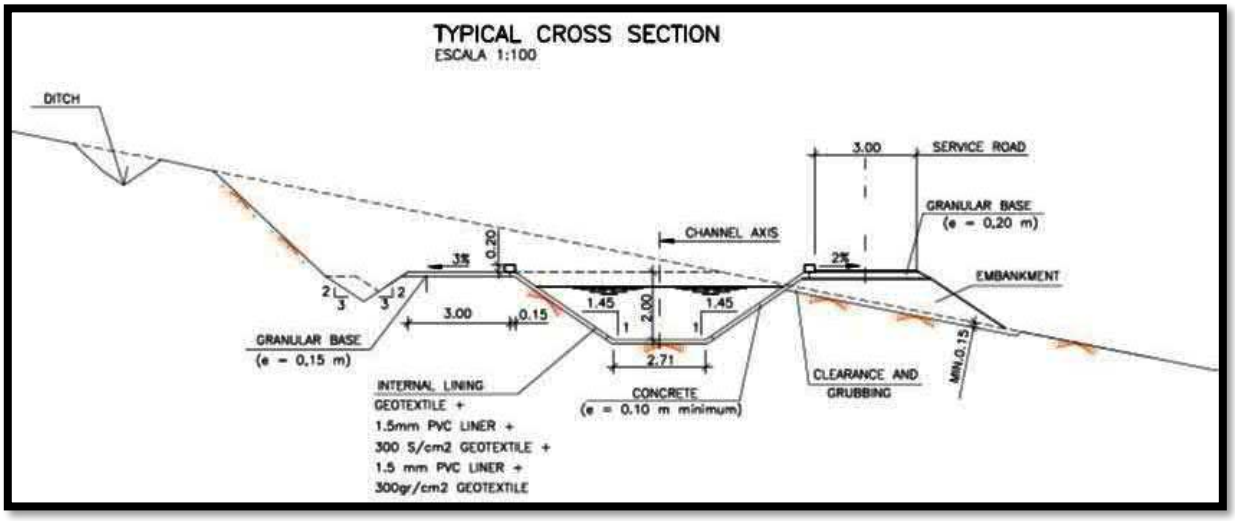


Figure 41. Typical Canal rehabilitation section.

This proposed section pursues the following goals:

1) The sections in cut have a berm of 3 m of protection to avoid entrance of debris or any element in the canal. In addition, it has a longitudinal gutter and a dich in the upper zone of the slope (in higher cuttings). The berm can be used as roadway in some areas.

Figure 42. Example of eroded and collapsed Hub Canal sections

2) The service road is usually arranged on the right side. A granular base is proposed, although greater protection of the pavement may be desirable to facilitate operation and maintenance.

Figure 43. Condition of the canal roadway after rainfall

3) The berms and roadway should incorporate transverse slopes to prevent rainfall from entering the canal.

Regarding the construction procedures, they will be conditioned by the need to ensure the flow of water to Karachi. The following procedure could be used:

- Step 1: Isolation of a stretch of 250 m by arranging a cofferdam and the implementation of a temporary bypass to ensure the flow of water.
- Step 2: Rehabilitation of this stretch.
- Step 3: Demolition of the cofferdam and construction of a new one for the next stretch to be rehabilitated downstream of this first one.

For the step 1, two different approaches could be considered:

- Construction of an earthen cofferdam, which is the method already used in the rehabilitation of the WAPDA canal. This is a known constructive procedure although it is labor-intensive and time-consuming.

Figure 44. WAPDA canal rehabilitation, earth storage

Figure 45. WAPDA canal rehabilitation, cofferdam detail.

- Use of a prefabricated cofferdam (usually metallic) which ensures watertightness by means of neoprene joins. This option requires workshop fabrication of the precast element but reduces the on-site time, resulting in a faster progress of the works.

Figure 46. Xúquer-Turia Canal Rehabilitation (Spain)

Figure 47. Xúquer-Turia Canal (Spain). Option for a Partial Rehabilitation

Additionally, for step 2, the following construction methods can be used:

- Traditional method, carrying out the repair work manually.
- Industrialized method with the use of machinery to facilitate the concreting works.

Figure 48. Options for Canal Rehabilitation

REHABILITATION OF THE AUXILIARY INFRASTRUCTURES:

During the field work and inspection of the different existing infrastructures along the canal, such as bridges and aqueducts, a considerable deterioration has been detected in a large part of them. Therefore, their upgrade must be considered as part of the rehabilitation works for the canal.

More precisely, after analysis, based on visual appraisals, it is recommended the demolition of the last aqueduct, which lies within the new pipeline stretch, and the rehabilitation of the other structures, as they have a design considered to be very deficient and whose collapse could put the whole system at risk. This risk is considered critical and should be reduced as much as possible. For this reason, these rehabilitation and construction works have been included in the BoQ.

Figure 49. Damages in bridges and aqueducts

The aqueduct identified as nº 11 is a clear example of a structure which, due to its current condition, should be demolished and reconstructed. However, this will not be necessary as this aqueduct lies in the stretch of the new pipeline. For the rest of the existing aqueducts, the following is proposed:

- Cleaning and removing any damaged concrete from inside of the aqueduct.
- All seepage hole and pits must be grouted with crystalline cement mortar or epoxy grout.
- All the inside walls and slabs should be coated with crystalline cement or epoxy-based water proofing material (CC plaster in the thickness of at least 20mm).
- On the outside, plastering with waterproof mortar and/or by jacketing the structure if there is considerable damage to concrete and steel.
- The jacketing work should also be carried out on the columns wherever required.

CONSTRUCTION OF THE NEW PIPELINE:

For the construction of the new 1900 mm diameter GRP pipeline, all special elements (offtakes, elbows, etc.) are envisaged with the same material. Likewise, the pipeline is assumed to come along with the appropriate elements of regulation and control, housed in concrete manholes with enough volume: sectioning valves, air-valves, drains and flowmeters.

The **pipeline** alignment is proposed within the existing RoW of the canal, but as far as possible from the canal to avoid problems during excavation and subsequent installation of the pipeline. It has a total length of 9 785 m until getting to the Hub pumping station (if it is placed over the Old Pump House site, in case of a booster pump station).

The **intake chamber** for the pipeline will have a gate and an **electromagnetic flowmeter** housed inside a concrete manhole, installed in the first meters of the pipeline. Electromagnetic flowmeters are based on the electromagnetic field generated by the reels that constitute it and the measurement of an electrical potential, detected by two electrodes when a conductor liquid circulates in the pipe. This electrical potential is proportional to the fluid speed, and it is processed by the electronic components of the flowmeter.

Tri- functional air valves are arranged in the highest points of the pipeline alignment, at intermediate locations, and in characteristic points, according to what is included in the drawings (see Annex 3). These elements allow the air entrance and air removal during the filling and emptying operations of the pipeline, along with the removal of small quantities of air that can be accumulated during normal operation.

The pipeline shall have 17 double air valves with a diameter of 150 mm. These elements will be placed in manholes to allow for their installation, access, manipulation and maintenance. The designed manholes will have a dimension of 2.20 m x 1.60 m. The connection between the air valve shafts and the main pipeline shall be made by means of GRP grafts, and each air valve must include a gate valve of the same nominal diameter.

Wash outs that allow the emptying of the pipeline are proposed in the low parts of the pipeline alignment, and there are a total of 10 units. Their function is to facilitate repair works, maintenance, installation of new elements, etc. The wash outs have been designed by taking into account the length of the pipeline stretches and the volume of water that can remain inside that pipeline stretch.

All the drains are displayed in manholes made up of two parts, one that is dry and other wet. The dry well has a double gate valve, whereas the wet well collects the drainage flow and raises it to the level at which it is

discharged out into a natural stream. As in the case of the air valves, the branch that connects the main pipeline to the drain shall be implemented with a GRP graft.

Finally, the total length of the pipeline stretch has been divided into three sections by installing 2 **sectioning valves,** at approximately 1/3 and 2/3 of the total alignment.

All hydraulic calculations are included in a specific chapter of **Annex 2**.

5.3. K-III Connection to Hub Pumping Station

Currently, waters from both K-III and Hub Canal get together into an approach canal prior to the pump intakes. Both K-III and KWC are currently free-surface flow hydraulic infrastructures. K-III is a 100 MGD canal coming from Keenjhar Lake, completed in 2006 and 80 MGD are derived to the KWC system when there is water scarcity at Hub Reservoir. All incoming water is pumped from the "New Pump House", commissioned in 2006, to the water treatment plant.

Supplementation of water from K-III has been made part of the project to ensure that District West gets a consistent water supply of 100 MGD.

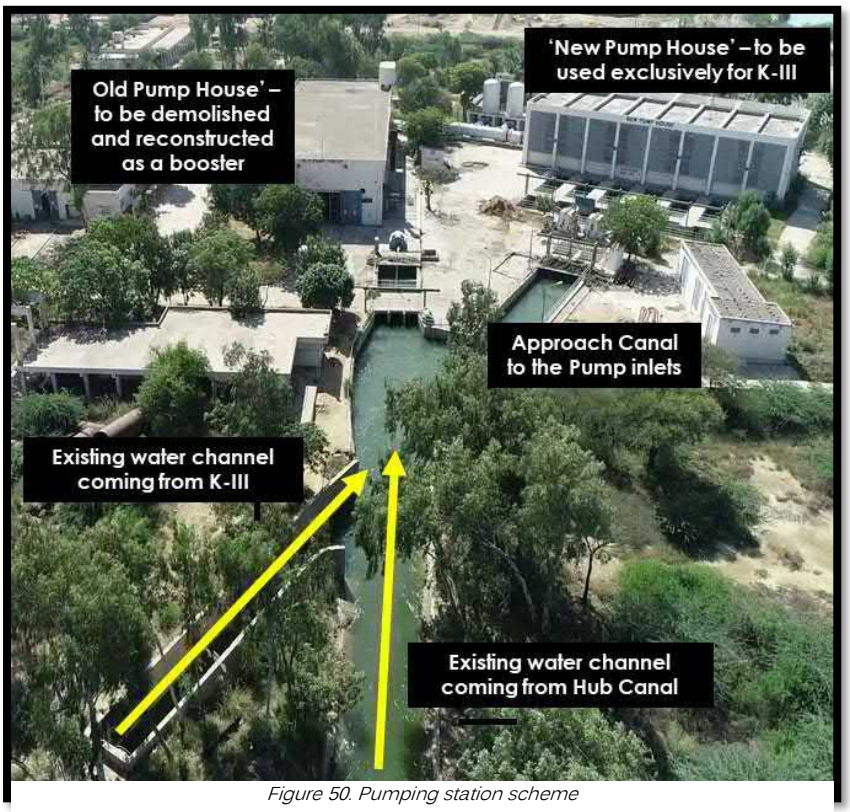


Figure 50. Pumping station scheme

By means of a proper metering and SCADA system, the private sector shall accurately measure inflows from Hub Canal and timely address any shortfalls from K-III.

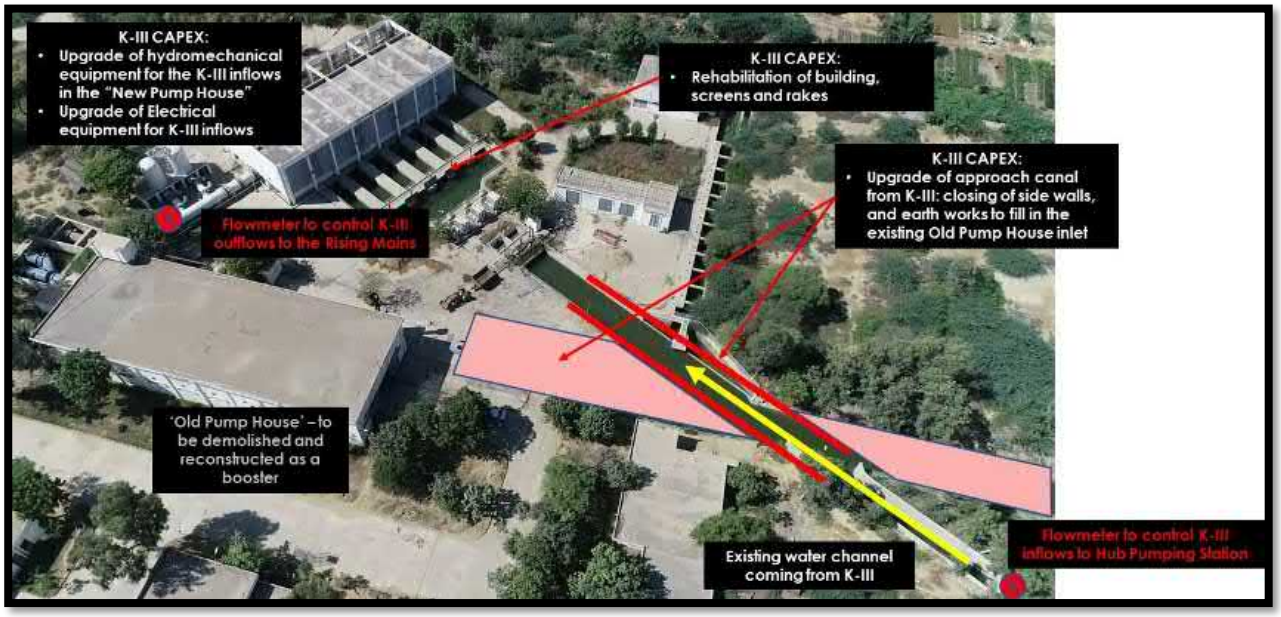
This arrangement ensures the complete transfer of operational risks of Hub Canal water system to the private sector with a clear allocation of responsibilities.

Based on the water quality tests completed on April 9th, 2021, the integration of K-III waters to the Hub system should not have a significant impact on the KWC facilities, other than the necessary rehabilitation works and the maintenance tasks. In any case, it is advisable that regular water quality tests are carried out for K-III waters, including WHO typical parameters.

No additional CAPEX or OPEX would be required for the WTP, though variable OPEX shall change to accommodate the additional treatment needs if K-III water arrived with a very poor quality.

With respect to the PS and Rising Mains, the inclusion of the K-III waters in the PPP project has the following implications:

- From a hydraulic point of view, and in order to take advantage of the power supply savings involved in this design proposal, the new KWC water conveyance system and the K-III must remain separate until waters reach the distribution chamber at the WTP:
    - The new KWC design is leveraging the topography of the area with the new GRP pipeline (pressure-flow), and the "Upgraded Pump House" will work as a booster in line with the new pipeline, thus saving around 1,000 kW at the design flow determined by KWSB and the GoS (that is 100 MGD, or 5.26 m^3/s). The upgraded pump house is finally located over the existing "Old Pump House", which shall be demolished and properly refurbished.
    - K-III waters currently get to the existing "New Pump House" with free-surface flow, and they shall be kept this way in the future. The peculiarity is that after the rehabilitation of the KWC, the K-III waters will be pumped alone from the existing pump house.
- The "New Pump House" was commissioned in 2006 and it is approaching its lifespan. If K-III is to be included in the KWC PPP, a complete upgrade of this pump house will also be needed. Apart from minor civil works, the main component will be the replacement of the hydro and electromechanical equipment, which should be done according to the K-III inflows exclusively. That means the number and type of pumping units at the existing "New Pump House" will change, and it is for the Concessionaire to make a decision in the detailed design.
- The future hydraulic circuits for K-III and KWC will be kept separate by means of a new valve chamber located downstream of both pump houses and connecting with the Rising Mains. With proper valve elements and operation, it will be possible to keep both hydraulic routes separate and this valve chamber will be like a "traffic regulator with traffic lights and signs to guide the traffic flow".
- At the exit point of this new valve chamber, we shall find the Rising Mains. One pipeline will convey the KWC waters, and the second pipeline will carry K-III inflows separately until they reach the distribution chamber at the WTP. The Metering/SCADA system envisaged will be able to measure the exact inflow that gets to the WTP from each pipeline.



Finally, it is worth the CAPEX-OPEX changes derived from the inclusion of K-III in the scope:

- **CAPEX**
  - Upgrade of hydromechanical equipment for the K-III inflows in the "New Pump House"
  - Upgrade of Electrical equipment for K-III inflows
  - Rehabilitation of building, screens, and rakes
  - Upgrade of approach canal from K-III: closing of side walls, and earth works to fill in the existing Old Pump House inlet
  - Integration in the metering and SCADA system (flowmeters and PS equipment)
- **OPEX**
  - Impact on the power consumption depending on the PS performance.
  - The K-III Upgrade of the New Pump House will have a power consumption that will depend on the design flow, given the hydraulic conditions.

5.4. Pumping Station

The solution demanded by KWSB involves the combination of waters from K-III and the Hub system, both of which will be conveyed from the pumping station to the water treatment plant. This due diligence report proposes that this is accomplish using to separate hydraulic circuits:

- **Hub Canal Hydraulic Circuit (HHC):** The Old Pump House shall be demolished and a new one will be reconstructed. This new facility will work as an in-line booster pump station that saves energy by harnessing pressure flow from the new pipeline, thus optimizing the energy consumption.
- **K-III Hydraulic Circuit (KHC):** The existing New Pump House will be exclusively used for pumping K-III waters.
- A **new valve chamber** is proposed to be implemented downstream of the pump houses and it will keep both hydraulic circuits separate until that point, but it will allow conveying waters to either rising mains.

Regarding the existing **New Pump House**, the proposal is to use for the K-III outflows exclusively, with a median flow of 18 MGD (0.947 m^3/s) and a maximum flow of 80 MGD (4.209 m^3/s), which is the total capacity of the K-III connection with the Hub system. Out of 6 pump units, right now, this pump house has 2 units out of order, and the fact that pumps in operation are close to the end of their useful life, highlight the need to seriously considering the **replacement of the mechanical equipment** and associated valves. Replacing old pumps with new ones implies the following advantages:

- Lower energy consumption by considering high energy efficiency pumps. Efficiency above 85%.
- Use of engines with the latest efficiency technology.
- Highest guarantee during a PPP contracting period. Lower O&M costs.

Also, chain raked screens and travelling band screens shall be replaced in this existing new pump house.

Unfortunately, no additional information or data is available with regard to the nee pump house, other than the inspection report included in **Annex 2**. To fully quantify the current performance of the pumps, it is suggested that KWSB considers the possibility of carrying out proper performance tests whenever possible. This implies having a minimum metering system to measure the performance of the system with different outflows, and recording power consumption (input kW), pump head (in meters, that is energy per unit weight of the fluid), and flow (m^3/s).

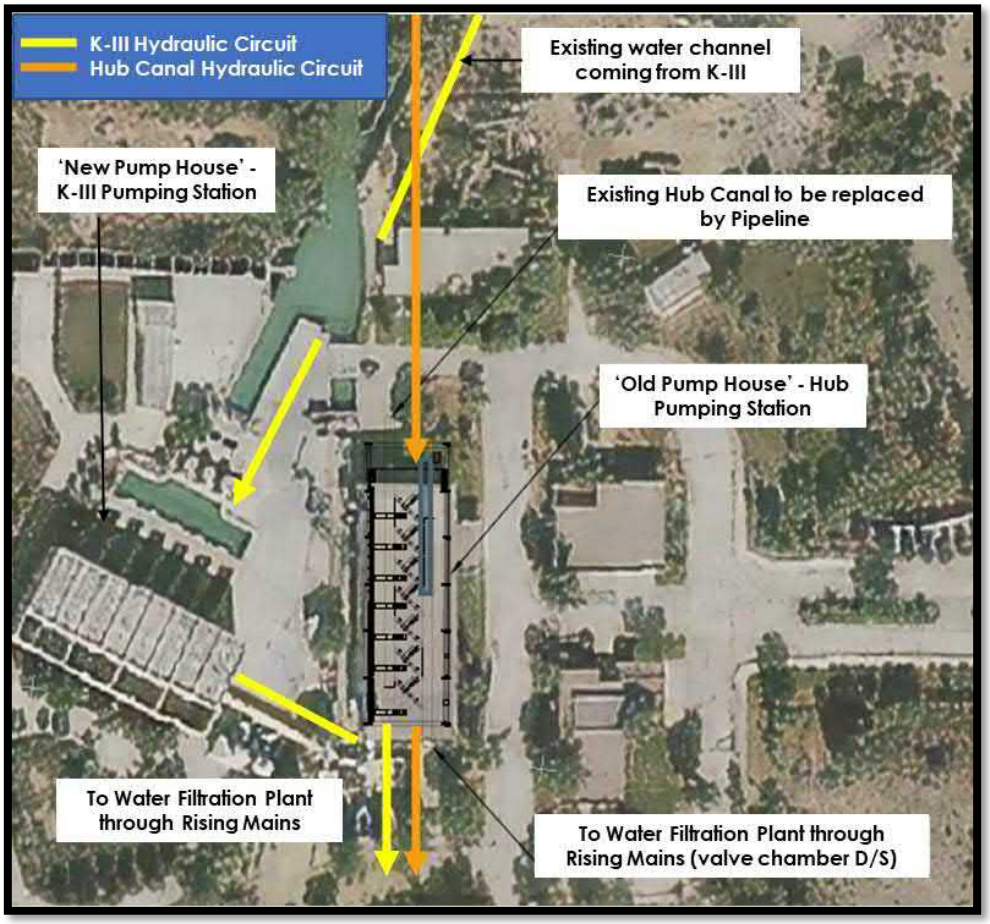
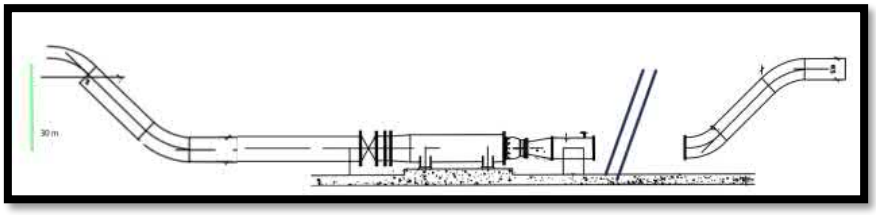


Figure 51. Pumping stations scheme

The potential Concessionaire will have to analyse the number of pumps units that are replaced in the existing new pump house, accounting for the potential outflows and use of K-III. That could be combined with a rental agreement with a manufacturer to account for drought events when the K-III connection may completely substitute the Hub system (likely to only happen from 2 to 3 times in a 20-year concession) In any case, in the CAPEX analysis full substitution of the units to pump the 80 MGD capacity of K-III has been considered.

Finally, the construction of a total **new booster pumping station** is proposed to convey waters from the Hub canal and new pipeline to the WTP. For this pumping station, two options are proposed to the potential developers:

- Construction of a traditional pumping station (building, pumps, etc.) for split case pumps.
- Provision of a submersible booster pump set. This in-line submersible solution implies that no new building is required (CAPEX reduction and environmental benefit), as the system is installed directly in a refrigerated casing.



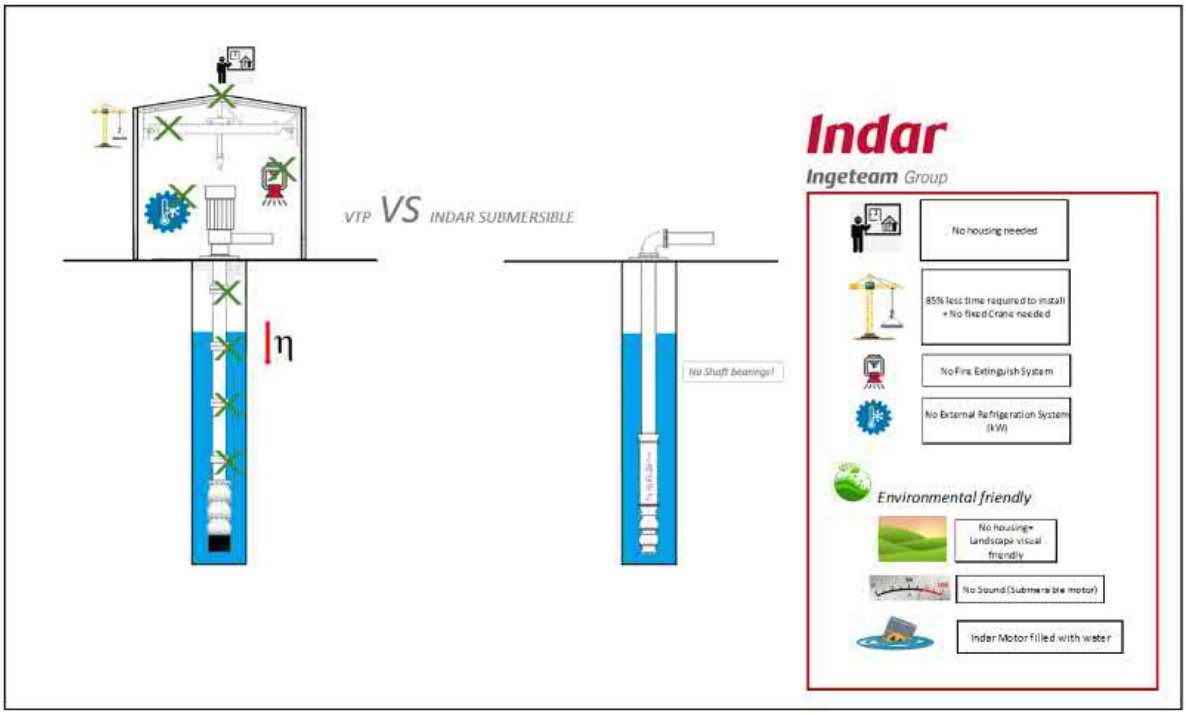


Figure 52. Submersible booster pump set option

Although both options are feasible, only the traditional option has been considered for the CAPEX-OPEX estimations. Thus, the proposed pumping station takes the water from the Karachi Water Canal to the Hub Water Treatment Plant through the raising mains (2x GRP DN1900).

The new infrastructure will be located on the site of the Old Pump House and the dimensions of the proposed building are 54,50 m x 16,70 m (the same width as the Old Pump Station, but 5,5 m longer).

Inside the building, 6+1 horizontal pumps for a total design flow of 5.26 m^3/s (100 MGD) are proposed. Upstream of each pump, a butterfly valve with a dismantling joint shall be installed.

The discharge of the horizontal pumps connects directly to a manifold. Each horizontal pump discharge pipe shall have a check valve and an insulation valve. Outside the building, the manifold shall have an electromagnetic flowmeter to check the flow that is pumped. The size of the flowmeter and pipe shall be adjusted to the fluid minimum speed when only one pump is running. The manifold also connects with a surge vessel to avoid a pipeline vacuum in case of a sudden pump shutoff. Additionally, the pipeline shall have three-functional valves to release the air (dissolved or during start-up) and to let air inlet during emptying and filling processes of the manifold.

The next image shows a scheme of the whole system, and all the proposed design is portrayed in the **Annex 3** drawings.

Figure 53. New Hub Water Canal System

This solution for the new booster pumping station has been proposed considering the following factors:

- Technical feasibility of the installation.
- Number of pumps.
- Total cost analysis of the installation.
- Suction power analysis of the pumps.
- The number of pumping units has been defined taking into account the basic measurements of the pumps, their separation, the size of the engines and the calculated minimum submergence or net positive suction head available (NPSH).
- The design of the pumping stations fulfils that NPSHa > NPSHr in order to avoid the phenomenon of cavitation in the equipment.
- Permanent-type operation units.
- Materials of all equipment fits the requirements of fluid and chemical composition to avoid excessive wear.
- Lifting and auxiliary equipment has also been considered.

All hydraulic calculations are included in a specific chapter of **Annex 2**.

5.5. Rising Mains

In relation to the three main pipelines that connect the pumping station (PS) with the water treatment plant (WTP), it has not been possible to undertake any survey in the area to make a direct assessment of the

condition of this pipeline. In addition, no original drawings or design documents are available for consultation. However, at the request of KWSB, the total replacement of these pipelines is considered in the project. Annex 2 includes the field reports carried out by the local collaborator, where KWSB personnel report poor performance of the rising mains and bursts.

For the design of the new rising mains, two pipelines of 1900 mm diameter in a GRP material have been considered, so that synergies with the pipeline stretch in the canal are achieved. Additionally, it is considered necessary to install two flow meters in the mains to check any potential leaks. One flow meter should be installed at the outfall of the pumping station and another one at the entrance of the water treatment plant.

Finally, the **study of cathodic protection for the pipe has been partially carried out with the soil resistivity tests but further analyses are recommended** within the maintenance tasks, including some electrical potential measurements in the pipeline, visual inspections and LRUT tests (long-range-ultrasonic-tests), in case the concessionaire decides to implement a steel pipeline instead of the proposed GRP material.

5.6. Water Treatment Plant

The existing Water Treatment Plant shall be upgraded to be used in the new system, taking into account that 80 MGD are currently entering the facilities, though the WTP is not able to fully deliver drinking water that complies with the WHO or Pakistani quality standards (both include IFC standards). Most parts of the WTP are more than 20 years old and, unfortunately, a proper maintenance of the facilities has not been fully accomplished, with many pieces of equipment not working and others that have never been replaced.

The final design flow for the future water treatment plant is 100 MGD (5.26 m^3/s), most of the time combining waters from the Hub canal and the K III connection.

Since the Hub system can convey 100 MGD (around 10% of the time), the inclusion of K-III waters into the system should imply no additional CAPEX for the WTP, though variable OPEX shall change to accommodate the additional treatment needs (more chemicals and power supply, in essence) if K-III waters arrived with very low quality. In this regard, a specific water quality test has been carried out on K-III waters on April 9th, 2021, and the following conclusions can be drawn:

- K-III does not carry brackish water, because it has around 500 mg/l of total dissolved solids (brackish waters would include more than 2,500 mg/l).
- In any case, we find a "hard water", with values between 182 and 190 mg/l. These figures are higher than the KWC waters, but neither one seems to be corrosive water.
- The K-III water does not have a high concentration of aluminum or heavy metals.
- Microbial contamination is to be expected in these waters, even though these results are not ready for the K-III samples. The coliform analyses that were carried out at KWC gave low values because these waters, either in a lake or a reservoir, are subjected to natural processes such as the incidence of ultraviolet light from the sun, predation by other bacteria, etc. However, this does not mean that these waters cannot include other microorganisms in the form of cysts, helminth eggs or viruses (which are more resistant to natural processes). In any case, the coagulation-flocculation and disinfection treatment carried out in the filtration plant should account for this issue.

- In the KWC water quality tests we carried out on September-18-2020 we had no E. Coli in any sample, and no total coliforms at the Hub WTP reservoir (some present at the Head Regulator and distribution chamber)
- Due to those results, among other details, on October-1-2020, the Consultant requested that 3 additional samples be taken before the PS, at the WTP distribution chamber and the WTP reservoir. This time, all samples before the disinfection treatment showed the presence of E. Coli and total coliforms, but they were absent at the WTP reservoir sample.
- Around that time, early October 2020, the Consultant suggested that additional water quality tests be taken for the K-III waters, provided that they are also treated at the KWC filtration plant.

- The excess of aluminum we found in the KWC waters could be fixed in the final process of the filtration plant, by means of adding NaOH, something that apparently was foreseen by KWSB personnel (according to the field visits).
- Finally, the existence of chloroform in the K-III water analysis, prior to being processed in the plant, is surprising. It does not seem to be dangerous (<100 µg/l), although it could indicate the presence of an industrial discharge at some point upstream.
- In any case, all these conclusions are based on just 2 samples and it is advisable that regular water quality tests (other than the ones carried out at the WTP laboratory) are carried out as validation and comparison tests, including WHO typical parameters.

This design proposals have been analysed taking into account the lowest environmental impact and investment cost using the existing plant infrastructure. The Consultant assumes that by replacing all mechanical equipment, the energy cost is likely to be improved, along with it the operational cost. For the rehabilitation, the following works and tasks are proposed:

REHABILITATION	NEW ITEMS
• Replacement of all mechanical equipment, pipes and valves • Replacement of all electrical equipment and generator, • Change of the "average" and the existing aeration system in the filters, • Rehabilitate the chemical building by changing tanks, pipes, pumps and valves. • Check/rehabilitate civil works on faulty tanks and buildings	• Introduce flow meters, instrumentation (pH, turbidity, residual chlorine, etc.) and SCADA in the plant. • Expand the filters area with 4 more new filters (total 20 = 16 existing + 4 news) + new pumps and blowers for these filters. (Nº 2 layout below) • New Sludge building with sludge pumps + mechanical decanter + polielectrolite pack + poliectrolite pumps + sludge storage (Nº 1 layout below) • Rehabilitation of reservoir tank (Nº 3 Layout below)

Table 10: Items necessary for the WTP Rehabilitation

The following figure, layout, shows the rehabilitation works proposed (yellow) and the new elements (in blue) required to increase the flow rate to 100 MGD.

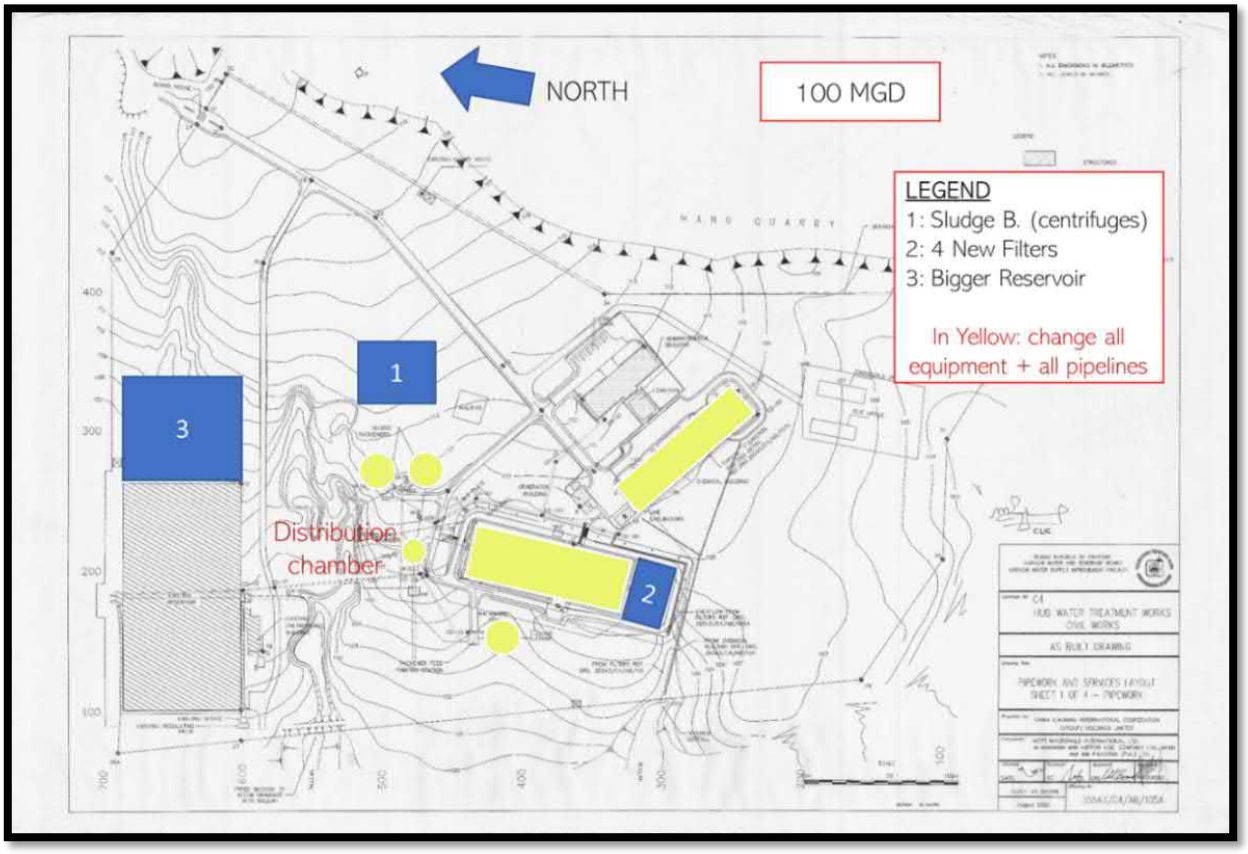


Figure 54: Layout of WTP Update

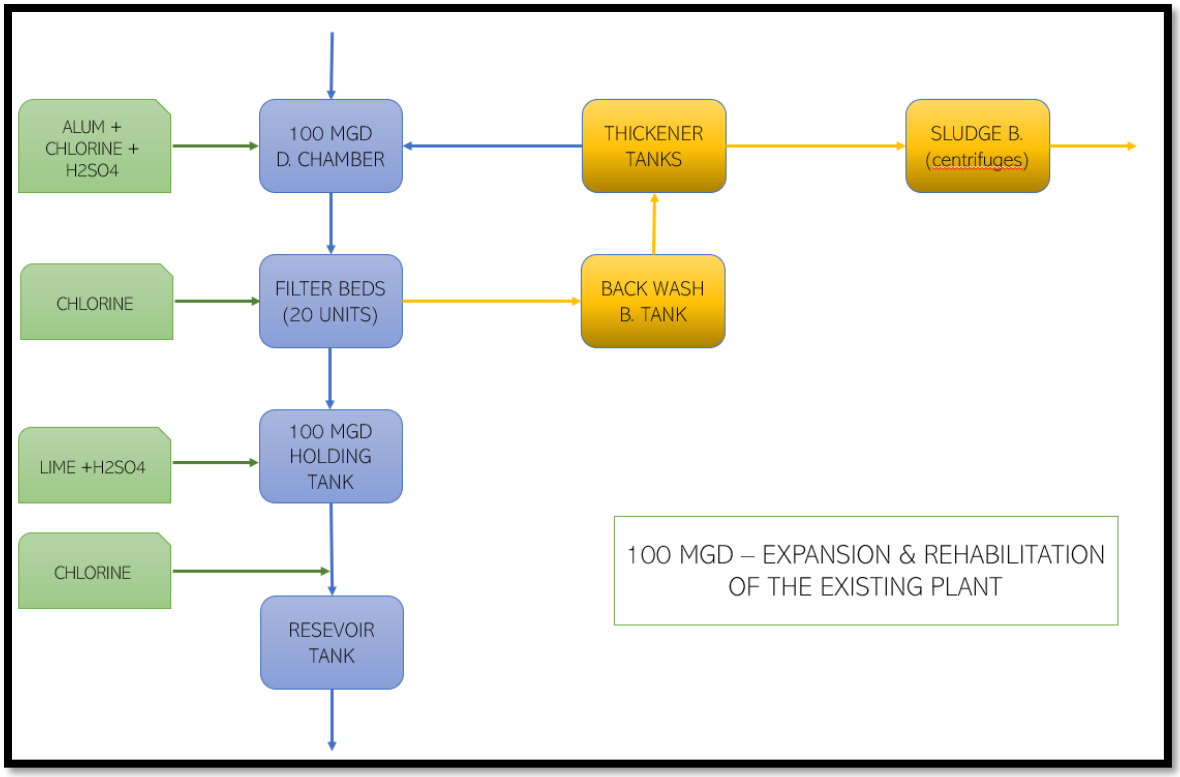


Figure 55: Flow Diagram for WTP Update

Thus, the following elements shall be considered in the detailed WTP design:

WATER LINE:

Water coming from the upgraded pumping station (K-III) and the new booster pumping station shall be received in the existing **Distribution Chamber,** which will have to be enlarged in order to operate for 100 MGD. Additionally, replacement of the existing screen for an automatic one and introducing a waste tank is needed.

In this distribution chamber, the water will be dosed with Alum, Chlorine and H_2SO_4. This dosage corresponds to a first pre-treatment. An inlet flow meter and instrumentation would be introduced to automatize the pre-chemical dosing and the existing dosing pipelines would have to be replaced due to their poor condition.

From this chamber, the flow will pass to **sand filters** in which the aim is to remove the suspended solids by passing the fluid through a filter bed (sand). This sand filters must be enlarged by:

- 4 **new filters** will be constructed of the same size as the existent ones, to increase the design flowrate from 80 MGD to 100 MGD.
- The state of the **underdrain systems** is unknown and must be checked. Retrofitting of the underdrain systems of all, or just some of the filters, may be needed.
- The condition of the **filter media** is very important. Replacement of media could be needed for all or some of the filters.
- All the **backwashing system equipment** has surpassed its design life span so, new blowers, pumps and auxiliary equipment are necessary. The size and technical specifications for these units in order to achieve a correct cleaning of the sand filter beds must be provided by taking into account that there are 16 filters in operation and 4 more are proposed to be constructed. The Concessionaire shall decide in the detailed design whether the current number of blowers and pumps units is sufficient or should be increased in view of the number of filters to be washed per day.

From the filter beds, the water will be conducted to a **holding tank** were lime + H_2SO_4 will be dosed and, finally, the flow will arrive to the **reservoir tank**. Both tanks should be resized to hold 100 MGD.

Finally, it must be noted that the right **dosing of chemicals** is very important for the optimum treatment of water. It would be necessary to replace all chemical pumps, mixers, storage tanks, chlorination system, pipelines, and valves. The sizing and technical specifications of the dosing pumps and ancillary equipment will need to be recalculated to allow for the treatment of 100 MGD of water with the following chemicals:

- The correct dosing of **coagulant (alum)** will allow the retention of most colloids by the sand filters decreasing the organic content of water. This leads to less formation of disinfection by-products after chlorination. The dosing system shall allow an alum dose between 20 and 60 mg/l of alum.
- **Sulphuric acid** shall allow to adjust the pH value to the optimum coagulation range of 6.0 to 6.8.
- **Lime** will be used to adjust the pH of the treated water, if needed.
- **Chlorine dosing system** must provide dosing at the distribution chamber and at the effluent of the plant, before entering the treated water tanks. Shall be sized for providing a dose of at least 2 mg/l of free chlorine in the treated water and 0,5 mg/l of free chlorine in the distribution chamber. The dosing

of chlorine must be done taking into account that THMs concentration will not exceed the limit established by international regulations for drinking water such us WHO regulations.

Additionally, it would be necessary to introduce flow meters and instrumentation to automatize the pre and post chemical dosing.

SLUDGE LINE:

The sludge line starts at the **washwater balance tank** which must be sized so it can hold the washwater coming from the filters. The Concessionaire shall determine in the detailed design whether more than one filter is to be washed at the same time and taking this into consideration, whether the capacity of the existing wash water balance tank is sufficient.

Feed thickener pumps must be sized to send the washwater to the sludge thickeners with a flowrate that allows hydraulic and mass loading rates within adequate limits for a good thickening of sludge.

Then, the sludge arrives at the **thickener gravity tanks**. In this respect, the sludge thickeners must have enough capacity to separate and thicken the sludge carried by the filters washwater. The thickened sludge shall have the necessary concentration (minimum 3% dry mass) to be sent to the new centrifuges for dewatering.

To improve the current performance, it would be necessary to replace the scrapers, sludge thickener pumps, pipelines, and valves. In addition, it would be necessary to introduce flow meters and instrumentation to automatize the unit process.

Finally, a new **sludge building** shall be constructed:

- The **centrifuges** and all auxiliary equipment shall be sized according to the estimated sludge production. A **dewatered sludge storage system** will be provided, so the dewatered sludge can easily be loaded into trucks for its evacuation to designated areas outside the plant.
- **Centrifuge feed pumps** must be selected according to the capacity of the centrifuges installed. Progressive cavity pumps are advised.
- For the sludge dewatering, a **polymer system** preparation and dosing shall be designed.
- The dewatered sludge must be sent to a storage area or silos from where it can be evacuated from the plant. Adequate transport and storage systems must be proposed.

AUTOMATION AND SCADA:

The automation system is out of service. Automation and SCADA systems must be provided to monitor and automate the processes:

- Automatic filters backwash system
- Automatic chemical dosing
- Automation of pumping systems
- Flowrates and level measurement
- Monitoring of water quality: turbidity, conductivity, pH
- Automation and monitoring of the sludge dewatering system.

5.7. SCADA and Metering System

The overall SCADA system shall integrate all data from the PS, WTP, pipeline and canal facilities, because it is highly advisable to centralise and integrate the WTP, Pumping Station, and the Canal-Pipeline SCADA in a Central Control Unit. This Central Control Unit shall include, at least, the following systems:

- Automatization of main and sectoring gates
- Water level sensors at gates
- GRP and/or mobile communication equipment
- Level, pressure sensor and flowmeters
- Integrated SCADA (canal, Pump station and WTP)

OPERATION PHILOSOPHY:

The **Software** of the centralized SCADA system for water management, operations administration, and customer service shall allow:

- The management of the canal gates and level sensors, within the WAPDA main canal, the Head Regulator, and the KWC stretch.
- The management of the new pipeline and flowmeters.
- The management of the Pump Station.
- The management of the Water Treatment Plant.
- The management of the Photovoltaic Plant.

It shall provide a modular and scalable architecture to enable specific modules to be easily and quickly installed and configured. The new SCADA shall be located at a Central Control Unit (CCU) at a new or adequate room at an accessible site (Pump Station or WWT).

It shall be designed specifically for water districts and based on specific software related to water demand management such as orders and rotations, about delivery operations, gates, canals and about customers, service points and invoices. It shall provide water authorities with:

- Better planning, making smarter decisions and fewer mistakes.
- Reporting capabilities using meaningful performance indicators such as overall system efficiency.
- Precise calculations (volumetric accumulation)
- A much higher user satisfaction.

The database shall be able to be configured from any client in the network and nearly all the system's functions shall be dynamic in the sense that the system shall not have to be offline to add/configure information in the system.

Building a solution on an industrial-strength relational database management system has considerable benefits including the ability to:

- Scale the system as the numbers of users grow and concurrent access increases.
- Leverage off transaction-locking facilities provided in the database system to prevent data corruption and ensure data security.
- Backup and recovery data as required using standard open database system tools.
- Secure data access using inbuilt database security features.
- Replicate data to any number of nodes on the network using standard tools provided by the database vendor.

The CCU shall receive real-time updates from connected devices with indications of current status, flow rates, canal water levels, gate positions, and indications of the correct functioning of all components (such as power status and communication signals). This information shall be stored in the database and made available in real-time to connected computers.

The designed SCADA shall allow operators to:

- Monitor the network with graphical displays of process variables in the network.
- Directly control any cross-regulator or offtake from the computer (for example to increase or decrease flow or to close or open an offtake).
- Invoke switchover between manual and automatic control in a seamless manner.
- Receive alarms if any component has a problem or if the variables deviate beyond prescribed thresholds (on-screen, via email or SMS).
- Analyze historical graphs of data from the network to diagnose problems or see patterns.
- Enter (and change) water orders received from users and water user associations by internet.
- Prepare reports for management or for water user associations about flow volume and water use.

The designed SCADA shall provide the following capabilities:

- **Reporting:** It shall allow a report output supporting PDF, HTML or CSV formats. Additionally, reports shall be able to be scheduled to run on a routine basis with the results automatically emailed to interested parties. It shall also allow users to set an authority level which determines which users will be able to execute and view a specific report.
- **Trending:** It shall be provided with data analysis and graphing modules to convert vast quantities of field data into on-screen visualizations that operators can use to analyze performance over time, providing readily accessible information which can be used to better manage the system. Any variable recorded in network (such as flow, water level or gate position) shall be able to be viewed as a graph showing how it has changed over time. This is useful to visually understand the performance of the water network over time and to diagnose and fix problems.
- **Network visualization:** SCADA shall provide a network visualization module as a schematic on-screen representation of the entire water network so that operators shall have an intuitive view of operations. Operators shall be able to view current flow, water levels, gate positions and demand for

any point in the network. Network Visualization will also display historical and future flow demand and supply for a site or section of canal. It shall provide a simple configuration to bring up full SCADA screen for detailed monitoring and control.

- **Alarms:** The designed SCADA shall provide alarming functionality as alarm notification, acknowledgement and critical alarm escalation to the operator's desktop, SMS, email or pager. Each variable data point defined in the database shall be able to have alarm limits configured which when exceeded will cause an alarm to occur. Different levels of alarm severity shall be able to be configured ranging from "low-low" through to "high-high", as well as alarms that shall trigger when a rate of fall or rise in a variable is exceeded. It shall allow operators to be alerted of an alarm in several different ways, including on the operator terminal screen, via email or via SMS. The system shall record the variable value that triggered the alarm, the alarm limit that was exceeded as a result, the time it was set, cleared, and acknowledged along with details of the operator that acknowledged the alarm.
- **Water Ordering and Demand Management**: SCADA shall be provided with water ordering and demand management modules to automate the collection of water orders and the scheduling of deliveries, ensuring a fair and equitable distribution of water and to utilize the maximum available capacity of the Karachi Canal System, and to instruct the offtakes to automatically open and close at the planned time to deliver water orders with precision.
- **Planning:** Scheduling shall be also able to be configured to ensure minimum pressures are maintained in pipeline systems based on hydraulic grade line calculations. The software shall ensure that scheduled water orders are communicated to the automated offtakes via the radio network, and they automatically operate to deliver the flow rate specified in the order. It shall provide powerful comprehensive pre-configured reports to be used to inform stakeholders of activity and system performance. Information shall also be able to be distributed to external parties (KWSB or government authorities) via industry standard XML formats.
- **Autonomous control:** Installed software shall coordinate the response of intelligent cross-regulator gates and refurbished automated gates throughout the network in response to changes in water use. It shall determine the optimal response of each, and every cross-regulator based on exact knowledge of the hydraulic behavior in each section of canal. The optimal response shall be calculated as to ensure that the change in flow has the effect of dampening the transient, wave-like impacts that occur elsewhere in the canal network because of a flow change, avoiding impacts that could cause instability throughout the canal system.
- **Customer communications:** The SCADA shall provide communications module with a range of communication tools that shall enable operator, KWSB, and other water authorities to communicate with users in various ways.
- **Billing:** A Billing module shall provide the flexibility to charge based on any network object defined in the software.

A **central server environment** with adequate redundancy and fail over mechanism would be required for the entire system. Physical separation shall be provided between the database and application layer. In an RAC environment, two or more computers each with a Relational Database Management System (RDBMS) instance concurrently access a single database. This allows an application or user to connect to either computer and have access to a single coordinated set of data. The main aim of the RAC is to implement a clustered database to provide performance, scalability, and resilience. When one node fails, the other seamlessly takes over.

The central database shall have different 'schemas' for the different field offices instead of having a server at every office, and their connectivity back to the main control center. Authorization shall be configured so that the district operator has access only to their part of the schema. This has many advantages:

- Simple and efficient IT architecture.
- Less IT infrastructure, and hence easy to maintain.
- Reduced cost of infrastructure at the field offices.
- Low ongoing maintenance and upgrade costs.
- The central server has knowledge of the entire network as information of the whole network is in one database, making it relatively easy to compute demand feasibility, and transfer control information between areas.

Components that will be required at the control center include but are not limited to, physical racks, servers, network switches, relational database and OS software, virtual management software, firewall, UPS, data backups and its management software.

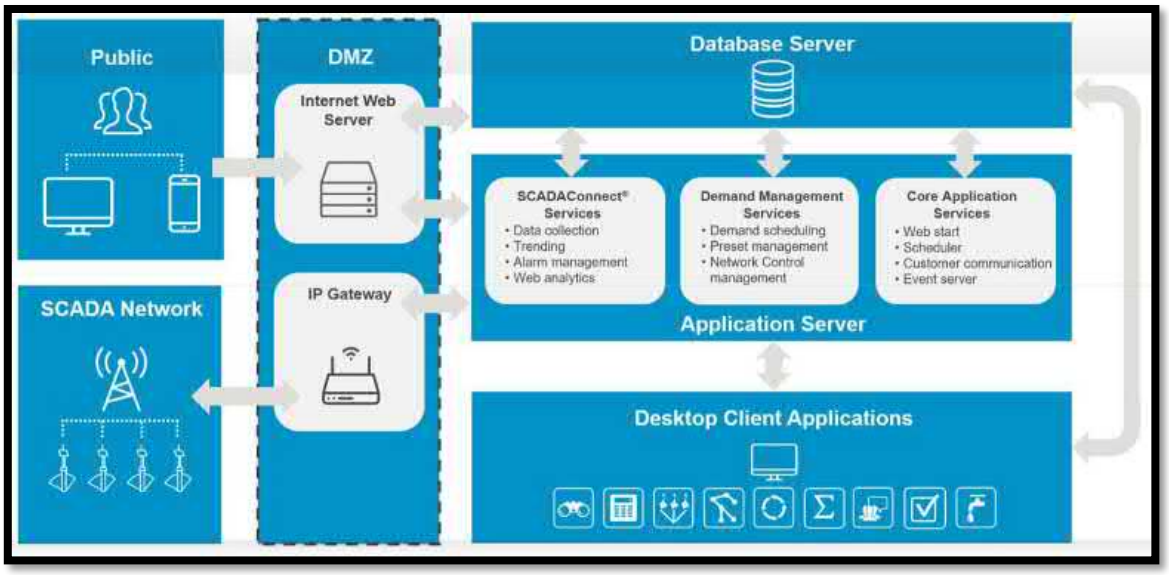


Figure 56. Software architecture

5.8. Power Supply

The purpose of this section is to analyse the applicability and feasibility of the photovoltaic solar technology to cover the power demand from the Hub Water Treatment plant. All the information regarding the studies that have been carried out to outline a potential PV plant to fit the site conditions and limited information provided by the client regarding available locations and power requirements in the facilities can be found within the **Annex 2.**

This plant will be primarily designed for self-consumption of the large electrical power demand of the water filtration and the pumping stations with the possibility of exporting the excess in production to the grid.

This initial design is a proposal from the Consultant, and the potential developers should assess whether they want to invest in a bigger solar plant to reduce the cost of the power network connection, and also how to size the back-up systems. This proposal includes:

- Configuration and capacity of the PV plant, comprising the kind of equipment and estimated layout on the selected location.
- Energy yield estimate based on the available meteorological data of the site for the first year of operation.
- CAPEX and OPEX estimates to evaluate the feasibility of developing a photovoltaic solar plant designed for self-consumption that will be used in the feasibility study of the complete project.

SITE PROPOSAL

The site for this PV plant is proposed considering the location of the facilities and main points of consumption as well as the residential and industrial buildings in the area. Furthermore, the selected area is located at the highest point of the complex to be free of shadows.

The geographical coordinates of the PV site are:

PV Solar Plant Coordinates	
Latitude (º)	25 (N)
Longitude (º)	67.03 (E)
Altitude (m)	110 m

Table 11: PV Solar Plant Coordinates

This PV plant is proposed to be on an empty area at the East of the Hub Water Treatment Plant, still, within the area owned by the KWSB. The proximity to a high energy consumption points also facilitates the interconnection of the PV plant and avoids distribution losses.

The distance to the pump station at the North is around 3 km and can be interconnected with a 11 kV line (either overhead or buried) with reasonable losses. Furthermore, the water treatment plant is protected by a perimeter fence and a security house at the main entrance. The proximity to these facilities provides some additional physical security to the PV site. The area shows no social or environmental issues, and it is far enough from any residential area.

The geotechnical survey that has been carried out in October 2020 evaluates moisture content, density, strength, and chemical characteristics. The results show that the site is mainly composed of clay and limestone. The rocks that have been found in most of the boreholes are mainly sandstones, siltstone, mudstone, and shale. Moreover, compactness is classified as medium dense/ dense material and the soil consistency is medium. Finally, the chemical aggressivity of the site is very low.

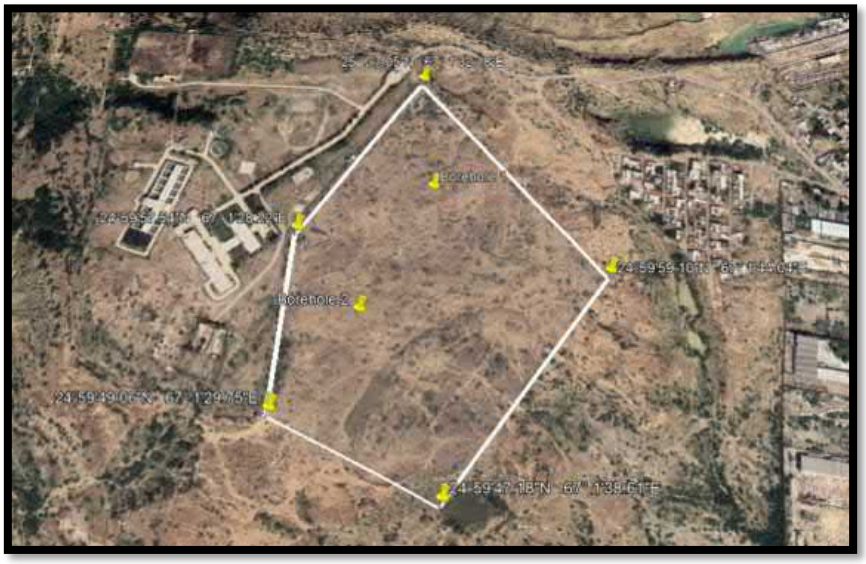


Figure 57. Location of boreholes (Geotechnical Survey)

According to this report also, the site's probability of earthquakes is low. The area is classified as Zone 2B according to the Building Code of Pakistan, meaning the intensity of earthquakes would range between V and VI (MMI scale). The seismicity of the area can be seen in the following figure:

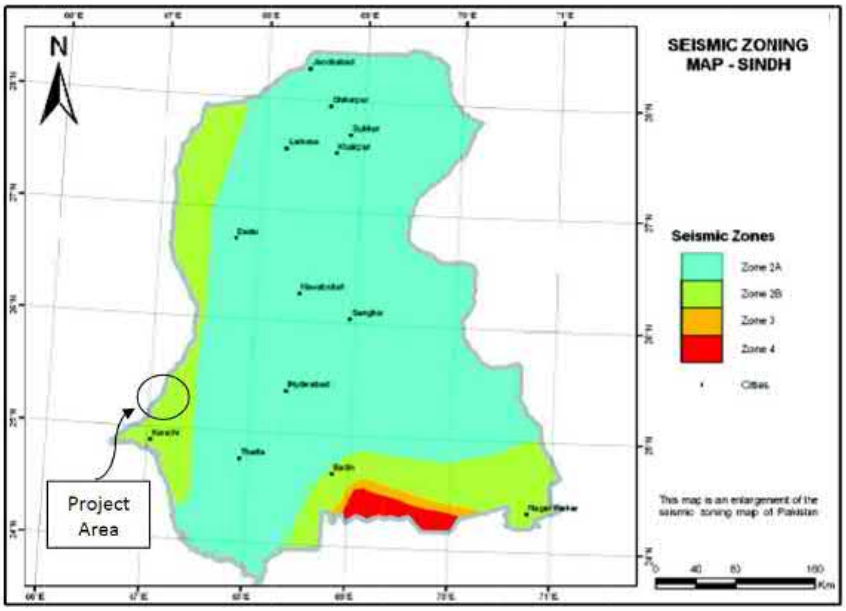


Figure 58. Seismicity of the area (Geotechnical survey)

The proposed area presents very slight slopes and low cliffs; therefore, the proposed equipment will be suitable to be deployed on site.

This survey also suggests that the civil works for the construction of the PV generator will be executed without real issues. Due to the existence of rocks found in the samples examined, pre-drilling works might be necessary. This finding does not rise any serious concern on the feasibility of the plant and the variation of overall CAPEX is very limited.

All these features make this site suitable for a PV plant. The figure below shows the proposed location within the white polygon, considered to be big enough for the construction of the proposed solution:

Figure 59. PV Plant site proposal

The PV plant covers an approximated area of 11.80 ha, enclosed by a perimeter fence that includes the PV panels, inverters, power transformers, roads and all the related electrical equipment necessary for the correct operation of the power generator.

TECHNICAL PROPOSAL

Taking into account the initial information provided by KWSB, the Consultant has decided to initially consider a PV plant with a capacity in the range of 4-5 MW to match with the maximum expected power demand. The final capacity available for consumption is 4.5 MVA, due to the different losses of the generator.

Hence, the operators of the Water Plant should maximize the operation of the facilities at daylight time, when the highest yield from the PV plant is expected.

In order to compensate the operating losses, the total capacity of the PV generator was proposed to have peak capacity of 6.03 MWp (DC/AC ratio of 1.34). This is a relatively high DC/AC ratio. However, the goal is to reassure that the plant covers the maximum demand at any moment. Furthermore, if sometime, the yield of the PV plant excesses the demand, the interconnection design must be designed to evacuate this surplus to the distribution grid.

It comprises a total of 11,600 bifacial modules with a maximum power of 520 Wp. The panels will transform the energy from the sun in DC electric power.

The reason for selecting bifacial modules is the high albedo level the ground shows in the meteorological data. During the last years, the capacity of modules is steadily increasing, allowing better performance in the same available land. The capacity selected allows for a maximization of energy production in a smaller area, but similar PV modules could be used. The current range for the capacity of modules varies from 350 to 550 Wp approximately.

The proposed solution considers that modules will be installed on fixed structures with a 2V29 configuration. This type of structure requires less surface, lower CAPEX and the maintenance is simple. On the other hand, the energy production is lower compared to the tracking systems. For the scope of this generator, a fixed

structure is considered more adequate, but a tracking system could also be used. This configuration means that each structure will have 58 modules (29 series wiring and 2 strings wiring parallel).

These structures have a tilt of 20º and a distance between axis of 12m. The inclination angle has been calculated based on the latitude of the location to maximize the annual production. The distance between axis or pitch ensures that the shadows between rows of structures will not be limited.

The proposed inverter is a string inverter since it requires less maintenance than central inverters. In any case, the string or central inverter solution do not significatively impact on the yield and occupation ratio. This project has a total of 20 inverters that transform the energy in DC to energy in AC.

The PV plant comprises a total of 2 blocks. Each one is formed by 10 inverters of 225 kVA (40ºC) and a power station of 2,500 kVA (40ºC), that will raise the output current from the inverters to 11 kV.

To make the interconnection to feed the rest of facilities, the output of the PV plant will be connected to the 11 kV substation located North, at the Water Pumping Station, where the energy meter is installed. The connection could be easily made through a 11kV line of about 3 km long from the switching centre al the PV plant, beside the water treatment plant. Since the voltage level is considered as medium voltage and the length is relatively short, this interconnection might be underground, through trenches of about 1 meter width and 1 meter deep without any special requirements.

Considering the single line diagrams described, a partial refurbishment of the electrical facilities at the K-substation will be needed to cope with the new feeder for the energy from the solar plant. The installation of control devices for interfacing with the internal and external distribution grid will be needed as well. Two separate sets of unidirectional meters shall be installed in order to measure the power supplied by the utility to the grid and the power received from the grid.

The construction of a brand-new K-E electrical room will clearly facilitate to arrange the new pieces of equipment. This substation should remain located in the vicinity of the interconnection to the external grid (since it will remain as main power supplier) and the major consumer (pumps). The available area at the North of the complex facility seems to be the most suitable location. Only 1 to 2 acres is more than enough surface for this room.

The following table presents the main data of the proposed PV plant:

PV Plant		
Location	Karachi, Pakistan	
Installed Power (MWp)	4.40	
Inverter Output (MVA)	4.50	
Ratio DC/AC	1.34	
Fenced area (ha)	11.80	
PV Modules	Nominal Power (Wp)	520
	Nº of modules	11,600
Inverters	Technology	String
	Nominal Power (kVA) (40ª)	225

PV Plant		
	Nº of inverters	20
Structures	Technology	Fixed
	Pitch (Axis-to-axis distance) (m)	12
	Tilt (º)	20
	Module configuration	2V29
	Nº of structures	200

Table 12: General characteristics

The configuration for this solution has been designed with the software AutoCAD to provide an idea of the implementation of the PV generator on the proposed site. The layout can be seen in the Appendixes. The following figure illustrates an estimated distribution of the proposed solution:

Figure 60. PV Plant distribution

The main access is located at the North corner, close to the main access to the filtration plant.

The interconnection of the PV plant to the K-Electric room has also been designed with AutoCAD. It can be seen in the Annexes.

Additionally, the following figure illustrates the single line diagram:

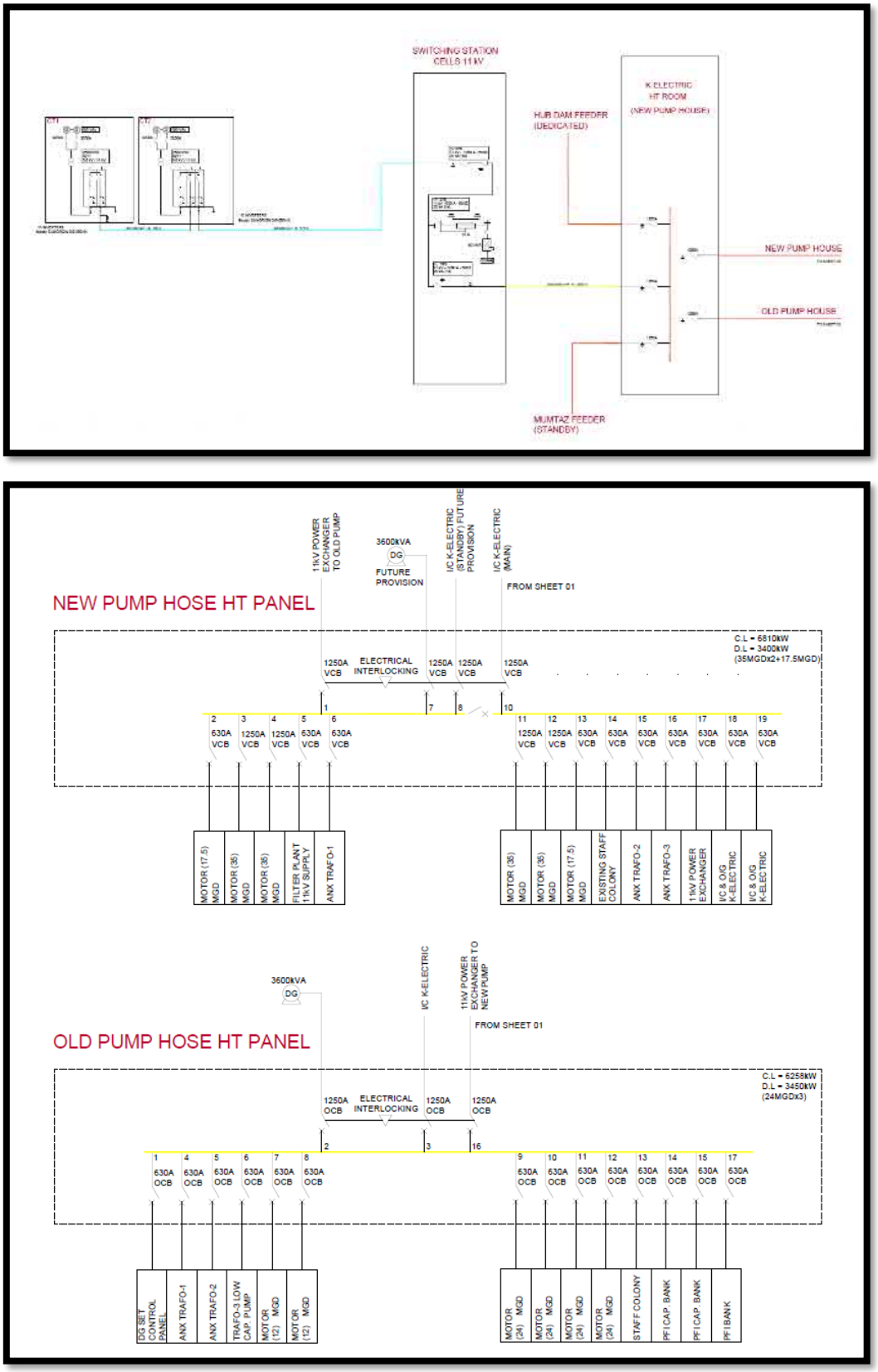


Figure 61. Single line diagram PV Plant

ESTIMATION OF YIELD

The yield has been estimated with a reputed software PVSyst, in the latest version (7.0.12). The results shown have been calculated for the first year of operation:

Results 1st year of operation (P50)	
Energy produced (MWh)	10,324
Specific production (kWh/kWp)	1,712
Performance Ratio (%)	80.68

Table 13: Estimated energetic production

The simulation has been carried out based on the information of the selected equipment (modules, inverters, structures) provided by the manufacturer and the characteristics of the PV plant (location, capacity, meteorological conditions). Other brands and models could be selected but the main figures would remain.

When running the simulation, several losses need to be considered to have a better approximation of the real yield of the PV plant. For this project, the following losses have been considered:

- Irradiation energy losses:
  - Far shadings: 0.08%. It refers to the horizon. This information is provided directly by PVSyst.
  - Near shadings: 0.70%. It represents the shaded fraction of the PV field with respect to the full sensitive area. It is calculated by PVSyst.
  - IAM factor on global: 1.50%. The incidence effect is defined by the software.
  - Soiling loss factor: 3.50%. An average loss is 2%. However, considering the conditions of the site, this loss has been considered higher.
- Electrical energy losses:
  - Module degradation loss: 0.27%. Every module suffers a degradation. A default value of 0.4% has been selected.
  - PV loss due to irradiance level: 0.41%. Since the module efficiency is given at standard conditions, it needs to be adjusted for lower irradiation levels.
  - PV loss due to temperature: 7.48%. It calculates the temperature of the cells and simulates this loss. Due to the high temperatures of the site, this value is within an acceptable range.
  - LID (Light Induced Degradation): 1.50%. It is related to the quality of wafer manufacture.
  - Mismatch loss, modules and stings: 0.54%. are related to the fact that the real modules in the array do not present the same I/V characteristics. The selected power loss for modules was 0.5% and 0.1% for strings (default value).
  - Ohmic wiring loss: 0.36%. The ohmic resistance produces energy losses. Since the configuration is string inverter, this value is within range. The loss fraction considered for the simulation was 0.5%.

- Inverter loss during operation (efficiency): 1.31%. This loss results from the energy conversion from DC to AC.
- Inverter loss over nominal inverter power: 0.11%. This loss comes from the power limitation at inverter level. It will decrease every year due to the degradation of modules.
- AC Ohmic loss: 0.96%. It covers the losses from the inverter to the transformer. The value is within range considering that the configuration is string inverter. The loss fraction considered for the simulation was 1.7%.
- Medium voltage transformer loss: 0.95%. This loss is calculated based on default values.
- MV line ohmic loss: 0.21%. The loss fraction considered for the simulation was 0.48%.
- System unavailability: 1.75%. It is established as a fraction of time of 2% in the simulation. The system considers this and calculates the energy loss provoked by these failure hours. The periods of unavailability are created randomly.

The following figure shows a typical daily production of the PV plant at inverter level. The inverter will limit the power output when the available power from the DC field is greater than the inverter's input power. This limitation is called clipping, and it is likely to happen during the first years of operation. This effect can be seen in the figure:

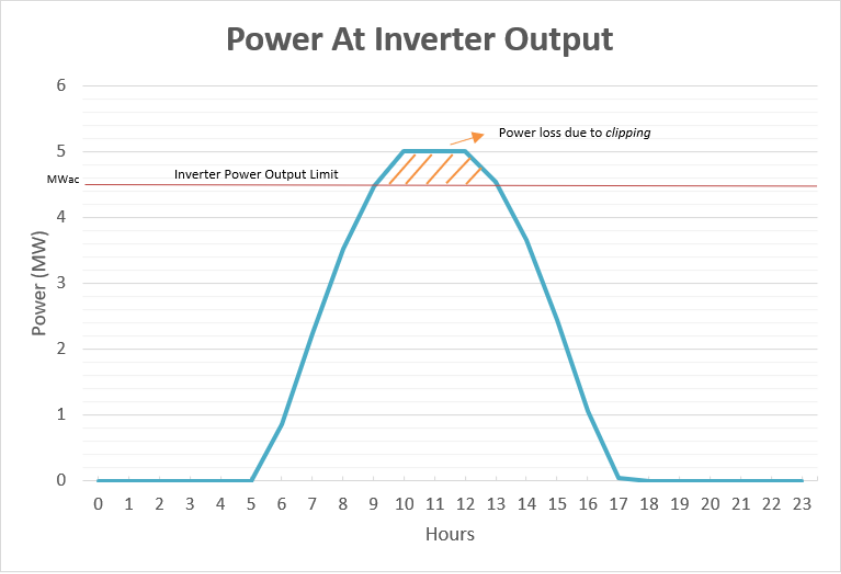


Figure 62. Estimated daily production profile.

Furthermore, in the event that the PV plant produces more that the internal consumption of the complex, the interconnection will be designed to inject that excess to the distribution grid in net-metering scheme.

The table below show the estimated monthly production. As expected, the greatest energy productions occur in March and April (dry season) with a sharp drop in production during July and August (rainy season).

Estimated monthly production (MWh)	
January	876
February	889
March	1,064
April	1,051
May	1,017
June	834
July	636
August	632
September	757
October	949
November	835
December	783

Table 14: Estimated monthly production profile

According to the results obtained in the simulation, the energy produced during the year will be approximately 10,324 MWh. Comparing this result to the consumption profile of the facilities which estimates an annual consumption of 42,836 MWh, the PV plant will cover around 24% of the energy demand in the Hub Dam water treatment plant throughout the year.

ECONOMIC ASSESSMENT FOR THE SOLAR PV PLANT; CAPEX

Prices in PV plants are ruled in a large extent by the price of their main components (modules, inverters, structures, MV switchyard) in the international markets. Civil works and electromechanical erection are around 15% of the total costs.

With the limited information of the proposed site, this Consultant has not identified any particular issue either civil or electromechanical that could significatively increase the international price of PV plants that are in the range of 600KUSD to 700KUSD per MWp in medium size installations.

According to NEPRA, the assumed figure of CAPEX in 2016 for solar photovoltaic projects in Pakistan between 1 MW and 20 MW was 1,185,846 $/MWp. However, in recent years the prices for PV projects throughout the world have steadily decreased. According to IRENA, the average total installed costs for solar photovoltaic projects has declined an average of around 14%/year in the period between 2014 and 2018. Considering this evolution and the forecasted reduction of costs in this technology, the value obtained from NEPRA has been adjusted with a reduction of 45% on the above prices, to reach an estimated cost of 652,239.86$/MWp.

This figure is supported by the latest CAPEX figures for Utility scale solar PV plants between 30 and 100 MWp that NEPRA has published in 2020. This value is around 591.500$/MWp. Considering that the scale of this project is smaller, the figure established for the CAPEX is adequate.

The CAPEX considers a PV plant of 6.03 MWp and has been broken down in 10 main items that cover all the features necessary for the construction of the PV plant. These items include the supply of equipment as well as the necessary works for the assembly and installation of the facility. The budget can be seen in the following table:

GENERAL BUDGET		
ITEM	COST	PERCENTAGE
Civil works	$167,152.77	4.25%
PV modules	$1,396,217.27	35.50%
Fixed structures	$1,337,222.17	34.00%
Inverters and power stations	$432,630.70	11.00%
Low voltage electrical installation	$294,975.48	7.50%
Medium voltage electrical installation	$196,650.32	5.00%
Control centre and storage	$1,966.50	0.05%
Control and monitorization	$9,832.52	0.25%
Project Management	$17,698.53	0.45%
Interconnection	$78,660.13	2.00%
TOTAL BUDGET	$3,933,006.39	100%

Table 15: Budget of the project

ECONOMIC ASSESSMENT FOR THE SOLAR PLANT; OPEX

NEPRA also considers an estimation of operational costs. In 2016, the estimated component for OPEX was 26,541 $/MW. Since the nominal capacity of the plant is 4.5 MW, an initial estimation is 160,042.23 $/ year.

This is a reasonable OPEX for a PV plant of medium size without associated costs for land.

However, this general figure can be adjusted considering that the PV plant is located within the water treatment complex, near the filtration plant. Thus, the same operation team could also maintain the PV plant, particularly for any electromechanical operation.

A more realistic OPEX should then, considers only very specific operations and materials for PV plants like regular module cleaning, maintenance contract for inverters, replacement of the spare parts, etc.

Considering these facts and based on projects with a similar scope, an annual OPEX in the range of $120,031 could be used for financial assessment.

CONCLUSIONS

The preliminary design presents an optimal solution to cover part of the energy demand at the Hub Water Supply System. The location of the project is on the outskirts of Karachi metropolitan area in the hilly zone of Hub near Manghopir in Gadap Town, Karachi.

Based on the information provided by the Karachi Water & Sewage Board (KWSB), that includes information related to the energy requirements of the facilities as well as information of the local conditions, a PV plant has been fully designed. It includes an optimal location, technical characteristics, and an estimation of the yield. An economic assessment has been carried out to estimate the costs of this implementation. The values show that the proposed solution is a viable project that could lead to important savings in the energy fee for the KWSB.

The solar photovoltaic plant presented in this report, has several features that show it as an optimal solution for the client's requests:

- The construction of a PV plant within the area within KWSB's ownership is considered to be feasible.
- The solar resource in the location selected is good for a PV plant. The irradiation levels are high, maximizing the production of the PV generator.
- Based on the provided information, no constraint for the implementation of a PV plant on main aspects like topography, geotechnical or hydrology features has been observed.
- The electrical interconnection and power supply to the facilities at the water plant can be simply made through the existing K-E room, either by some modification to add the feeders to connect from the PV plant or through the construction of a new K-E room. Either option is technically feasible with no complicated requirements.
- The consumption of the facilities is considered to remain constant 24/7 at the nominal level of approximately 4.5 MWac, which means that, under normal operating conditions, all the energy produced by the PV plant will be automatically self-consumed by the water plant. Under this operation scheme, the PV plant will cover around 24% of the total energy demanded by the water plant. The contribution of the PV plant will be during the daylight periods, particularly at noon.
- The current local regulations support and encourage this type of self-consumption facilities, improving the viability of this kind of facilities. No large excess in energy is expected due to the operating scheme of the water plant. In any case, exportation of the excess with a net billing scheme is considered. As the size of the PV generator is above 1 MW, the net billing scheme allows bidirectional energy flows, from and into the electrical network.

The current tariff fee for the energy consumed in the facilities is 25 c$/kWh. The approximated figure of LCOE for this power generator, based on the PVSyst simulation and the current costs for similar generators, is around 6-9 PKR/kWh (depending on the solar plant size, capital structure and other project parameters the tariff for recent solar power plants in Pakistan has been around PKR 7-9/KWh for initial 10 years while levelized cost of around PKR 6-7/KWh over 20 years concession period). This is considerably cheaper than the average tariff of PKR 25/KWh being charged by the private grid power supplier in Karachi). Therefore, the installation of a PV plant in Karachi with this configuration also shows an attractive economic feasibility.

5.9. Capital Expenditure (CAPEX)

Capital expenditure usually refers to funds that are used for the purchase, improvement, or expansion of long-term assets that are typically physical, fixed, and non-consumable assets, such as infrastructure. For this project, we are obviously referring to the design costs, procurement and construction costs involved in the rehabilitation of the Karachi Water Canal System (Hub Canal)

To prepare a realistic identification of the CAPEX costs, the Consultant has conducted an analysis of prices and costs collected from typical projects around the world, based on recently conducted works. That has been combined with quotations and cost estimations from local vendors in Pakistan, even though the equipment is manufactured in different countries other than Pakistan.

At the same time, regional and local import taxes, plus C&F costs have been considered and broken down for better analysis. In the province of Sindh, 13% taxes are applied over civil works items, whereas 17% are over imported off-shore equipment.

As a result, the main sources of information to define construction costs have been the following:

Canal rehabilitation:	▪ WAPDA ▪ KWSB ▪ Local costs identified by the Consultant with the local collaborators.
Pipeline & Control devices	▪ Prices provided by local vendors for GRP pipelines and accessories (manufactured in China) ▪ International projects conducted by TYPSA (in Turkmenistan, 2020; KSA and Spain, since 2017 to date)
Pumps:	▪ Prices provided by the local representatives of KSB (German company) ▪ INDAR-INGETEAM, for submersible booster pumps set (an alternative solution) ▪ TORISHIMA: double-suction volute pumps ▪ International projects conducted by TYPSA (Turkmenistan 2020)
Solar:	▪ International projects conducted by TYPSA (Sri Lanka, Uzbekistan 2020-2021) ▪ The International Renewable Energy Agency (IRENA)
Water Treatment Plant:	▪ Benchmarking comparable upgrade projects in WTPs with similar design flows in Spain (Canal Isabel II, Aguas de Valencia, Mancomunidad de Canales del Taibilla)
SCADA:	▪ Vendor information. Rubicon Water (Rubicon Water)
Labour cost:	▪ KWSB ▪ Local labour costs
Energy costs:	▪ The National Electric Power Regulatory Authority (NEPRA)
Taxes:	▪ Pakistan Customs Tariff 2020-21

Based on the collected information, and the definition of the works required for the development of the project, included in the proposed design drawings, the estimated CAPEX is broken down in the following summary table, whereas a more detailed breakdown is included in **Annex 5**.

	Total CAPEX Cost (USD)
Karachi Canal Rehabilitation (11 km) & Partial Decommissioning	USD 9,849,474
New GRP Pipeline DN1900 (100 MGD) Length = 9.8 km	USD 11,524,354
Upgrade of Hub Pumping Station (100 MGD; operating at 82 MGD)	USD 4,459,474
K-III Connection with Hub Pumping Station (18 MGD)	USD 2,999,810
Rehabilitation of Rising Mains (2 GRP DN1900 mm pipes)	USD 5,389,709
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 14,225,000
SCADA and Metering System (including telecommunications)	USD 1,205,000
Solar PV Plant (4.5 MW) + Distribution line (2.5 km)	USD 3,508,903
Government of Sindh Taxes over Imported Off-Shore Equipment (17%)	USD 4,238,600
E&S Mitigation Measures (3% of CAPEX excluding taxes)	USD 1,594,852
Contingencies (10% of CAPEX excluding taxes)	USD 5,316,172
Overheads (12% of CAPEX excluding taxes)	USD 6,379,407
Profit (6.5% of CAPEX excluding taxes)	USD 3,455,512
TOTAL Construction Works (excluding civil work 13% taxes)	**USD 74,146,267**
Independent Engineer (1%)	USD 741,463
Independent Auditor (0.2%)	USD 148,293
Design Consultancy (1%)	USD 741,463
Project Management (1%)	USD 741,463
Staff Cost	USD 2,595,119
Insurance (1.5%)	USD 1,112,194
Consultants (Legal & Financial) (0.6%)	USD 444,878
Project Development Fee (1.5%)	USD 1,112,194
TOTAL (excluding civil work 13% taxes)	**USD 81,783,333**

Note.-
Government of Sindh Taxes over Civil Works (13%) add up to USD 3,669,743
They are not included in the above table.

5.10. Operating Expenditure (OPEX)

OPEX (Operation Expenditure) budgets are usually prepared to estimate the cost of operation per annum. As costs reflect day-to-day operations, which are continuous throughout the lifetime of the facility, these costs are usually treated as a constant value throughout the lifetime of the plant.

Cost components for most OPEX infrastructures are mainly fixed costs, such as maintenance, repair, and labor costs, but for facilities like the water treatment plant or the pumping station, the variable costs are more relevant. In any case, OPEX is separated both into fixed (per annum basis) and variable (per kWh or per Kg basis) components; the latter being energy, chemical and sludge treatment costs.

The Concessionaire will obviously have to break down and prepare the OPEX according to the means, resources, and the final scope of their proposal. This due diligence report includes a reasonable estimation based on the Hub system and the way it will be rehabilitated, assuming that O&M will be carried out by the private sector. Therefore, the primary components considered for the OPEX budget are hereby portrayed.

LABOUR COSTS

All staff involved in the day-to-day operation of the facilities and all associated infrastructure are included in this cost component. This cost includes direct salary, overheads, social charges, and any allowances. The cost of recruitment, training, leave, and other indirect costs are also added.

The number of people considered is adjusted for the private sector, considering the labor-intensive features of the Pakistani labor market and the salaries envisaged for a private company.

ADMINISTRATION EXPENSES

Administrative costs, such as management, office premises and equipment, licenses, permits and other regulatory costs, accounting, auditing, and legal fees.

INSURANCE

Insurance is a valuable tool for managing and mitigating risk in projects like this one. A diverse range of insurance products are available covering all stages of development and operation. Insurance costs are budgeted under the annual OPEX budget, and they typically account for roughly 0.5 to 1.5 percent of the construction CAPEX, for industrial, mechanical, and electrical facilities, and 0.1 percent of the construction CAPEX for civil works. In this case, an overall 1% percent of the total cost has been used for the annual insurance OPEX cost (in addition to this OPEX insurance cost, the CAPEX summary table shows that 1.5% is also considered for the CAPEX, though that one is a unique insurance cost, as opposed to the yearly OPEX)

VEHICLES, FUEL AND RELATED CONSUMABLES

This chapter is tailored to the potential vehicles that the private sector may end up using for the operation of the system. The number and type of vehicles, along with insurance, fuel, consumables ad lubricants is considered.

SPARE PARTS

Spare parts include interchangeable items that are kept in an inventory and used for the repair or replacement of failed units. Some of them are strategic, because despite the fact of having a long life or a small chance of failure, they would cause a long shutdown, usually because it would take a long time to get a replacement for them. The mechanical and electrical spare parts for the pumping station and filtration plant have a specific unit as well. Others are not as important and are not repairable, thus considered as consumable parts that are scrapped when they are found to have failed.

PLANNED MAINTENANCE AND INSPECTION COSTS

The planned maintenance and inspection costs will vary from year to year and may have a cyclical pattern. Thus, a five-year or long-term budget is typically used. However, for a new facility like ours, an average cost over the life of the facility is enough as it will cover the variability of these costs on an annual basis.

These activities include equipment repairs (civil, electrical, mechanical), access roads and bridge repairs, building repairs, scheduled inspections (civil, electrical, mechanical), and other miscellaneous items depending on production and run-time, such as consumables, oil, lubricants, and spare parts.

SEVERAL CONSUMABLE COSTS

Provision for consumables and any service fees is included in the variable costs of the different infrastructure elements. They may include:

- major maintenance and testing equipment, hand tools, etc.
- personal safety equipment, including radios, satellite phones, and venting equipment.
- workshop equipment (compressors, welding sets, etc.)

KEY VARIABLE O&M COSTS

Relevant variable costs are essentially linked to energy consumption (per kWh basis), and in the case of the filtration plant, there are also chemical and waste disposal costs (per kg basis and lump sum).

For the power consumption, based on the willingness expressed by KWSB and the GoS to yield 100 MGD (5.26 m^3/s) from the Hub system whenever possible, it is assumed that in an average day this will be accomplished by combining waters from Hub Reservoir and the K-III connection. Therefore, the median Hub Reservoir outflow of 82 MGD (4.31 m^3/s) is used in conjunction with 18 MGD (0.947 m^3/s) from K-III, and both figures are used to estimate a typical variable power consumption in the system.

Based on the design already described for the upgraded pumping station and water treatment plant, the following power is assumed:

- Upgraded Hub Pumping Station at 100 MGD: 3,000 kW
- Upgraded Water Treatment Plant at 100 MGD: 700 kW
- Other facilities at 100 MGD: 800 kW

For the pumping station, the consumption depends on the performance curve of the pump units, the number of pumps used and their scheme (series, parallel) The relationship between the pump head used and power consumption is non-linear, but the design point is obviously used for the 100 MGD design flow. In the case of the typical operation day, 82 MGD are used instead of the design flow of 100 MGD, and we will assume that 5 pumps are used with a power consumption adapted for those conditions. The consumption at the water treatment plant and the other facilities is the system will just be proportionally adjusted, thus yielding:

- Upgraded Hub Pumping Station at 82 MGD: 2,460 kW
- Upgraded Water Treatment Plant at 82 MGD: 574 kW
- Other facilities at 82 MGD: 656 kW
- Total power consumption: 3,690 kW
- Total yearly consumption: 32,324 MWh/year

In the case of the K-III connection, we will assume that the existing pump units are used to convey 18 MGD (0.947 m^3/s). We do not have access to the pump performance curves, but we know the design flow points for the different pump units, so we will make an estimation based on experience. In particular, we will assume the following working conditions at the existing New Pump House:

- Pump Unit P100/2 running at maximum flow: 700 kW and 0.925 m^3/s
- Pump Unit P101/1 at a limited percentage to reach 18 MGD (0.947 m^3/s), consuming 230 kW

This way, on top of the upgraded Hub Pumping Station, when using 18 MGD (0.947 m^3/s) from the K-III connection the following figures will we added up:

- Existing New Pump House at 18 MGD: 930 kW
- Upgraded Water Treatment Plant with those extra 18 MGD: 126 kW

- Other facilities at 18 MGD: 144 kW
- Total power consumption: 1,200 kW
- Total yearly consumption: 10,512 MWh/year

Combining 82 MGD (4.31 m^3/s) from Hub canal and 18 MGD (0.947 m^3/s) from K-III we get an overall consumption of 42,836 MWh/year, and we can assume that the solar PV plant may yield 10,324 MWh/year, thus giving the following ratios:

- New Solar Plant yearly contribution: 24%
- Power grid consumption from K-Electric: 76%

Obviously, the Concessionaire will have to adjust these figures to their specific proposal, accounting for a larger or smaller solar plant, or power back-up systems, but these numbers are a reasonable assumption, and they will serve the purpose of portraying how the typical operation of the system may be.

If we account for those figures and we share out the "other facilities" consumption proportionally between the pumping station and the water treatment plant, assuming 25 PKR/kWh (0.15625 USD/kWh) we can find the power consumptions broken down in the OPEX table.

With regard to the variable cost of chemicals in the water treatment plant, for coherence, we will assume that all water being treated with chlorine (NaClO) and aluminum sulphate, applying the following data:

- Cost of Chlorine: 25 PKR/ton (0.16 USD/ton)
- Cost of Aluminum Sulphate: 23 PKR/ ton (0.14 USD/ton)
- 100 MGD (5.262 m^3/s) yield 454,637 m^3/day
- For raw and treated water, 9 mg/l of Chlorine will be assumed, yielding 4.09 ton/day
- The Aluminum Sulphate will be dosed with 30 mg/l, yielding 13.63 ton/day

Finally, the O&M annual cost estimates (OPEX) are broken down in the summary table, whereas a more detailed breakdown is included in **Annex 5**.

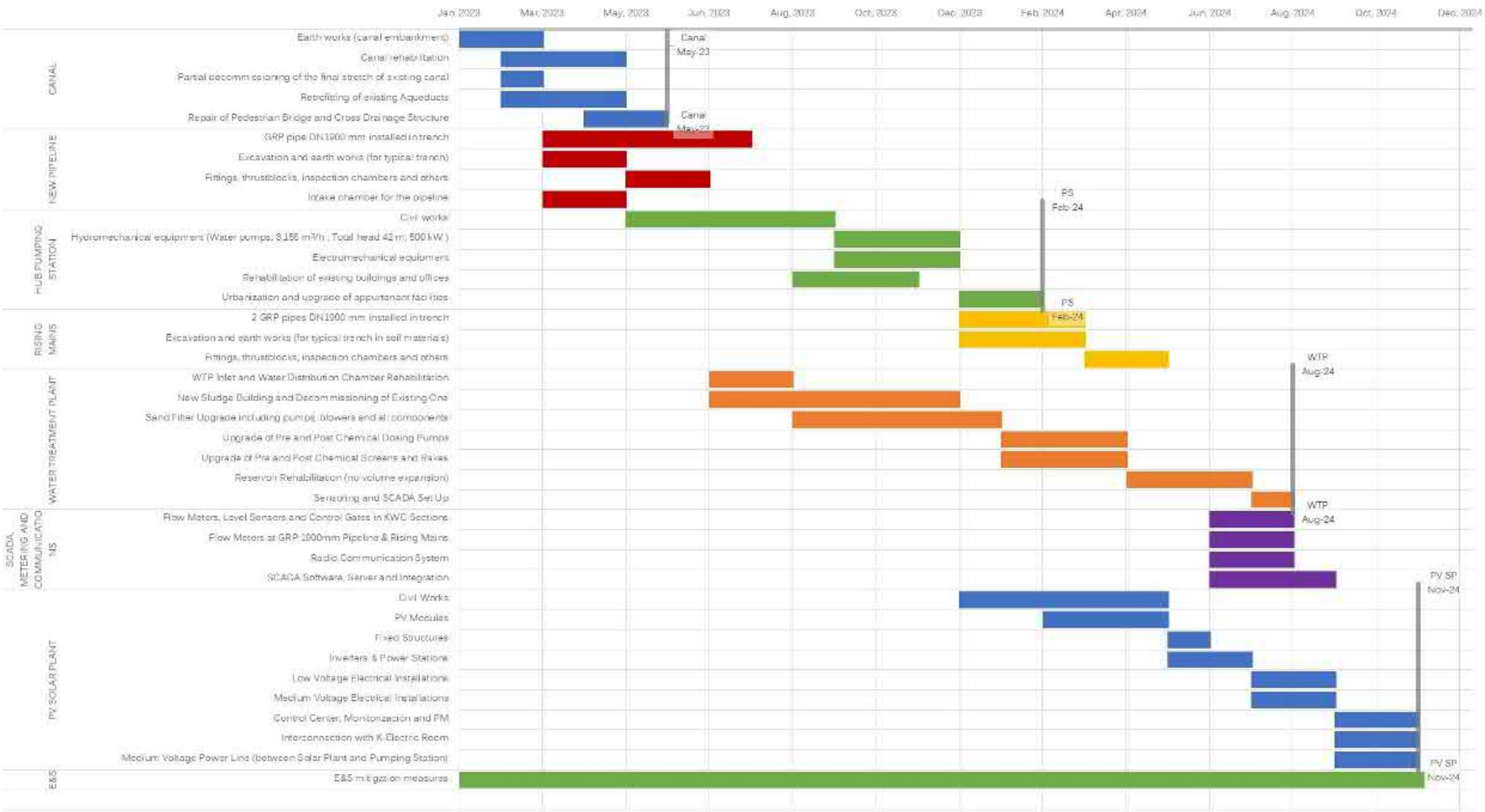
	Total OPEX Cost (USD/year)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)
Karachi Canal Rehabilitation (11 km) & Partial Decommissioning	USD 285,384	USD 265,384	USD 20,000
New GRP Pipeline DN1900 (100 MGD) Length = 9.8 km	USD 331,833	USD 316,833	USD 15,000
Upgrade of Hub Pumping Station (capacity of 100 MGD; operating at 82 MGD)	USD 3,306,229	USD 123,049	USD 3,183,180
K-III Connection with Hub Pumping Station (18 MGD)	USD 1,256,105	USD 83,211	USD 1,172,894
Rehabilitation of Rising Mains (2 GRP DN1900 mm pipes)	USD 155,597	USD 148,097	USD 7,500
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 2,422,485	USD 389,513	USD 2,032,972
SCADA and Metering System (including telecommunications)	USD 43,617	USD 33,617	USD 10,000
Solar PV Plant (4.5 MW) + Distribution line (2.5 km)	USD 131,463	USD 96,463	USD 35,000
TOTAL OPEX	**USD 7,932,714**	**USD 1,456,168**	**USD 6,476,546**

5.11. Construction Schedule

Considering the kind of works involved in this project, and the urgent need to finish the Hub system rehabilitation as soon as possible, 24 months is considered as the maximum duration for the design, procurement, construction, and commissioning of the upgraded infrastructure.

Due to the physical layout of the Hub system, from the head regulator down to the water treatment plant, the works should be organised and planned resorting to several production units, with most of the works being carried out simultaneously, which would result in a shorter execution period.

Depending on the planning of the works signed off by the Concessionaire, and the workload for the different production units and their coordination, this period could even be optimized, considering 18 months as a reasonable period.


Jan 2023
Mar, 2023
May, 2023
Jun, 2023
Aug, 2023
Oct, 2023
Dec, 2023
Feb 2024
Apr, 2024
Jun, 2024
Aug, 2024
Oct, 2024
Dec, 2024
CANAL
Earth works (canal embankment)
Canal rehabilitation
Partial decommissioning of the final stretch of existing canal
Retrofitting of existing Aqueducts
Repair of Pedestrian Bridge and Cross Drainage Structure
Canal May-23
NEW PIPELINE
GRP pipe DN1900 mm installed in trench
Excavation and earth works (for typical trench)
Fittings, thrustblocks, inspection chambers and others
Intake chamber for the pipeline
HUB PUMPING STATION
Civil works
Hydromechanical equipment (Water pumps: 8.166 m³/h ; Total head 42 m; 500 kW)
Electromechanical equipment
Rehabilitation of existing buildings and offices
Urbanization and upgrade of appurtenant facilities
PS Feb-24
RISING MAINS
2 GRP pipes DN1900 mm installed in trench
Excavation and earth works (for typical trench in soil materials)
Fittings, thrustblocks, inspection chambers and others
PS Feb-24
WATER TREATMENT PLANT
WTP Inlet and Water Distribution Chamber Rehabilitation
New Sludge Building and Decommissioning of Existing One
Sand Filter Upgrade including pumps, blowers and all components
Upgrade of Pre and Post Chemical Dosing Pumps
Upgrade of Pre and Post Chemical Screens and Bypass
Reservoir Rehabilitation (no volume expansion)
Sensoring and SCADA Set Up
WTP Aug-24
SCADA, METERING AND COMMUNICATIONS
Flow Meters, Level Sensors and Control Gates in KWC Sections
Flow Meters at GRP 1900mm Pipeline & Rising Mains
Radio Communication System
SCADA Software, Server and Integration
WTP Aug-24
PV SOLAR PLANT
Civil Works
PV Modules
Fixed Structures
Inverters & Power Stations
Low Voltage Electrical Installations
Medium Voltage Electrical Installations
Control Center, Monitorization and PM
Interconnection with K-Electric Room
Medium Voltage Power Line (between Solar Plant and Pumping Station)
PV SP Nov-24
E&S
E&S mitigation measures
PV SP Nov-24

6. OPERATION & MAINTENANCE BASIC REQUIREMENTS

In this chapter, a preliminary listing of operation and maintenance tasks is included, though this should be accounted for in the bidder's proposals and adapted to the concessionaire detailed design and resources.

The Concessionaire will be required to carry out Operations & Maintenance (O&M) complying with applicable standards and in accordance with the Concession Agreement. The general scope of Operations & Maintenance shall include all services associated with the planning, management and delivery of the operations, maintenance, and asset preservation activities to ensure compliance with applicable standards and with all performance measures set out in the Concession Agreement.

Equipment shall be maintained according to the recommendations of the suppliers as prescribed in respective equipment schedules, the cost of which shall be deemed to be included in the concession agreement.

6.1. BASIC OPERATION GOALS

The following goals can be set for the general operation of the Hub water conveyance system:

- The Concessionaire shall ensure the smooth flow of in the canal and pipeline stretches, and uninterrupted smooth operation of the equipment in the old and new pump houses, the rising mains, and the Water Treatment Plant.
- The Concessionaire shall ensure smooth operation of the SCADA system, the power supply systems and communications.
- The Concessionaire shall ensure the administration, monitoring of water quality and effective water treatment as prescribed in the Concession Agreement.
- The Concessionaire shall ensure the quality management on a self-auditing basis, in conformity with an approved quality manual.
- The following operation methodology could be followed by the Concessionaire:
    - Patrolling on four- or eight-hour intervals, on 24/7/365 basis, ensuring the proper security.
    - Emergency & rescue response system.
    - Provision of emergency medical services/ambulance/clinic.
    - Maintaining canal and pipeline flow data.
    - Maintaining pump operations data.
    - Maintaining electrical panels data.
    - Maintaining/ operating all electrical equipment, back-up systems, and the solar plant.
    - Maintaining the canal, pipeline, and appurtenant structures.
    - Maintaining the inspection and access road to the canal and pipeline.
    - Maintaining the pumping station premises, except those section which are not included in the Concession.
    - Maintaining breakdown data.
    - Maintaining death/injuries data.
    - Preparing daily reports comprising of flow data, water quality offtake and water quality at outfall.
    - Maintaining operational crew & equipment for emergency maintenance.
    - Maintaining fire-fighting systems.

6.2. BASIC MAINTENANCE GOALS

Concessionaire shall be responsible for maintaining the Concession Assets, including the Project Facilities and emergency maintenance, where a basic proposal follows:

a) Annual/Routine Maintenance

- Canal – general repair and maintenance of lining surface and joints as applicable.
- Aqueducts – general surface repair, repair of leakage, repair to any bed protection under the aqueducts, repair
- General maintenance and repair of access roads and appurtenant structures, including fences, gates, and drainage systems.
- General maintenance and upkeep of the pipeline stretches, including any water offtakes.
- Any damage or wear & tear caused to the old pump house building including low voltage fixtures, flooring, doors, and windows.
- General maintenance and repair of MV panels.
- General maintenance and calibration of the SCADA and metering system.
- General maintenance and repair of the various gauges, valves, pressure vessels, pipe etc. including the manifold comprising the transmission line but excluding the rising mains.
- General maintenance and repair of the various components of the Water Treatment Plant including sluice gates, pumps, valves, piping, filter beds, water channels etc.
- General maintenance and repair of the laboratory facilities and equipment installed within.
- General maintenance and upkeep of the security and fire-fighting systems installed on the project according to recommendations of the equipment supplier and best industry practice.
- General maintenance and upkeep of the soft landscape within the Pumping Station premises.
- General maintenance and repair of the solar plant and power back-up systems as per the supplier's recommendations.
- General maintenance and upkeep of the overall project premises except those features and areas which are excluded from the Concession.
- General maintenance, repair, and upkeep of the JV offices.

b) Periodic/Major Maintenance

- For hydromechanical and electrical equipment, plus the solar plant, as prescribed and recommended by the equipment and plant manufacturers/suppliers.
- All buildings and boundary walls to be painted every three years.
- Repair of canal lining / patch work on annual basis during the annual closure period.

6.3. OPERATION AND MAINTENANCE GENERAL CRITERIA

During the operations phase of the Concession, the Concessionaire shall be responsible for the efficient operation of the Project. In this regard, the Concessionaire shall formulate detailed SoPs. A series of minimum performance standards shall be set out that must be met always by the Concessionaire. The Concessionaire shall be required to operate an operation manual, to be approved by the GoS, setting out procedures whereby these standards – or higher performance standards as may be agreed upon – are to be met.

An essential aspect of delivering a state-of-the-art water conveyance and treatment system is for the Concessionaire to ensure the system fulfils its performance and design life intention, without exceeding the planned lifecycle cost profile. This is to go hand in hand with maximizing process efficiency that will reduce

running costs and ensuring the system is always available to prevent any failure. This will require the application by the Concessionaire of a comprehensive asset operation and maintenance program.

Good management of the assets ensures that operational and maintenance costs are in line with the detailed design projection and ensure that full design life is achieved. It also reduces the likelihood of major failure, which can carry significantly higher cost as well as the risk of failing performance commitments. It must also be considered that many system warranties will be linked to the ability of the Concessionaire to demonstrate that the system has been operated and maintained in line with manufacturer's instructions and state-of-the-art standards.

It is important that the Concessionaire establishes a robust asset management throughout the concession period that:

- maximizes operation and maintenance efficiency;
- records operation and maintenance activities; and
- maintains up-to-date asset data.

During the construction period, commissioning of the systems, equipment and installations, and through the concession period the private developer will be required will be required to manage all systema data through the use modern of intelligent design and asset management tools. In this regard, the metering/SCADA system will be a critical input.

The system long term data storage facilities shall incorporate the ability to maintain operational and maintenance data through the lifetime of the Hub system. These systems shall be designed to deliver an asset management system that will lower whole life cost through reducing unplanned maintenance and reduce system failure risk.

The Concessionaire is to ensure the systems and tools are administered by competent, well-trained, and appropriately skilled operational teams and continuous training to match the technology improvements that will occur during the concession period. It will also be necessary that a proper period of transfer of knowledge and practices of the Project will be implemented before the expiry of the concession, if required.

The Concessionaire shall report to the Independent Engineer/KWSB on a monthly basis on:

- All Hub system failures and repairs;
- All replaced equipment;
- Meantime between failure trending;
- Asset condition; and
- Hub system predicted asset life.

Operability, maintenance, and safety requirements shall be provided by the incorporation of the following:

- ease of access to equipment, controls etc. for PS, WTP and solar plant operators;
- electrical equipment lifting devices shall be provided for all pumping and engines rooms;
- separate storage facilities for chemicals (including secondary containment);
- lighting to all operating areas;
- ventilation of all covered operating areas for odour control;

- machinery guards;
- proper electrical insulation facilities;
- noise suppression and insulation;
- stairs, handrails, covers etc.;
- appropriate safety systems;
- dangerous gases monitors (where relevant);
- best international health and safety practices and procedures; and,
- all pipework must be marked showing direction of flow as per the appropriate standard.

The Concessionaire shall provide and implement a long-term training program for the personnel of the Hub system.

The Concessionaire shall provide a workshop and facilities on site sized to function as a workshop and shall be equipped with tools, instruments, and special equipment as necessary to perform routine and intrusive maintenance of all the Hub system and equipment. The workshop shall be climate controlled and sized to store major items in accordance with Good Utility Practice and taking into consideration the most optimum combination of 'in-house' and outsourced maintenance teams. The Concessionaire shall provide adequate proof of availability of all critical spares which should ideally be stored on site or at a designated facility.

6.4. HUB SYSTEM SECURITY SYSTEM

The Concessionaire shall also provide appropriate CCTV camera coverage of the system specifically to aid the early detection of failures of major canal, pipeline, PS, rising mains, WTP, and solar plant units. The cameras are to be fitted with powerful LED lights where there is low natural lighting, and the design shall ensure the easy access to or withdrawal of the cameras and lights for cleaning, maintenance, and replacement.

A comprehensive security solution shall be provided for all facilities and focus on intrusion detection, video surveillance, access control, control centres and danger management. All facilities of the Hub system shall be provided with all needed equipment to achieve comprehensive security including any other remote facility which is part of the project. The SCADA control room shall be provided with the possibility to view and control all the cameras located within the Hub system and outlaying facilities.

On the outer perimeter of all Hub system facilities, a boundary fence shall be constructed, (subject to the ESIA visual impact assessment and KWSB requirements). The total height of the fence shall be minimum 3.0 m. Gates, guardhouses, and PS, WTP, and solar plant accesses shall be properly designed and implemented.

6.5. MAINTENANCE TASKS AND REQUIREMENTS

The following **general requirements** can be stated for the maintenance tasks in the Hub water supply system:

- It is an implicit requirement of the Concession that the Concessionaire shall maintain the facility in good order throughout the Concession Period. It is also a requirement that Concessionaire shall transfer the facility to the GoS, at the end of the Concession Period in an acceptable and well-maintained condition.

- The Concessionaire shall be required to prepare SOPs and undertake a maintenance program with the objective of ensuring that the project can be operated efficiently throughout the Concession Period and satisfies the condition Criteria at transfer.
- Maintenance of the facility can be broadly divided into two specific areas:
    - Day-to-day corrective action to remedy faults due to routine operational wear and tear, vandalism and reported malfunctions.
    - Planned maintenance based on regular inspection, assessment of condition against specified performance thresholds.
- For both types of maintenance activities, a comprehensive database shall be established by the Concessionaire, detailing in date order, all reported faults and the corrective action taken. All such records shall remain available for inspection by the GoS during the Concession Period.

In the case of the **Karachi Water Canal**, the following basic maintenance tasks can be proposed:

- The need for annual maintenance of the canal shall be determined during annual closure through detailed inspections. The function of inspections shall be to record, in both absolute and relative terms, the canal's condition, lining and joints reliability and structural integrity.
- On an annual basis, condition surveys shall be undertaken of the whole canal within the concession area. These surveys shall be divided into half-kilometre sections and shall record the location, type, and magnitude of all cracking in the lining, settlement if any, damage to joints, signs of seepage etc.
- Based on the findings of these inspections, immediate maintenance shall be carried out as required and to the extents possible during the annual closure period. For less immediate concerns, a planned maintenance program shall be developed for the following year, the objective of such a program being to take remedial action at the earliest possible time to both reduce the overall need for maintenance and the consequent disruption to water supply.
- All earthworks shall be inspected for signs of deterioration, at three- monthly intervals, and more frequently during the monsoon season, as part of a 'rolling planned maintenance program and appropriate remedial action shall be taken to make good any identified defects.
- In addition, daily inspections of any susceptible areas of earthworks shall be made during periods when unusually high-water levels are identified adjacent to the Concession Area or the rainy season takes place, and appropriate action shall be taken to both safeguard the structural integrity of the facility and to remedy any defects that occur.
- The drainage system shall be inspected and routinely maintained at six-monthly intervals. The timing of these inspections shall be such as to ensure that the system is fully functional at times of heaviest rainfall and there is no water ponding which may cause damage to the road pavement.
- The six-monthly inspection and routine maintenance shall be designed to ensure that the system is free of silt and other debris, all covers, and manholes are in place and secured, and are fully functional. Catch basins and culvert inlets and outlets should also be cleaned regularly to remove accumulated debris.
- In addition, at two-yearly intervals the drainage system shall be fully inspected to ascertain its structural integrity, and appropriate remedial action shall be taken, as necessary.

For the **structures and aqueducts**, the following basic maintenance requirements can be pointed out:

- All structures shall be fully inspected at two yearly intervals as part of a planned monitoring procedure, and any identified defects shall be remedied within a period of six months from the date of inspection.

- If such an inspection shows that the structure's structural integrity has been compromised, appropriate action shall be taken immediately to ensure the safety of project and its personnel. Remedial repairs should then be undertaken, as soon as is practical, to restore the structure to a safe operational condition.
- Minor damage that does not in any way compromise the structural integrity of the structure shall be carried out within three months as part of a rolling maintenance program.

For the **Pumping Station, Rising Mains Pipeline, and Water Treatment Plant** the main maintenance requirements shall cover the following elements:

- Inlet and raw water distribution without obstructions or waste.
  - Inlet screen.
  - Sulphur acid dosing.
  - Alum and Chlorine dosing.
  - Waste tank
  - Inlet flowmeter and instrumentation
- Sand filters, backwashing pumps and blowers, along with their specific instrumentation.
- Pre and post chemical dosing
  - Pumps, mixers, storage tanks, chlorination system, pipelines, and valves.
  - Flow meters and instrumentation to automatize the pre and post chemical dosing.
- Washwater balance tank, thickener, feed pumps and sludge thickener gravity tanks
- CCMs:
  - CCM-1 – Admin Building
  - CCM-2 – Submerged thickened sludge pumps + backwashing pumps.
  - CCM-3 – Rest of the equipment (like blowers, all chemical pumps, etc.)
- Back-up power generators
- Automation & SCADA:

6.6. CONCESSIONAIRE PROJECT FACILITIES

The bidders will have to include in their proposals a listing with all the project facilities involved in the concession but following there is a preliminary proposal.

FACILITIES

The Concessionaire shall provide furnished, equip, and maintain site office for the Independent Engineer, the Project Manager, and their staff. Office provided shall always be maintained by the Concessionaire during the Concession/Construction Period including extension period if any.

The Concessionaire shall provide following facilities for the Independent Engineer, the Project Manager, and their staff:

a) Provide, furnish, and maintain site office
b) Survey Equipment
c) Vehicles

Temporary Supply

Any supply which may interrupt in result of execution should be provided by alternate temporary supply until connected as before. All such arrangement shall be done by concessionaire to avoid any disturbance to public or site staff.

Concessionaire Offices, Laboratory Facilities with Testing Equipment

The JV offices, workshops and required maintenance facilities are proposed to be located within the Hub pumping station premises. Any additional accommodation required shall be constructed by the JV at this location. By using the existing accommodation and grounds, unnecessary expenditure on the project shall be avoided.

The Concessionaire shall furnish the laboratory testing facility with testing equipment, services, supplies, attendants, furniture, and its running maintenance cost for the tests to be conducted. The Concessionaire shall also furnish the laboratory with two vehicles and drivers to be approved by the Independent Engineer for the sole use of the laboratory to transport testing equipment's, testing samples and laboratory technicians, for carrying out inspection and testing on site throughout the same period.

All tests shall be executed according to AASHTO and ASTM and all required equipment (except such equipment as is mutually agreed between the Independent Engineer and the Concessionaire) for facilitation of the tests should be furnished in the lab with two sets of latest editions of prescribes standards (one to be placed in the laboratory and other for the Independent Engineer).

Temporary Road, Traffic Management, Control & General Protection

Layout plans showing the detailed proposals of temporary diversions to be carried out by the Concessionaire shall be submitted to the Independent Engineer/GoS and to concerned district police, authorities, and civil agencies for their written approval 10 days before the implantation date.

Diversion must be constructed in advance of any interference within the existing carriageway and shall be maintained in accordance with traffic load in condition satisfactory to engineer.

Location of Utility Services

Location and identification of all services, in consultation with relevant utility service provider(s), whether above ground or below the ground shall be Concessionaire and its Contractor(s) responsibility following transfer of that utility with conformity to its concern authorities and provision of the Project Site to the Concessionaire, free from any Encumbrances, however, the removal, relocation, reinstatement or diversion of obstructing utilities shall be the responsibility of the GoS in accordance with this Agreement.

7. KEY PERFORMANCE INDICATORS

Key Performance Indicators (KPIs) are systematic and consistent ways of measuring an organisation's performance against others in the same industry. For this PPP Project, KPIs will be used to monitor and quantitatively assess how the concessionaire is performing in relation to the strategic objectives and targets of the project.

In general, KPIs are increasingly being used by regulatory bodies to analyse and review organisation's performance, compare organisations, and measure progress against set targets. They are assessment tools which enable regulators to evaluate the performance of water supply services.

The International Water Association (IWA) developed a set of 170 PIs – based on 232 variables that need to be monitored regularly. These were broadly categorised as follows:

- Water Resources
- Personnel
- Physical
- Operational
- Quantity of Water Supplied
- Economic and Financial

Another interesting reference is set by the International Benchmarking Network (IBNET) platform, including indicators that were designed for utilities that distribute water and/or collect wastewater; and may also abstract and treat water and/or treat wastewater. These indicators have been grouped under 12 headings as follows:

- Service Coverage
- Water consumption and production
- Nonrevenue water
- Metering Practices
- Pipe Network Performance
- Costs and Staff
- Quality of Services
- Billings and Collections
- Financial performance
- Assets
- Affordability of Services
- Process Indicators.

Obviously, this project focuses on the main water conveyance infrastructure rather than the water distribution network downstream, but the appropriate KPIs are picked out for that sake. Based on these references, the most relevant for the development of the present PPP are included in the following table:

Service	KPI	Unit	Definition
Capacity performance	WR1	%	Real losses during the assessment period expressed as a percentage of the system input volume during the assessment period.

Service	KPI	Unit	Definition
Water Quality	E.Coli	unit	Number of supply points at which E. coli samples are greater than the target value divided by the total number of supply points for which samples are taken. WHO
Total dissolved solids	TDS	mg/ (Threshold < 1000)	Number of treated water tests carried out during the evaluation period / number of treated water tests required by standards or number of treated water tests required by standards or legislation during the evaluation period, at the reservoir tanks.
Disinfection	Chlorine residual	mg/l (Threshold 0,2-0,5)	Number of treated water tests carried out during the evaluation period / number of treated water tests required by standards or number of treated water tests required by standards or legislation during the evaluation period, at the reservoir tanks

Table 16. Main KPIs proposed to be used at the KWC PPP

These indicators shall be used as well to determine the tariff to be paid to the Concessionaire, depending on the performance and availability of proper drinking water at the end point of the system.

Nevertheless, additional KPIs that could be applied progressively to obtain more detailed information about the performance of the system are also included herein:

Service	KPI	Unit	Definition
Tests performed	Op 40	%	Number of treated water tests carried out during the evaluation period / number of treated water tests required by standards or number of treated water tests required by standards or legislation during the evaluation period x 100
Organoleptic tests performed	Op41	%	Number of organoleptic tests of treated water carried out during the evaluation period / number of organoleptic tests of treated water required by standards or legislation during the evaluation period x 100
Microbiological tests carried out	Op42	%	Number of microbiological tests of treated water carried out during the evaluation period / number of microbiological tests of treated water required by standards or legislation during the assessment period x 100
Physico-chemical tests carried out	Op43	%	Number of physico-chemical tests of treated water carried out during the evaluation period / number of physico-chemical tests of treated water required by standards or legislation during the evaluation period x 100
Reliability Functioning time:		%	Functioning time during a particular period divided by the duration of that period
Water losses per mains length	Op24	m^3/km/day	Water losses during the assessment period expressed by total water conveyance infrastructure length
Standardised energy consumption	Ph5	kWh /m^3/m	Average pumping energy consumption in the system per 1 m^3 at 1m head
Non-revenue water by volume	Fi46	%	Percentage of system input volume that corresponds to non-revenue water
Reliability		Days/hours	Functioning time: the number of days in a month or year when the system is in operation

Service	KPI	Unit	Definition
Employees per water produced	Pe2	No. /(m³/year)	Number of full-time equivalent employees of the water utility expressed with respect to water produced during the assessment period
Training		days	Number of days spent on training per year

Table 17. Additional KPIs that could complement and enhance the KWC PPP follow-up

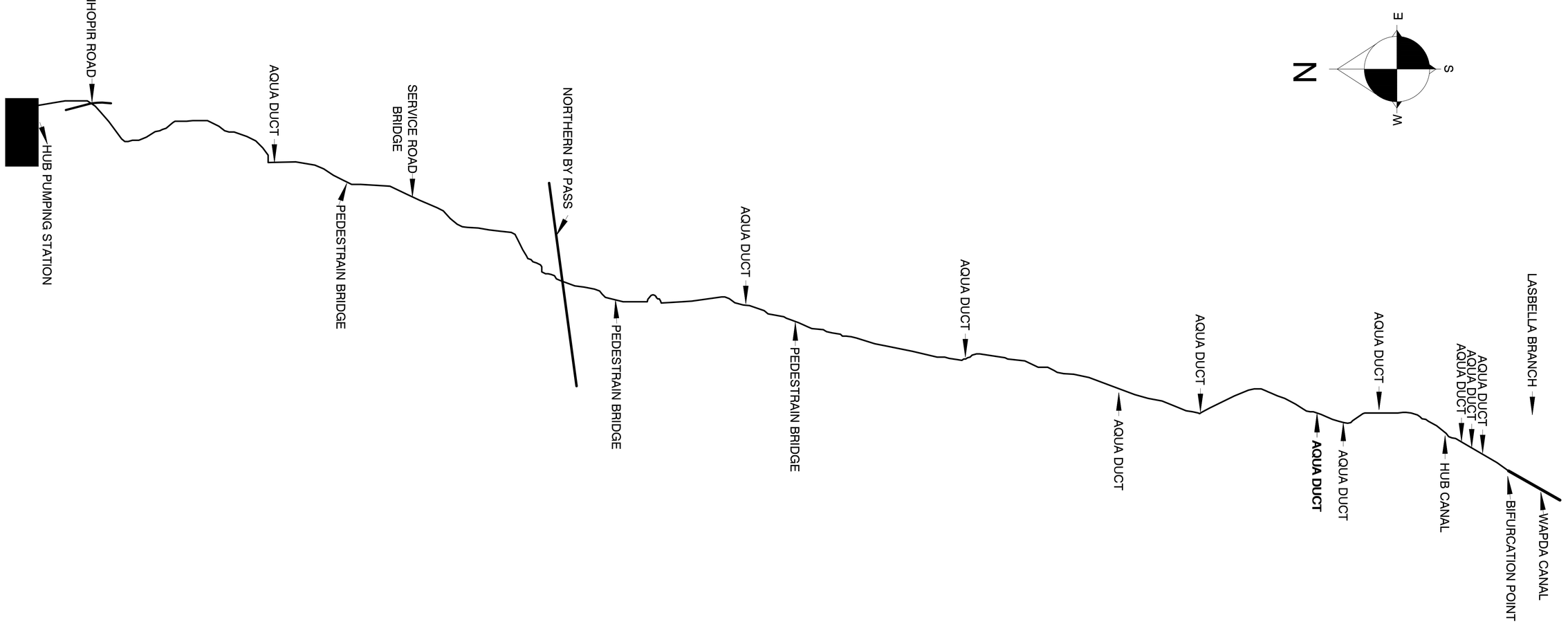
ANNEXES

Annex 1. Drawings of the Existing Facilities

CONSULTING SERVICES KARACHI WATER CANAL PPP

Annex 1. EXISTING DRAWING

CONSULTING SERVICES KARACHI WATER CANAL PPP



CONSULTANTS:

ENGINEERING ASSOCIATES
AL,-9, 15TH LANE, KHYBAN-E-HILAL
PHASE VII, DHA, KARACHI# 75500.
info@eaworld.com

CLIENT:

KARACHI WATER & SEWERAGE BOARD

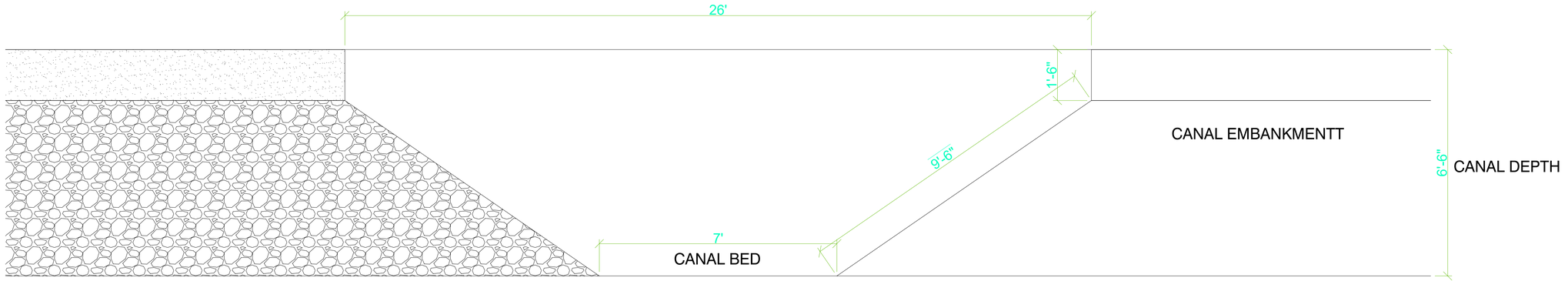
Rev	Date	Drawn	Description	Ch'k'd	App'd

PROJECT:
REHABILITATION OF HUB CANAL

TITLE: GENERAL LAYOUT PLAN

Drawing No. EA/KW&SB/HC/01

DRAWN	M. IMTYAZ KHAN AFRIDI
DESIGN	M.A.
CHECKED	M.A.
APPROVED	A.H.S.
SCALE	N.T.S.
REV	--



CROSS SECTION OF HUB CANAL

CONSULTANTS:

ENGINEERING ASSOCIATES
AL,-9, 15TH LANE, KHYBAN-E-HILAL
PHASE VII, DHA, KARACHI# 75500.
info@eaworld.com

CLIENT:

KARACHI WATER & SEWERAGE BOARD

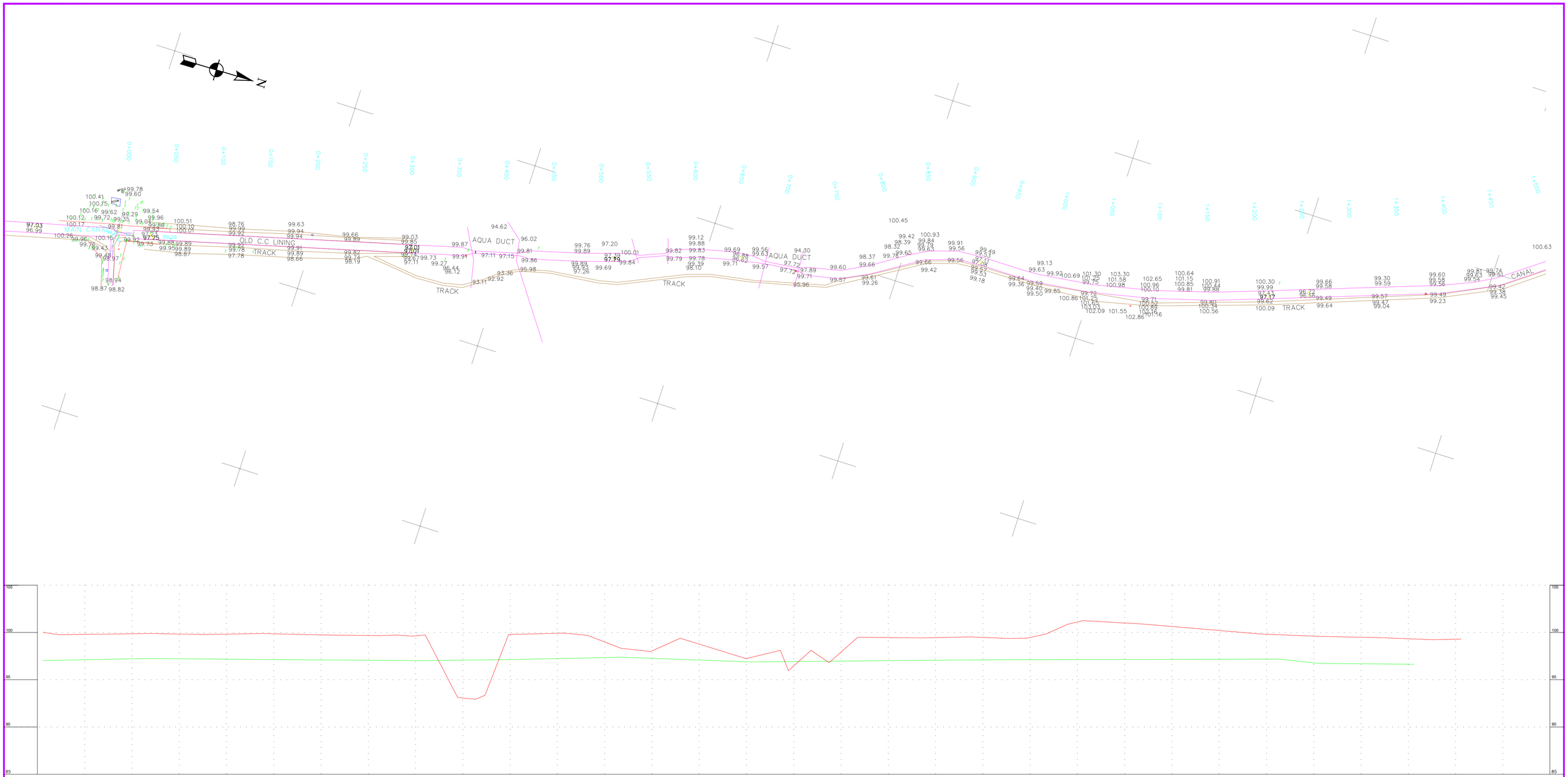
Rev	Date	Drawn	Description	Ch'k'd	App'd

PROJECT: REHABILITATION OF HUB CANAL

TITLE: CROSS SECTION HUB CANAL

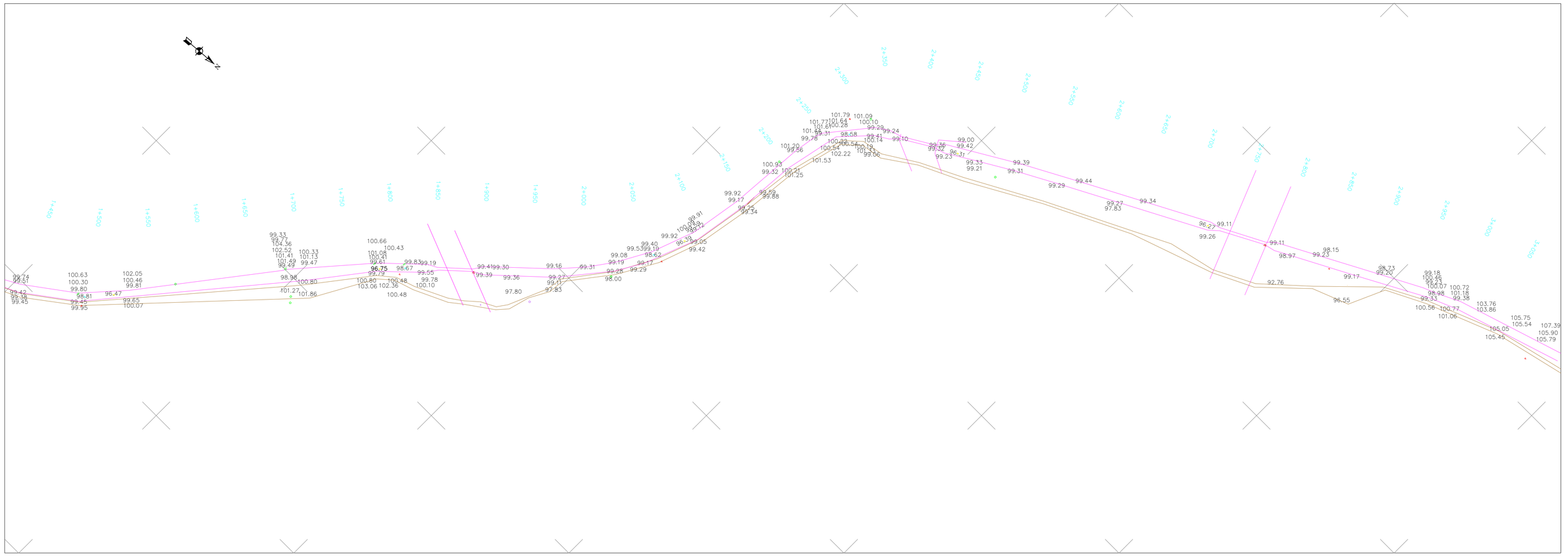
Drawing No. EA/KW&SB/HC/01

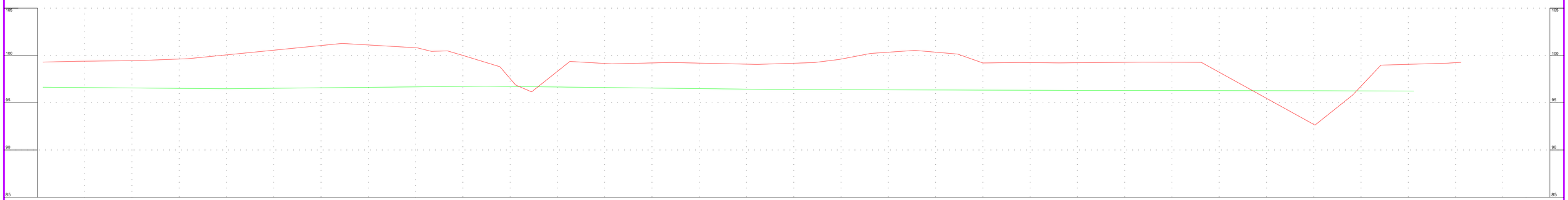
DRAWN	M. IMTYAZ KHAN AFRIDI
DESIGN	M.A.
CHECKED	M.A.
APPROVED	A.H.S.
SCALE	N.T.S.
REV	--


N
MAIN CANAL
QLD C.C LINING
TRACK
AQUA DUCT
AQUA DUCT
TRACK
TRACK
TRACK
CANAL

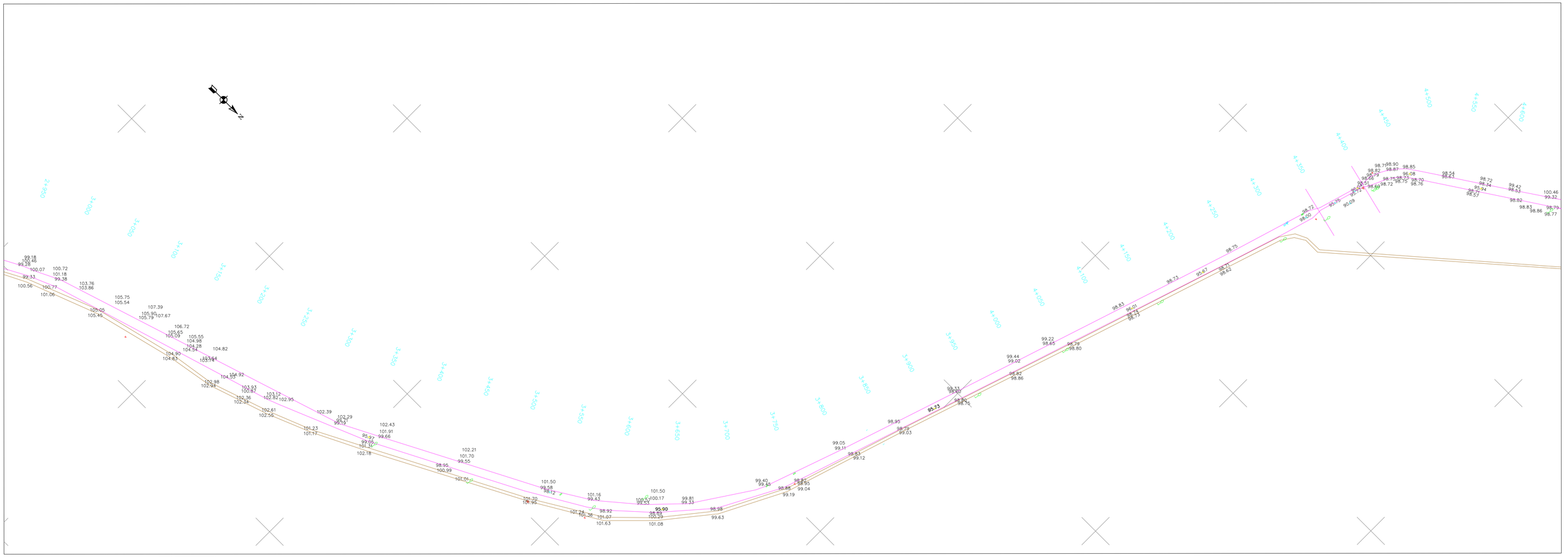
105
100
95
90
85

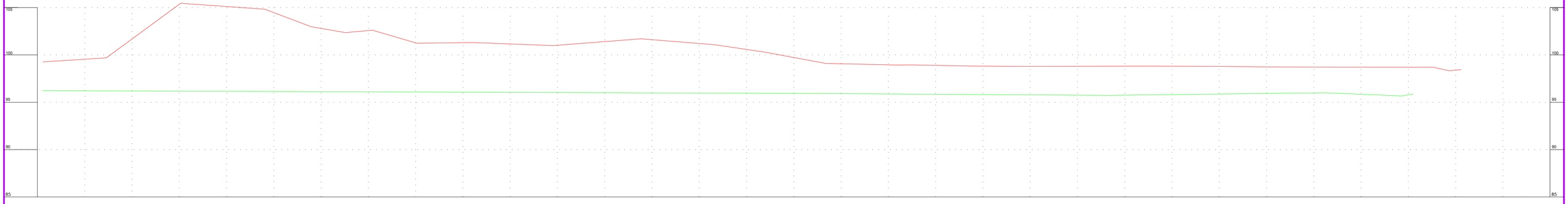
| | | |


1+450
1+500
1+550
1+600
1+650
1+700
1+750
1+800
1+850
1+900
1+950
2+000
2+050
2+100
2+150
2+200
2+250
2+300
2+350
2+400
2+450
2+500
2+550
2+600
2+650
2+700
2+750
2+800
2+850
2+900
2+950
3+000
3+050

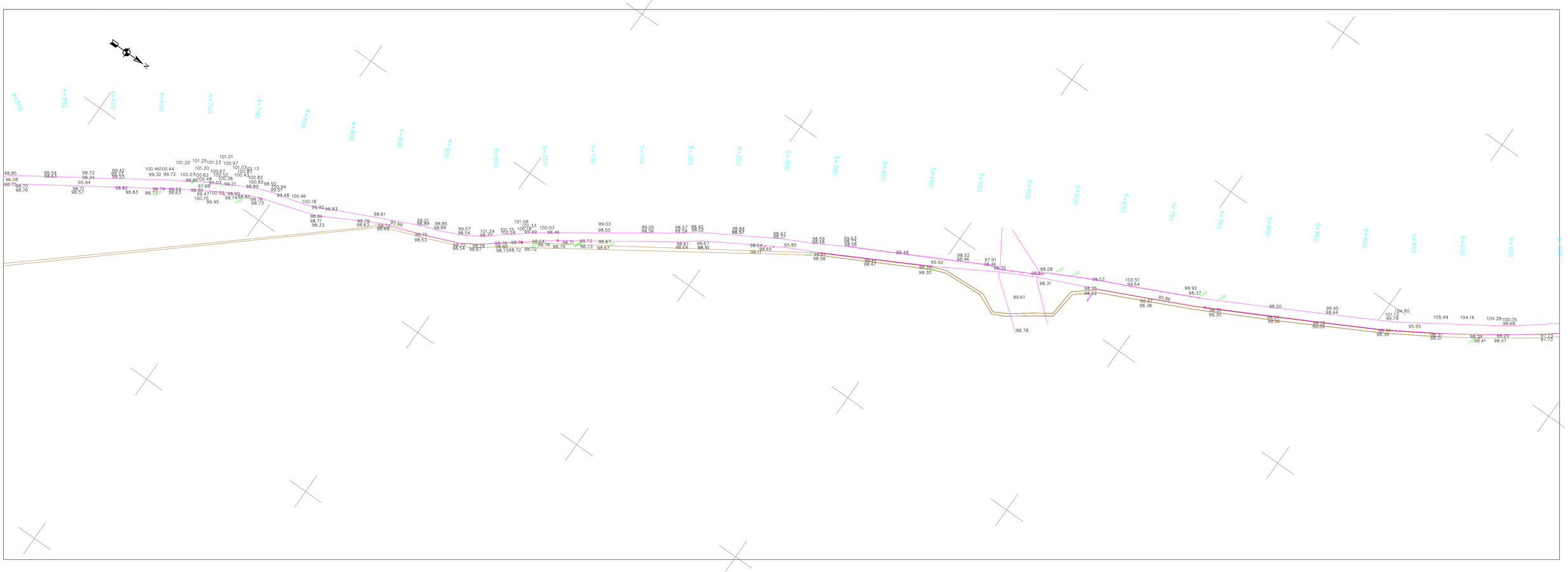

105
100
95
90
85

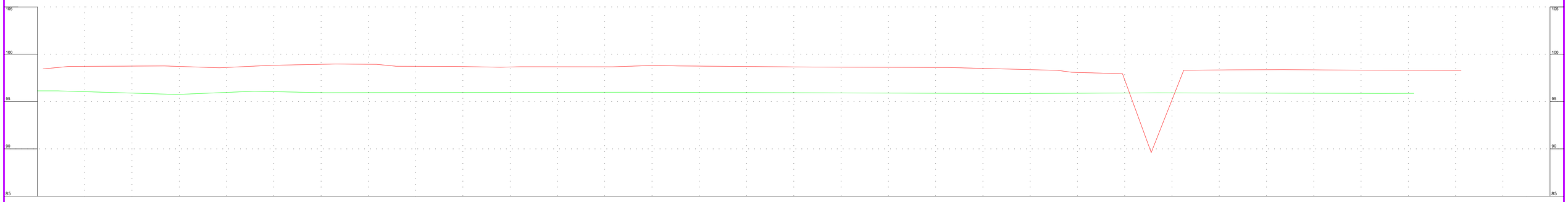
| | | |


N
2+950
3+000
3+050
3+100
3+150
3+200
3+250
3+300
3+350
3+400
3+450
3+500
3+550
3+600
3+650
3+700
3+750
3+800
3+850
3+900
3+950
4+000
4+050
4+100
4+150
4+200
4+250
4+300
4+350
4+400
4+450
4+500
4+550
4+600

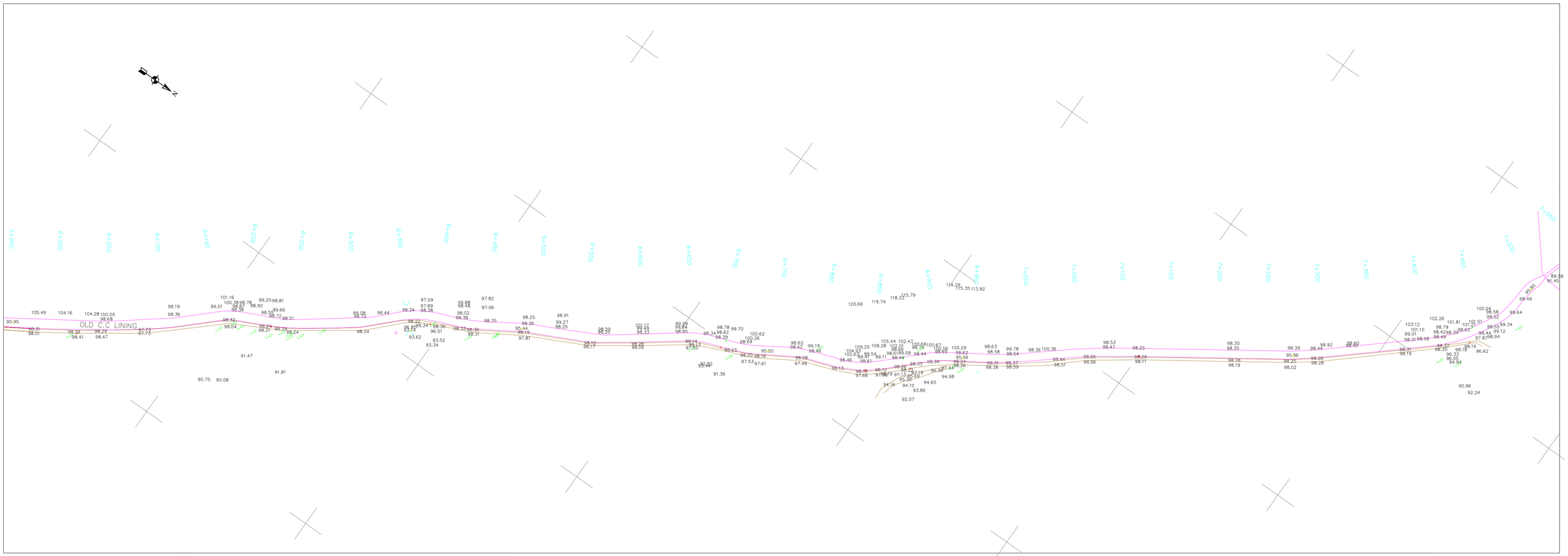

105
100
95
90
85

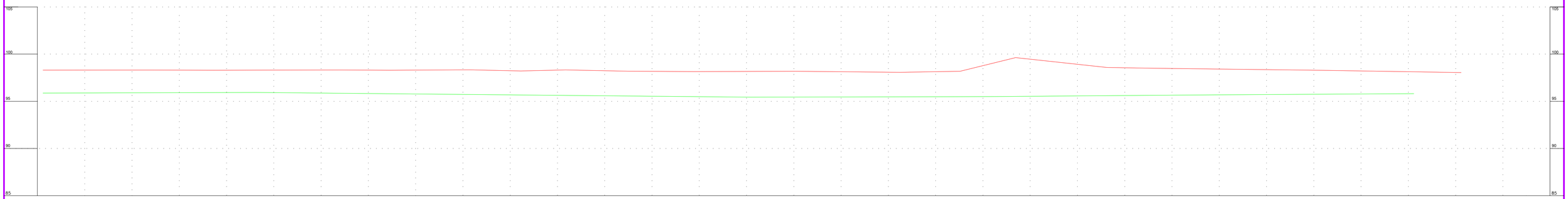
| | | |


4+500
4+550
4+600
4+650
4+700
4+750
4+800
4+850
4+900
4+950
5+000
5+050
5+100
5+150
5+200
5+250
5+300
5+350
5+400
5+450
5+500
5+550
5+600
5+650
5+700
5+750
5+800
5+850
5+900
5+950
6+000
6+050
6+100

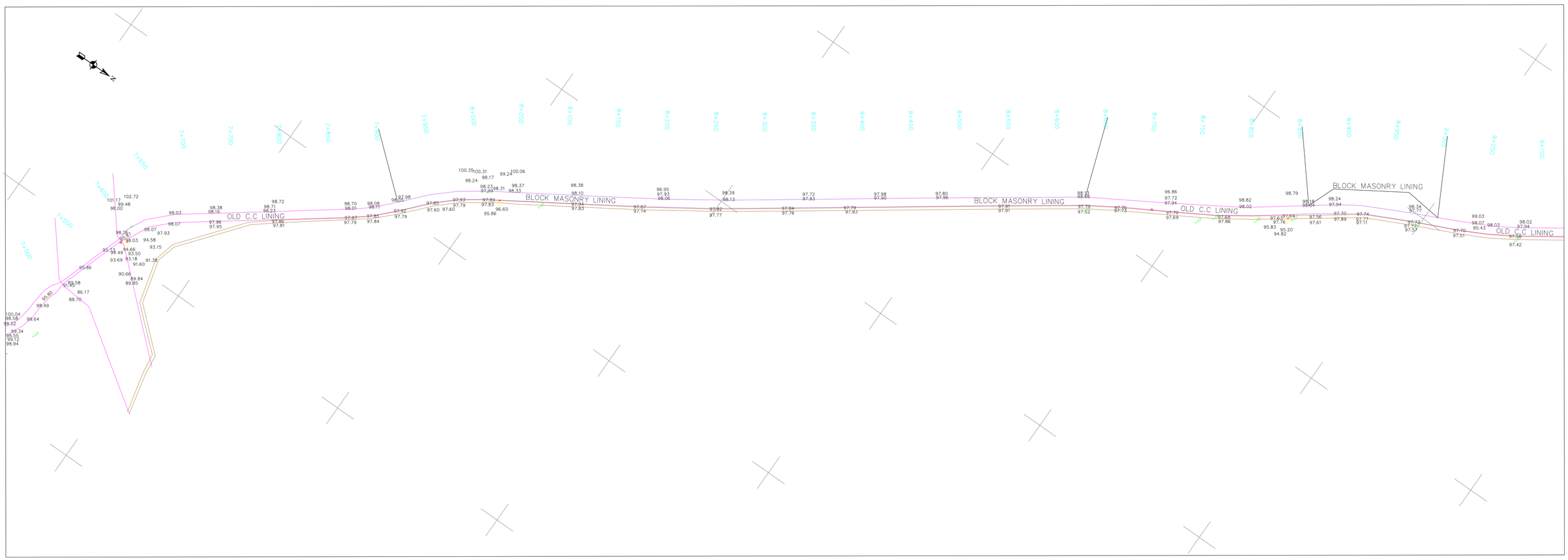

105
100
95
90
85

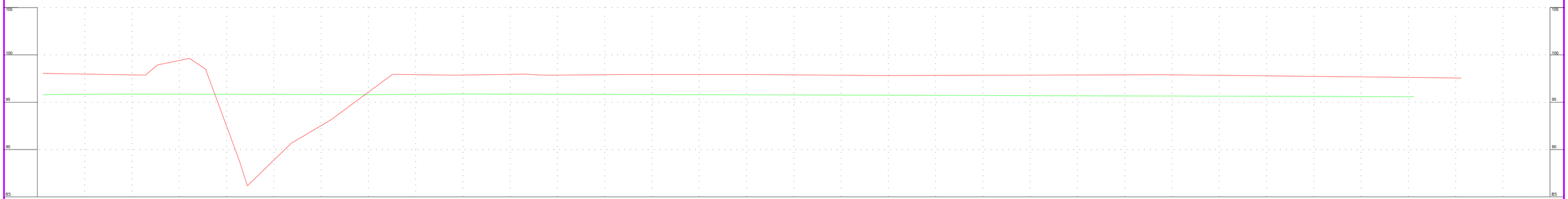
| | | |


N
OLD C.C LINING
5+950
6+000
6+050
6+100
6+150
6+200
6+250
6+300
6+350
6+400
6+450
6+500
6+550
6+600
6+650
6+700
6+750
6+800
6+850
6+900
6+950
7+000
7+050
7+100
7+150
7+200
7+250
7+300
7+350
7+400
7+450
7+500

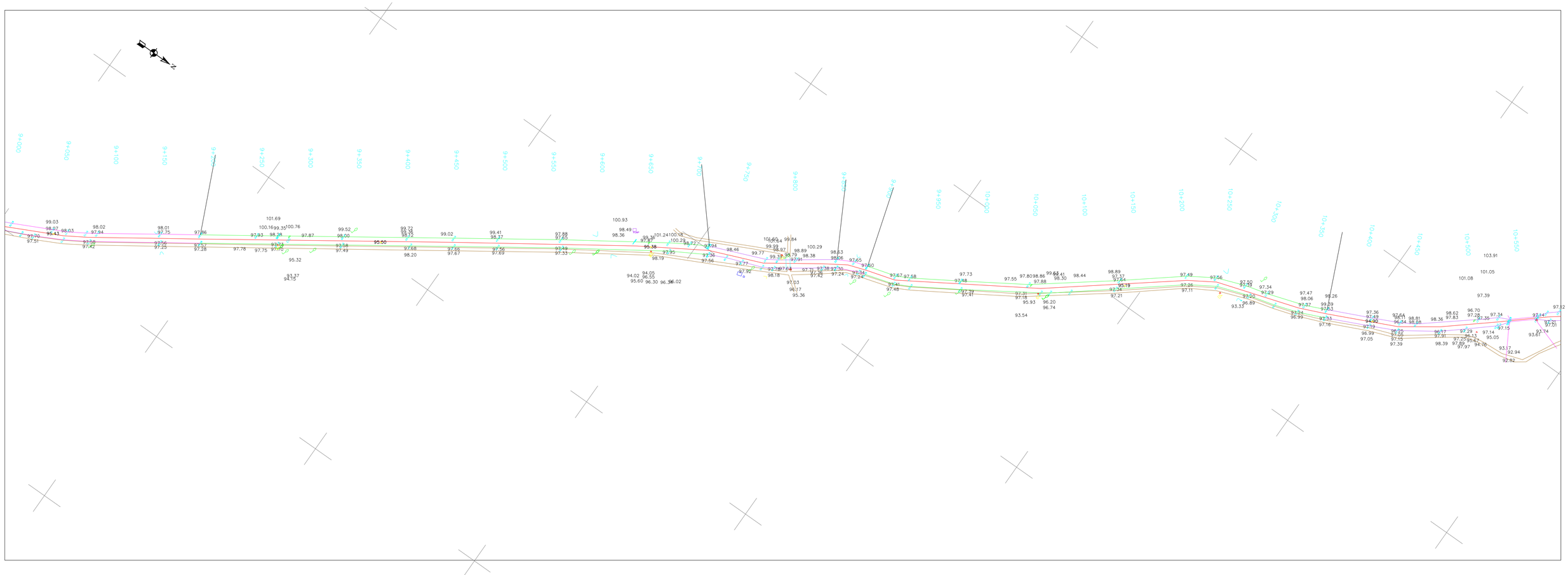

105
100
95
90
85

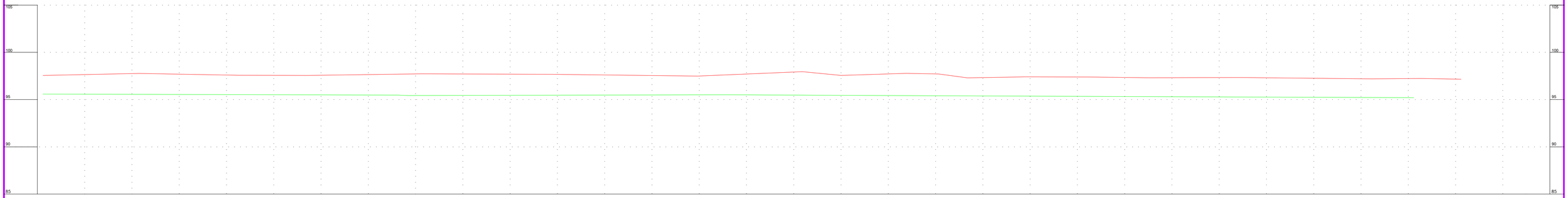
| | | |


7+450
7+500
7+550
7+600
7+650
7+700
7+750
7+800
7+850
7+900
7+950
8+000
8+050
8+100
8+150
8+200
8+250
8+300
8+350
8+400
8+450
8+500
8+550
8+600
8+650
8+700
8+750
8+800
8+850
8+900
8+950
9+000
9+050
9+100
OLD C.C LINING
BLOCK MASONRY LINING
BLOCK MASONRY LINING
OLD C.C LINING
BLOCK MASONRY LINING
OLD C.C LINING

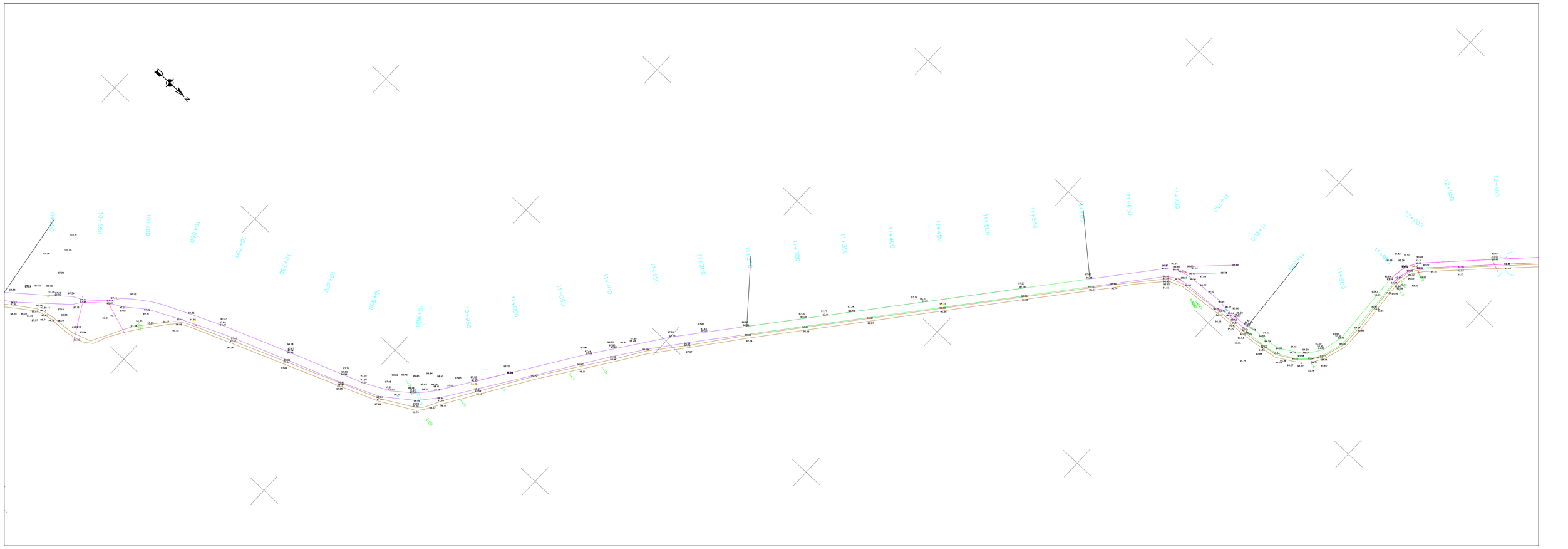

105
100
95
90
85

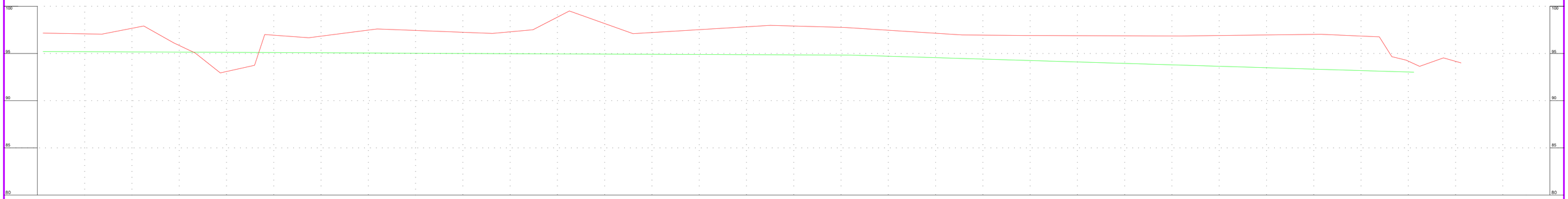
| | | |


9+000
9+050
9+100
9+150
9+200
9+250
9+300
9+350
9+400
9+450
9+500
9+550
9+600
9+650
9+700
9+750
9+800
9+850
9+900
9+950
10+000
10+050
10+100
10+150
10+200
10+250
10+300
10+350
10+400
10+450
10+500
10+550

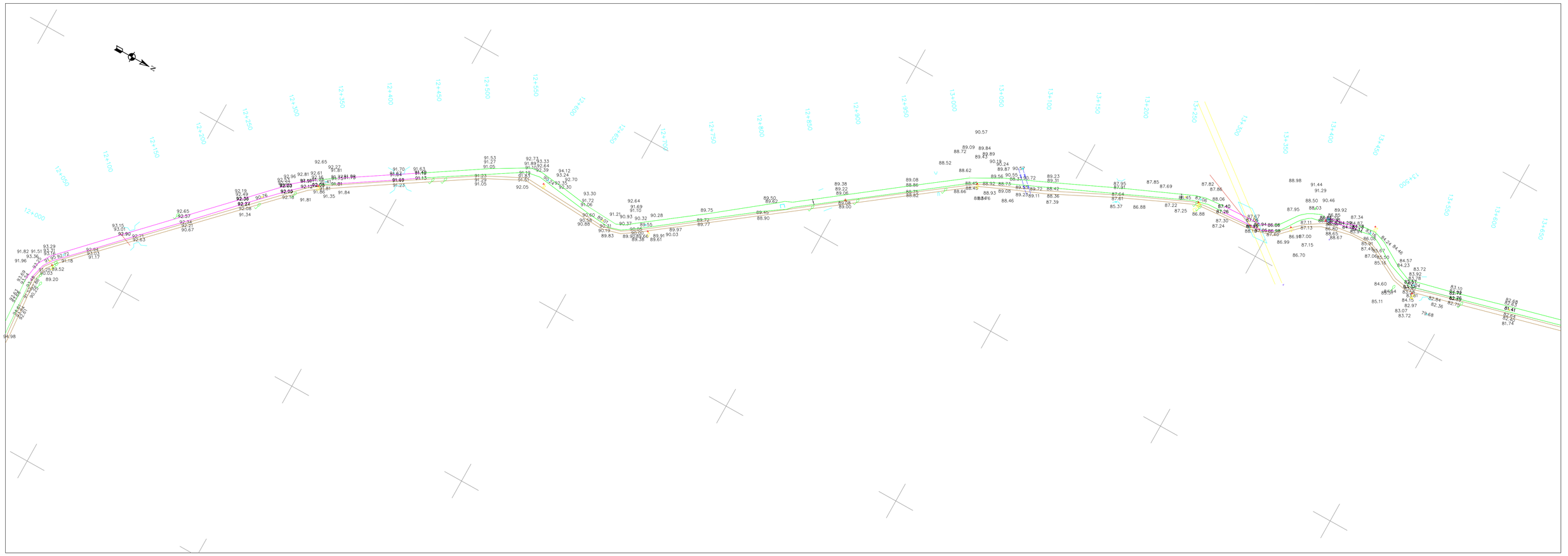

105
100
95
90
85

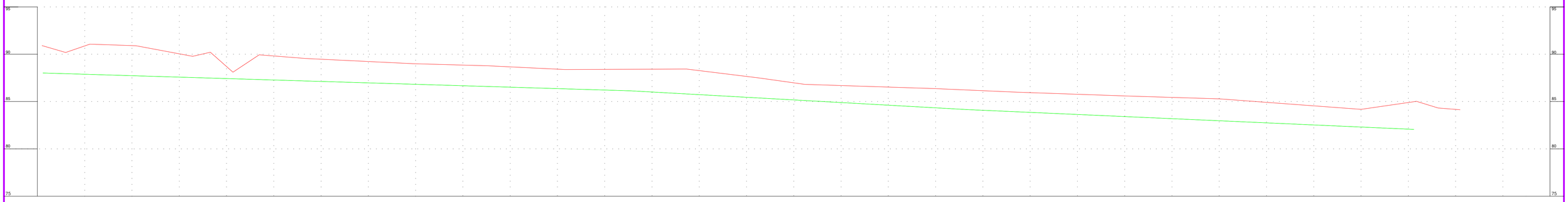
| | | |


10+000
10+050
10+100
10+150
10+200
10+250
10+300
10+350
10+400
10+450
10+500
10+550
10+600
10+650
10+700
10+750
10+800
10+850
10+900
10+950
11+000
11+050
11+100
11+150
11+200
11+250
11+300
11+350
11+400
11+450
11+500
11+550
11+600
11+650
11+700
11+750
11+800
11+850
11+900
11+950
12+000
12+050
12+100

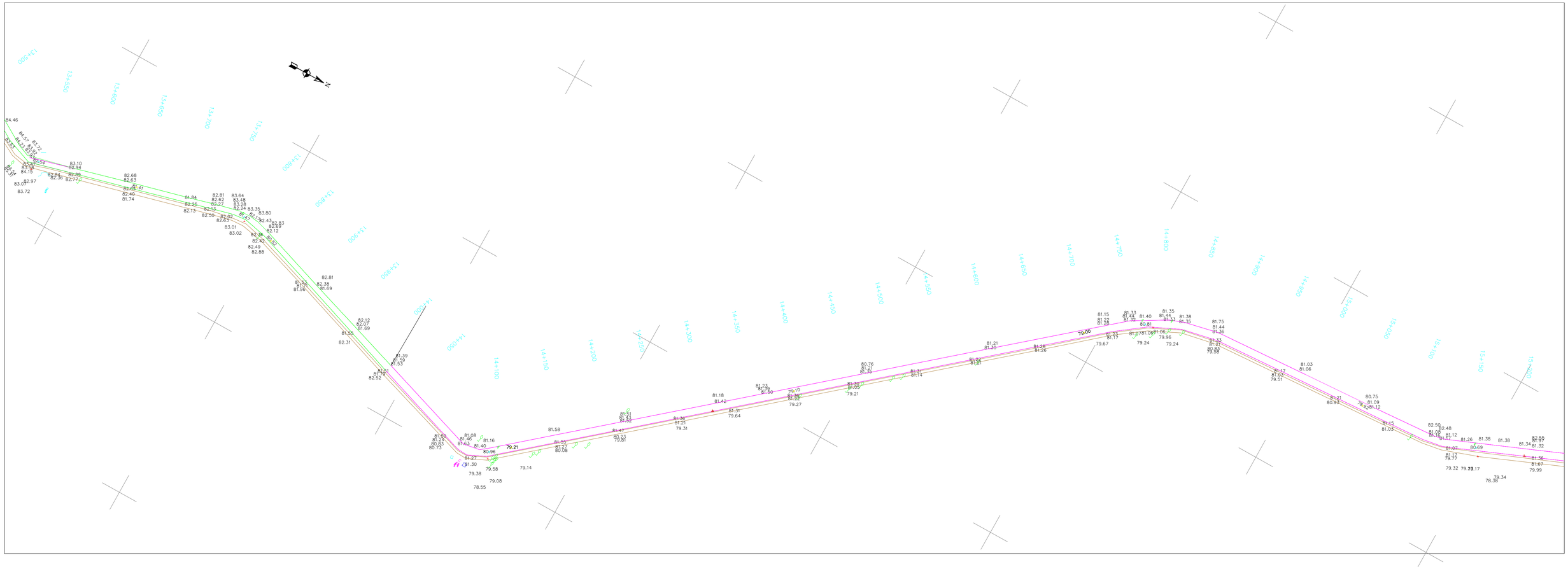

100
95
90
85
80

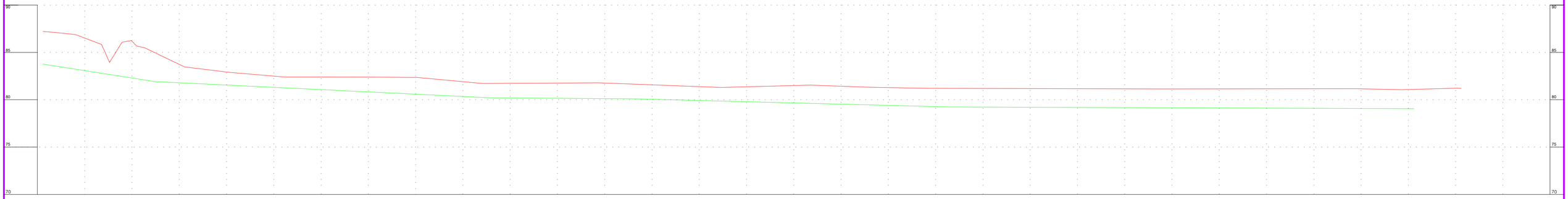
| | | |


12+000
12+050
12+100
12+150
12+200
12+250
12+300
12+350
12+400
12+450
12+500
12+550
12+600
12+650
12+700
12+750
12+800
12+850
12+900
12+950
13+000
13+050
13+100
13+150
13+200
13+250
13+300
13+350
13+400
13+450
13+500
13+550
13+600
13+650

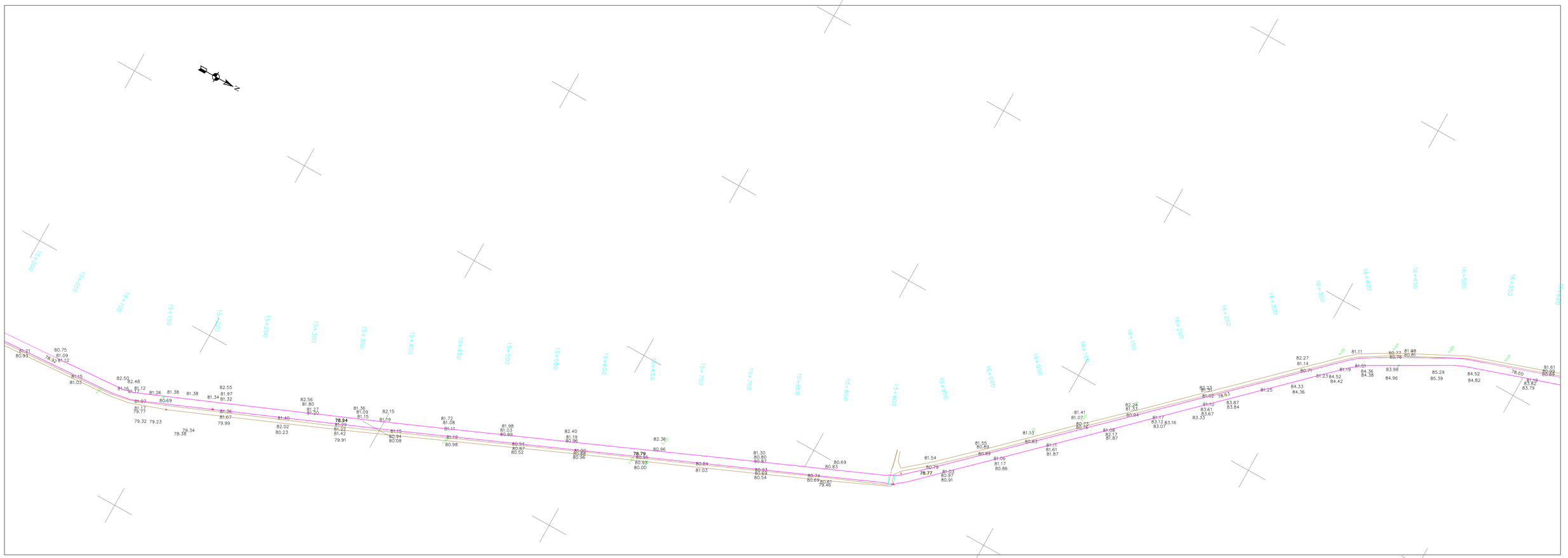

95
90
85
80
75

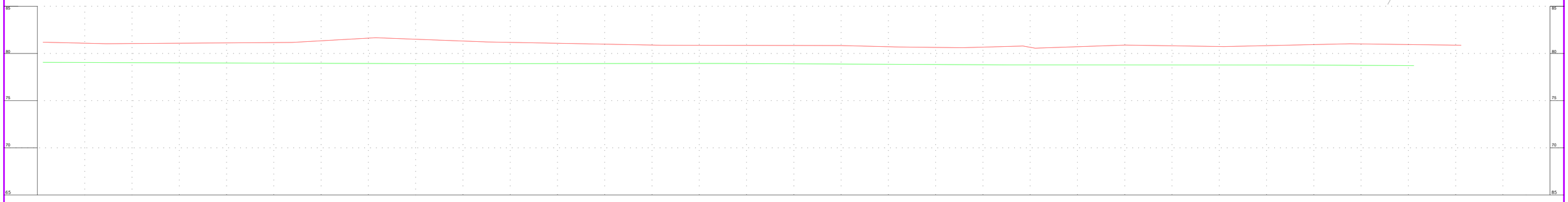
| | | |


13+500
13+550
13+600
13+650
13+700
13+750
13+800
13+850
13+900
13+950
14+000
14+050
14+100
14+150
14+200
14+250
14+300
14+350
14+400
14+450
14+500
14+550
14+600
14+650
14+700
14+750
14+800
14+850
14+900
14+950
15+000
15+050
15+100
15+150
15+200
N

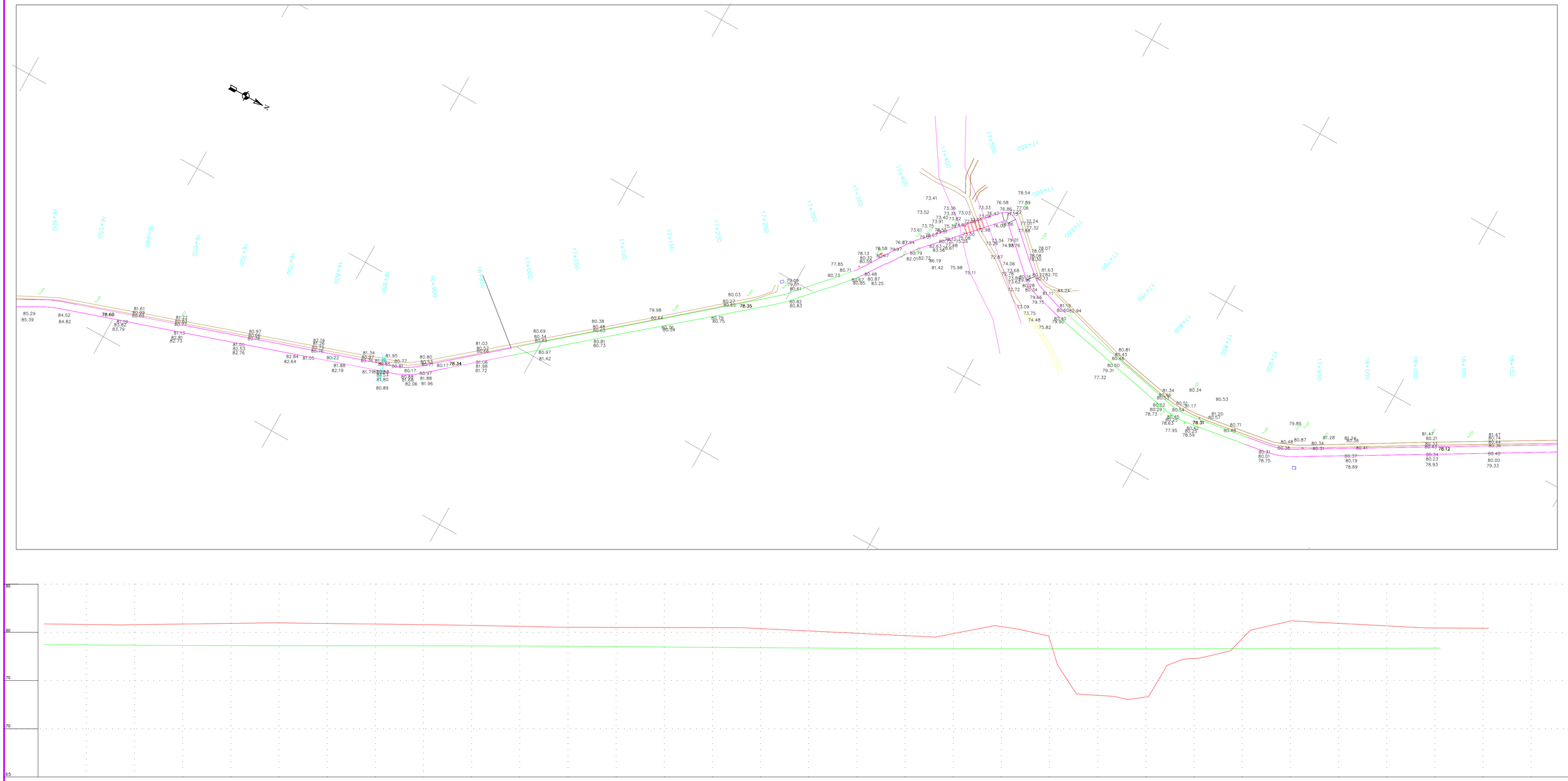

90
85
80
75
70

| | | |


N
15+000
15+050
15+100
15+150
15+200
15+250
15+300
15+350
15+400
15+450
15+500
15+550
15+600
15+650
15+700
15+750
15+800
15+850
15+900
15+950
16+000
16+050
16+100
16+150
16+200
16+250
16+300
16+350
16+400
16+450
16+500
16+550
16+600

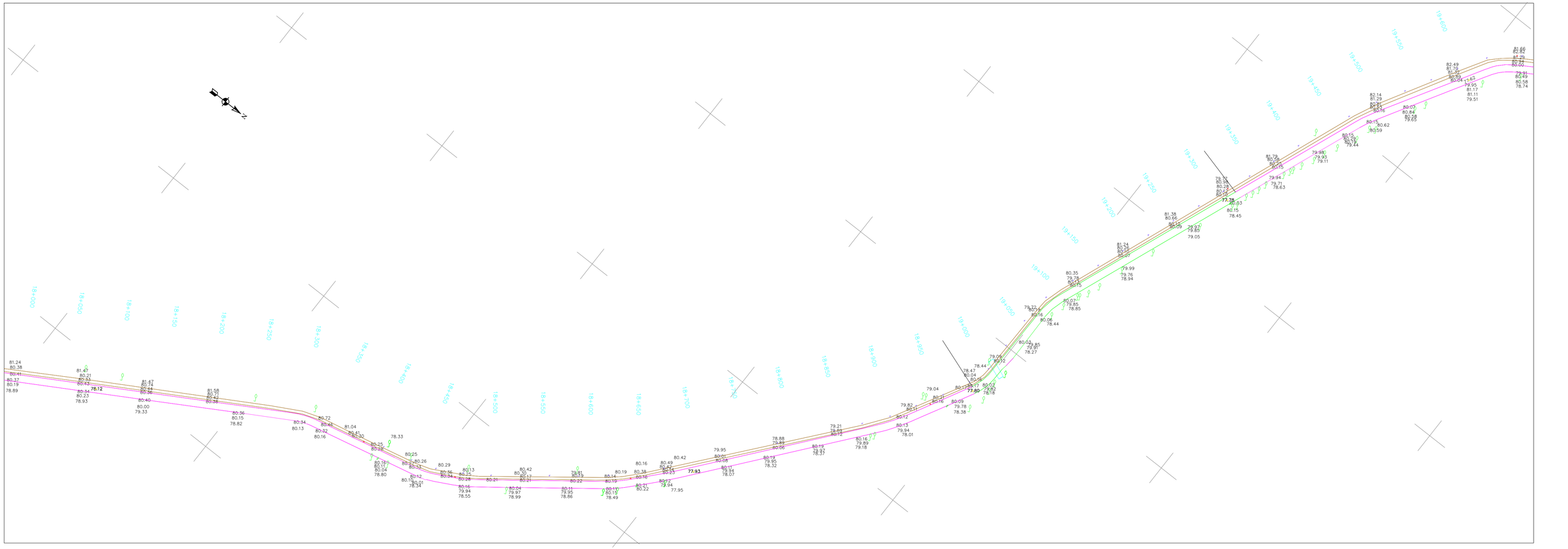

85
80
75
70
65

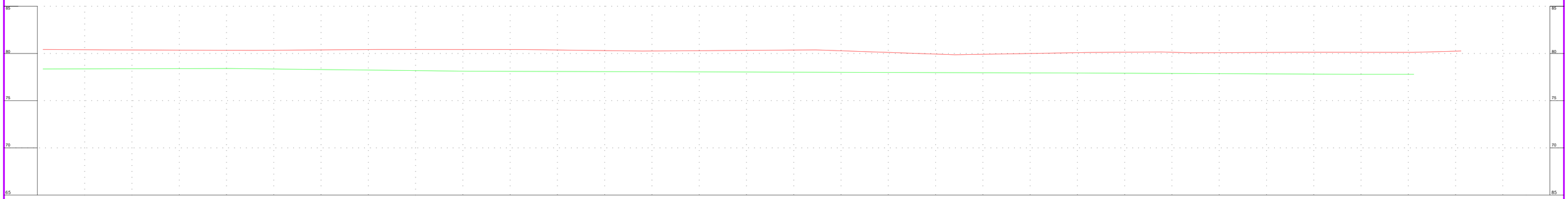
| | | |


16+500
16+550
16+600
16+650
16+700
16+750
16+800
16+850
16+900
16+950
17+000
17+050
17+100
17+150
17+200
17+250
17+300
17+350
17+400
17+450
17+500
17+550
17+600
17+650
17+700
17+750
17+800
17+850
17+900
17+950
18+000
18+050
18+100
18+150

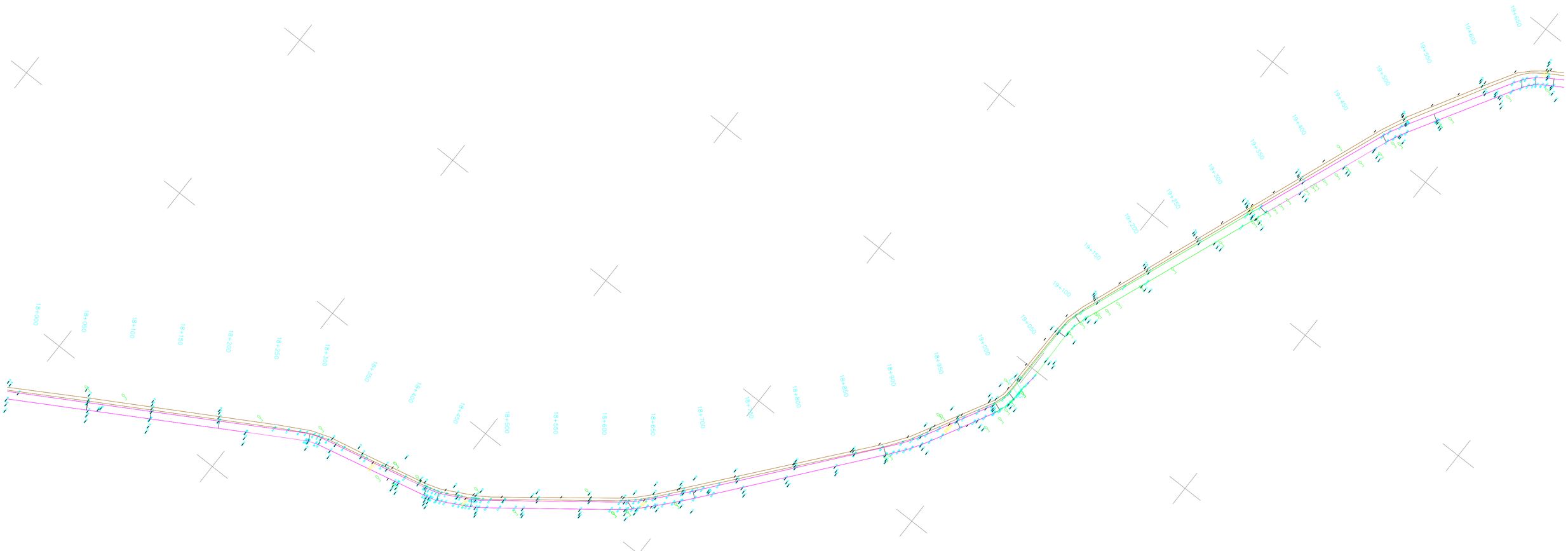
85
80
75
70
65

| | | |


18+000
18+050
18+100
18+150
18+200
18+250
18+300
18+350
18+400
18+450
18+500
18+550
18+600
18+650
18+700
18+750
18+800
18+850
18+900
18+950
19+000
19+050
19+100
19+150
19+200
19+250
19+300
19+350
19+400
19+450
19+500
19+550
19+600
N


85
80
75
70
65

| | | |



GROUND ELEVATION

INVERT ELEVATION	CHANNAGE
77.797	18850
77.795	18900
77.792	18950
77.789	19000
77.786	19050
77.783	19100
77.782	19119.208
77.764	19150
77.735	19200
77.706	19250
77.677	19300
77.648	19350
77.62	19397.998
77.62	19400
77.619	19450
77.618	19500
77.617	19550
77.616	19600
77.615	19650
77.615	19654.769
77.603	19700
77.589	19750
77.575	19800
77.561	19850
77.548	19900
77.534	19950
77.532	19956.953
77.493	20000
77.447	20050
77.402	20100
77.392	20110.896
77.382	20150
77.37	20200
77.357	20250
77.356	20256.047
77.361	20300

ABBREVIATIONS :

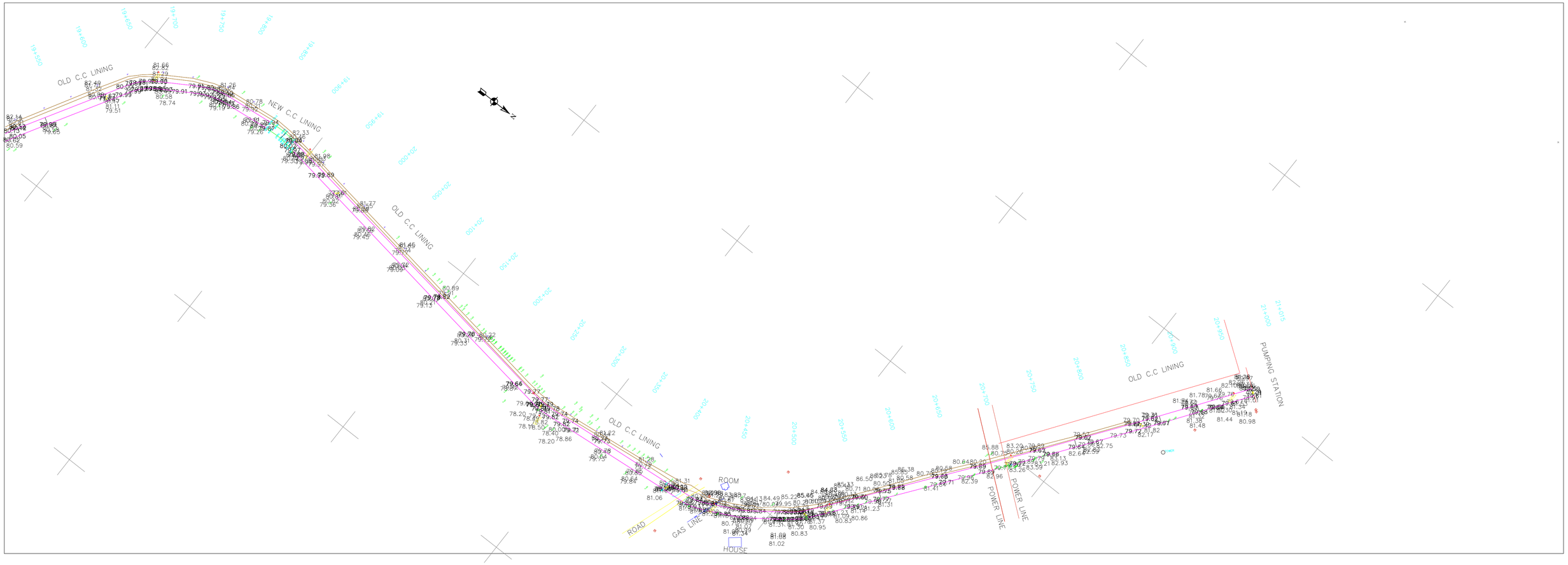
TP = TURNING POINT
TS = TRAVERSE STATION
CH = CHAINAGE
E = EASTING
N = NORTHING
HT = HEIGHT ABOVE MEAN SEA LEVEL
D = DISTANCE FROM BACK STATION
B = BEARING AT BACK STATION
DA = DEFLECTION ANGLE
TBC = THRUST BORE CASED
TBU = THRUST BORE UNCASED
OCU = OPEN CUT UNCASED
CL HT. = VERTICAL CLEARENCE OF HIGHTENSION/POWER LINE

LEGEND :

TRAVERSE LINE WITH POINTS
RIGHT OF WAY (PERMANENT)
RIGHT OF WAY (TEMPORARY)
EXISTING METALLED\PAVED ROAD
EXISTING UNMETALLED\UNPAVED RD.
CART TRACK
RAILWAY LINE
TELEPHONE & TELEGRAPH LINE
POWER LINE (LOW TENSION)
POWER LINE (HIGH TENSION)
UNDER GROUND CABLE

FENCING
OIL PIPELINE
BUND(EMBANKMENT)
BRIDGE\CULVERT
GAS PIPELINE
WATER PIPELINE
WATER COURSE
CANAL\WAH
SMALL DISTRIBUTARY
DRAIN
NALLAH

TEMPORARY BENCH MARK\KM STONE



GROUND ELEVATION										
INVERT ELEVATION	77.361	77.366	77.371	77.376	77.381	77.387	77.392	77.393	77.343	77.279	77.239
CHANNAGE	20300	20350	20400	20450	20500	20550	20600	20611.484	20650	20700	20731.294

NOTES:-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE STATED.

ABBREVIATIONS :

TP = TURNING POINT
TS = TRAVERSE STATION
CH = CHAINAGE
E = EASTING
N = NORTHING
HT = HEIGHT ABOVE MEAN SEA LEVEL
D = DISTANCE FROM BACK STATION
B = BEARING AT BACK STATION
DA = DEFLECTION ANGLE
TBC = THRUST BORE CASED
TBU = THRUST BORE UNCASED
OCU = OPEN CUT UNCASED
CL HT. = VERTICAL CLEARENCE OF HIGHTENSION/POWER LINE

LEGEND :

TRAVERSE LINE WITH POINTS
RIGHT OF WAY (PERMANENT)
RIGHT OF WAY (TEMPORARY)
EXISTING METALLED\PAVED ROAD
EXISTING UNMETALLED\UNPAVED RD.
CART TRACK
RAILWAY LINE
TELEPHONE & TELEGRAPH LINE
POWER LINE (LOW TENSION)
POWER LINE (HIGH TENSION)
UNDER GROUND CABLE

FENCING
OIL PIPELINE
BUND(EMBANKMENT)
BRIDGE\CULVERT
GAS PIPELINE
WATER PIPELINE
WATER COURSE
CANAL\WAH SMALL DISTRIBUTARY
DRAIN
NALLAH

BUILDING PUCCA\KUTCHA
HUT PERMANENT\TEMPORARY
CULTIVATED AREA
SAND DUNE
GRAVE YARD
PROMINENT TREES, DATE TREES, BUSHES
CHARGING POINT
TEMPORARY BENCH MARK\KM STONE
DEPRESSION WITH RELATIVE DEPTH
HAND PUMP\WELL\TUBEWELL
MOSQUE

VALVE ASSEMBLY
ANCHOR BLOCK

REV	DATE	DESCRIPTION OF REVISION	DRAWN	CKD.	APPR.
0.	03-03-2008	FOR REVIEW / APPROVAL	SHAKEEL	S.A	

CLIENT : KWSB

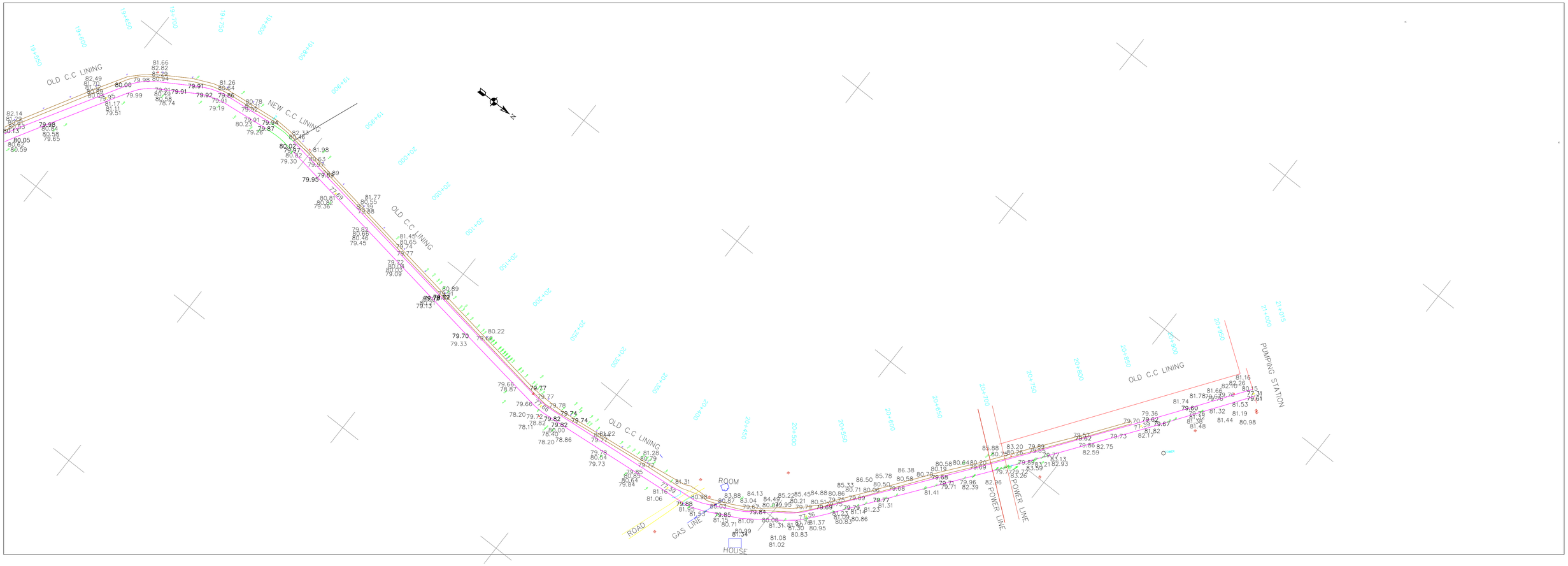
CONSULTANT: ENGINEERING ASSOCIATE (pvt.) LTD.

SURVEYED BY: KOHINOOR SURVEY ENGINEER'S
SHOP # 08 FALK NAZ VIEW OPP. JINNAH TERMINAL SHAHRAH E FAISAL KARACHI.
TELEPHONE: 92-21 5447319-4604047-03002196614

TITLE: – TOPOGRAPHIC SURVEY OF KARCHI CANAL ZERO POINT TO PUMPING STATION

DRAWING NO.540-PP-015 | JOB NO. 540

SHEET: 15 OF 15 | SHEET SIZE – A1 | HOR.SCALE : 1:2000 –VER. :1=200



GROUND ELEVATION										
INVERT ELEVATION	77.361	77.366	77.371	77.376	77.381	77.387	77.392	77.393	77.343	77.279	77.239
CHANNAGE	20300	20350	20400	20450	20500	20550	20600	20611.484	20650	20700	20731.294

NOTES:-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE STATED.

ABBREVIATIONS :

TP = TURNING POINT
TS = TRAVERSE STATION
CH = CHAINAGE
E = EASTING
N = NORTHING
HT = HEIGHT ABOVE MEAN SEA LEVEL
D = DISTANCE FROM BACK STATION
B = BEARING AT BACK STATION
DA = DEFLECTION ANGLE
TBC = THRUST BORE CASED
TBU = THRUST BORE UNCASED
OCU = OPEN CUT UNCASED
CL HT. = VERTICAL CLEARENCE OF HIGHTENSION/POWER LINE

LEGEND :

TRAVERSE LINE WITH POINTS
RIGHT OF WAY (PERMANENT)
RIGHT OF WAY (TEMPORARY)
EXISTING METALLED\PAVED ROAD
EXISTING UNMETALLED\UNPAVED RD.
CART TRACK
RAILWAY LINE
TELEPHONE & TELEGRAPH LINE
POWER LINE (LOW TENSION)
POWER LINE (HIGH TENSION)
UNDER GROUND CABLE

FENCING
OIL PIPELINE
BUND(EMBANKMENT)
BRIDGE\CULVERT
GAS PIPELINE
WATER PIPELINE
WATER COURSE
CANAL\WAH SMALL DISTRIBUTARY
DRAIN
NALLAH

BUILDING PUCCA\KUTCHA
HUT PERMANENT\TEMPORARY
CULTIVATED AREA
SAND DUNE
GRAVE YARD
PROMINENT TREES, DATE TREES, BUSHES
CHARGING POINT
TEMPORARY BENCH MARK\KM STONE
DEPRESSION WITH RELATIVE DEPTH
HAND PUMP\WELL\TUBEWELL
MOSQUE

VALVE ASSEMBLY
ANCHOR BLOCK

REV	DATE	DESCRIPTION OF REVISION	DRAWN	CKD.	APPR.
0.	03-03-2008	FOR REVIEW / APPROVAL	SHAKEEL	S.A	

CLIENT : KWSB

CONSULTANT: ENGINEERING ASSOCIATE (pvt.) LTD.

SURVEYED BY: KOHINOOR SURVEY ENGINEER'S
SHOP # 08 FALK NAZ VIEW OPP. JINNAH TERMINAL SHAHRAH E FAISAL KARACHI.
TELEPHONE: 92-21 5447319-4604047-03002196614

TITLE: – TOPOGRAPHIC SURVEY OF KARCHI CANAL ZERO POINT TO PUMPING STATION

DRAWING NO.540-PP-015 | JOB NO. 540

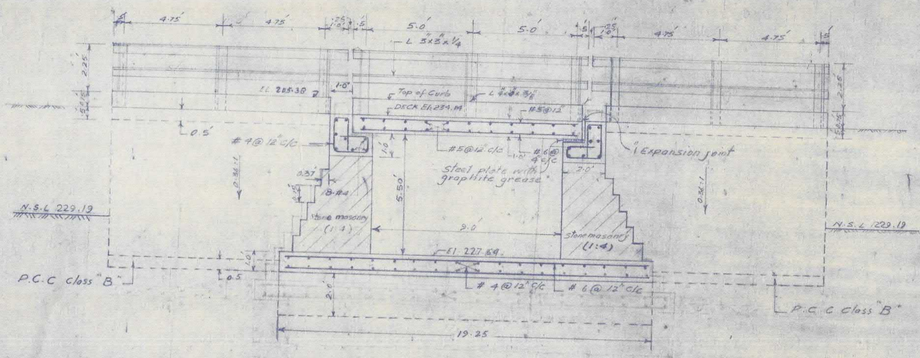
SHEET: 15 OF 15 | SHEET SIZE – A1 | HOR.SCALE : 1:2000 –VER. :1=200

EXISTING KWC: AQUEDUCTS DETAILS

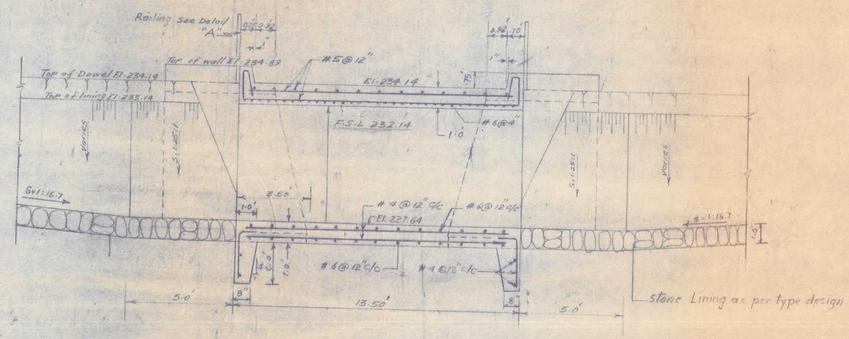
CONSULTING SERVICES KARACHI WATER CANAL PPP

1. OBJECT

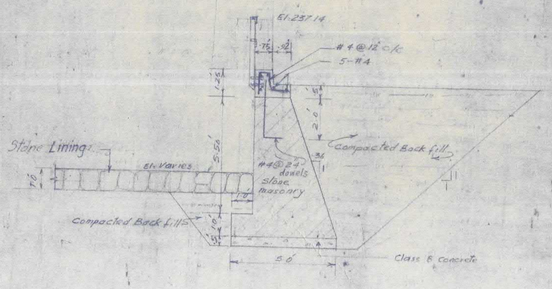
The shop drawings for the aqueducts and culverts are shown below.



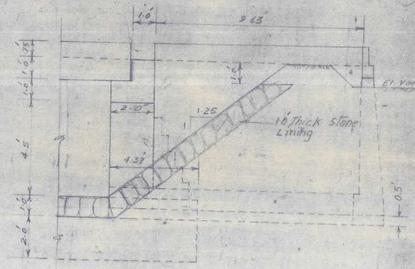
SECTION A-A
scale: 1" = 3.0'



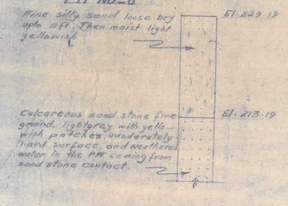
SECTION B-B
Scale: 1" = 3.0'



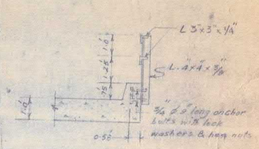
SECTION E-E
Scale: 1"=3.0'



SECTION C-C
Scale: 1"=3.0'



DETAIL "X"



DETAIL "A"
Scale: 1"=3.0'

WS/451-R-1 WS/452-	L. SECTION OF CANAL
W.S. 455-R-1	TYPICAL SECTIONS OF LINING
110-4A-C-462	PLAN OF VILLAGE ROAD CULVERT
DRAWING NO.	TITLE OF DRAWING
REFERENCE DRAWING	

REV NO.	DATE	DESCRIPTION	BY	CKD.	APPVD
1	25.9.80	Abutment Caps Revised on Sections A-A & C-C			

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

VILLAGE ROAD CULVERT AT CH. 28+17

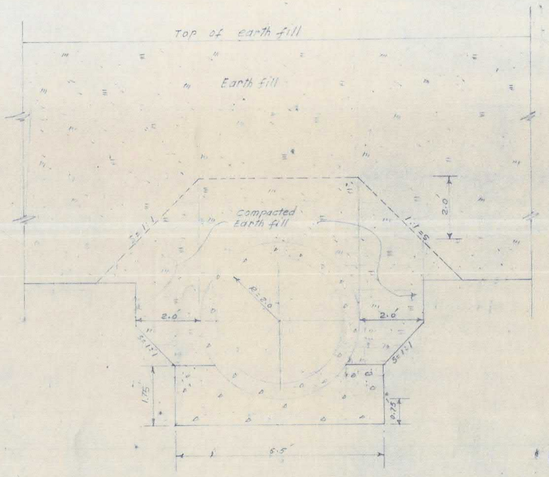
REINFORCEMENT DETAILS & SECTIONS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

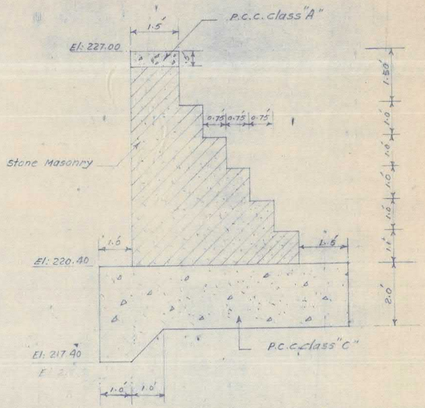
DSN. ---
DWN. MOHAMMAD RIAZ
TRD. ---
CKD. ---
REVD. ---

SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

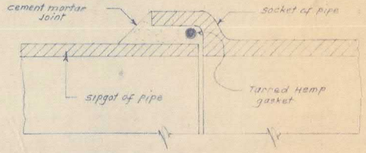
DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES.	C.D.O (W) 110-4A-C-462



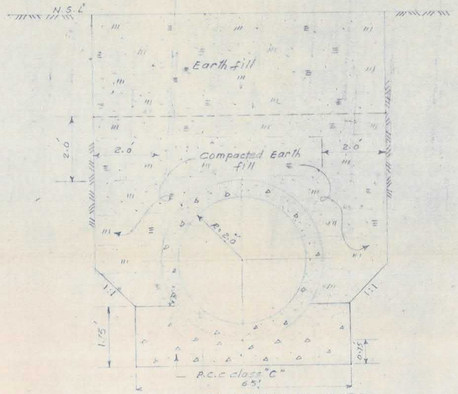
TYPICAL SECTION OF PIPE
PROJECTING CASE
Scale:- 1" = 2.0'



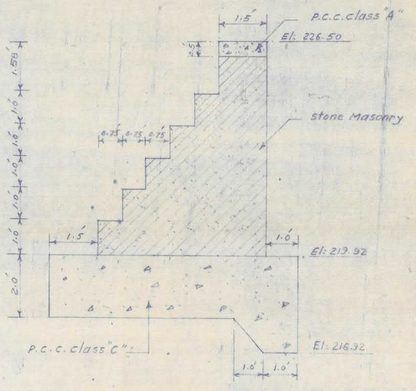
U/S HEAD WALL
Scale:- 1" = 2'



JOINT OF PRECAST PIPE
NOT TO SCALE



TYPICAL SECTION OF PIPE
EMBEDDED CASE
Scale:- 1" = 2.0'



D/S HEAD WALL
SCALE:- 1" = 2.0'

REV. NO.	DATE	BY	DESCRIPTION	APPVD.

REVISIONS

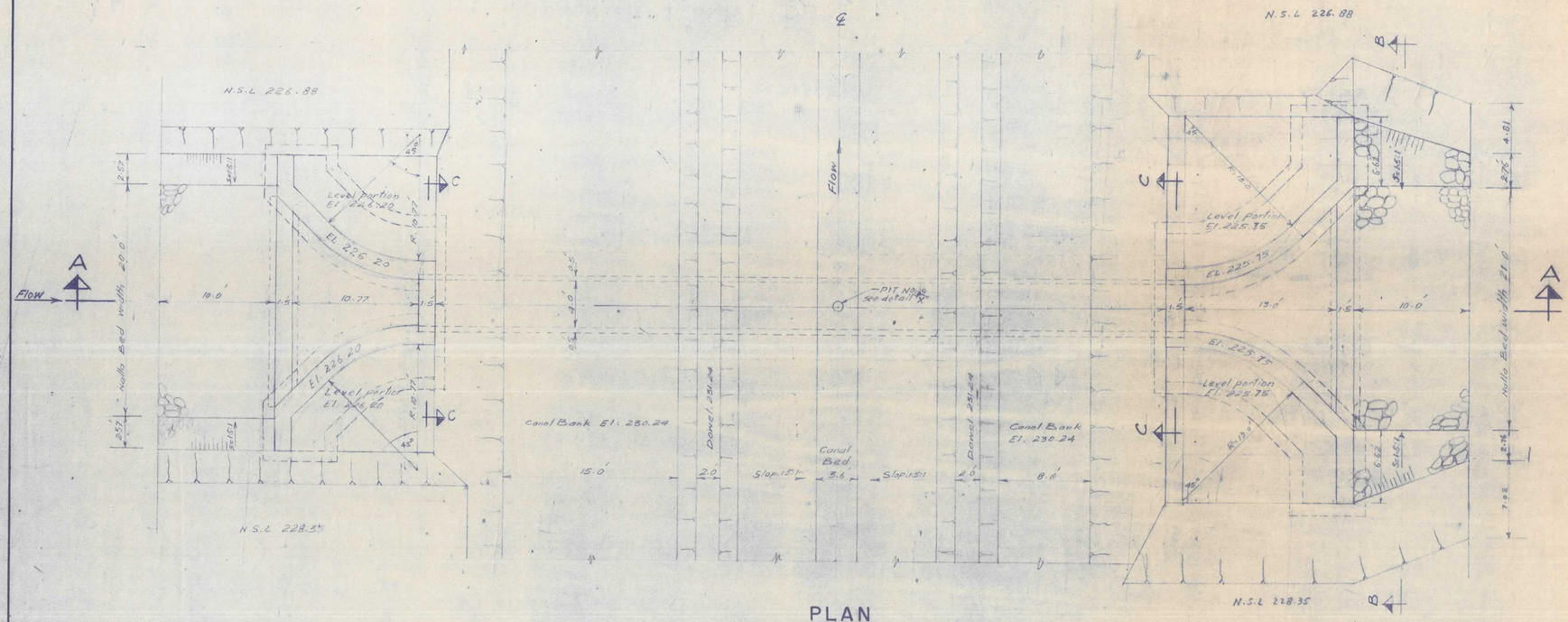
CONSTRUCTION DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL (210 CUSECS)
DRAINAGE CROSSING AT CH 29+57
SECTION & JOINTS OF PRECAST PIPE
Q = 110 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

110-4A-C-A/4	DRAINAGE CROSSING PLAN & SECTION	DSN.	SUBMITTED / RECOMMENDED
W.S.457-R-1 W.S.452	L-SECTION OF CANAL	DWN. GHULAM MUSTAFA	DEPUTY DIRECTOR / DIRECTOR DESIGN
W.S.455-R-1	TYPICAL SECTION OF LINING	TRD.	APPROVED
DRG. NO.	TITLE	CKD.	CHIEF ENGINEER DESIGN
REFERENCE DRAWINGS		REVD.	

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
5-12-1979 LAHORE PAKISTAN	110	4-A	WW DES.	C.D.O. (W) 110-4A-C-465



PLAN
Scale: 1"=5'

REV NO.	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 33 + 72

DISCHARGE OF NALA 87 CUSECS

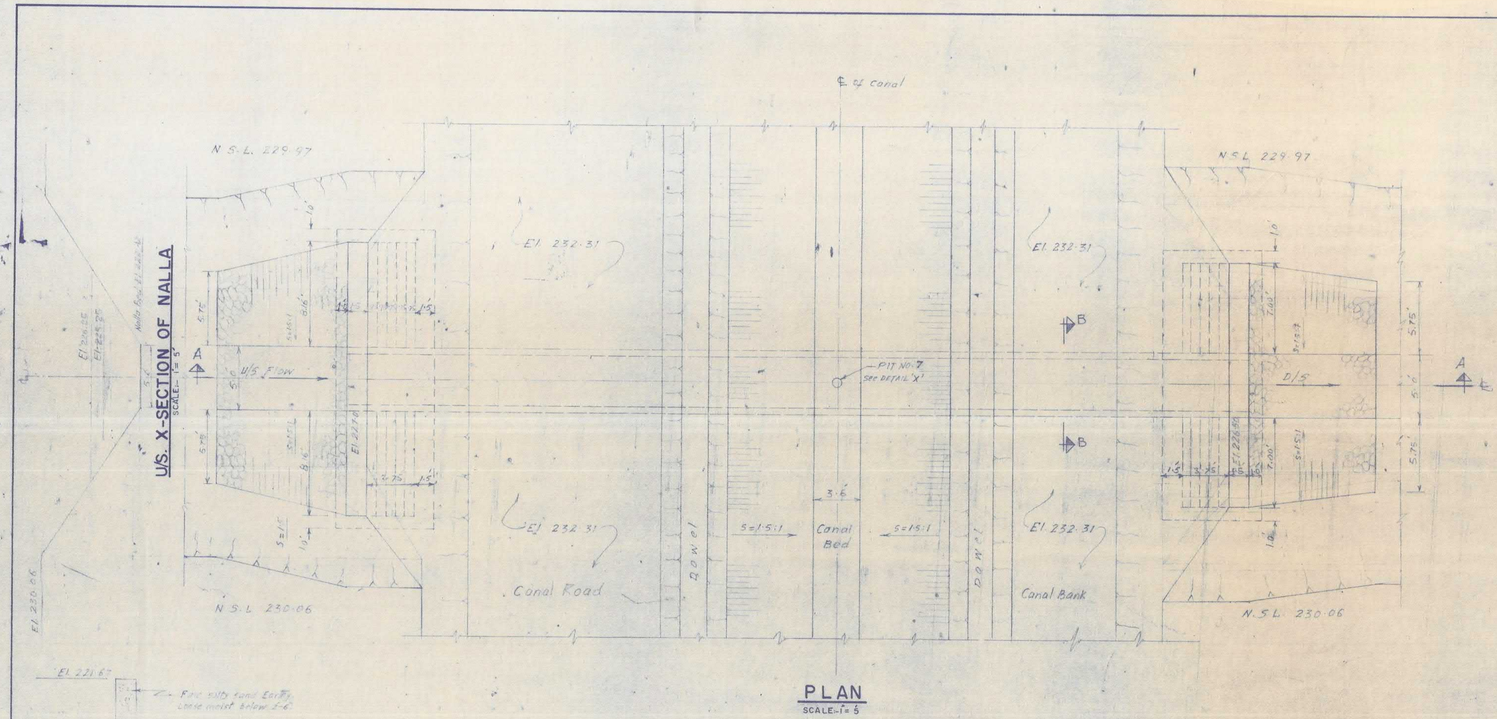
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.		SUBMITTED	RECOMMENDED
DWN. MUHAMMAD RIAZ D/M		DEPUTY DIRECTOR	DIRECTOR DESIGN
TRD.		APPROVED	
CKD.		CHIEF ENGINEER DESIGN	
REVD.			

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	H.O.	4-A	W.W.DES.	C.D.O.(W)110-4A-C-466

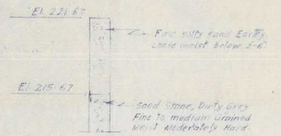
W.S. 451 R-1 W.S 452	L-SECTION OF CANAL
W.S-455 R-1	TYPICAL SECTION OF LINING
110-4A-C-464	DRAINAGE X-ING AT CH. 29+57
110-4A-C-467	DETAIL OF JOINT AND WING WALLS
DRAWING NO.	TITLE OF DRAWING

REFERENCE DRAWING

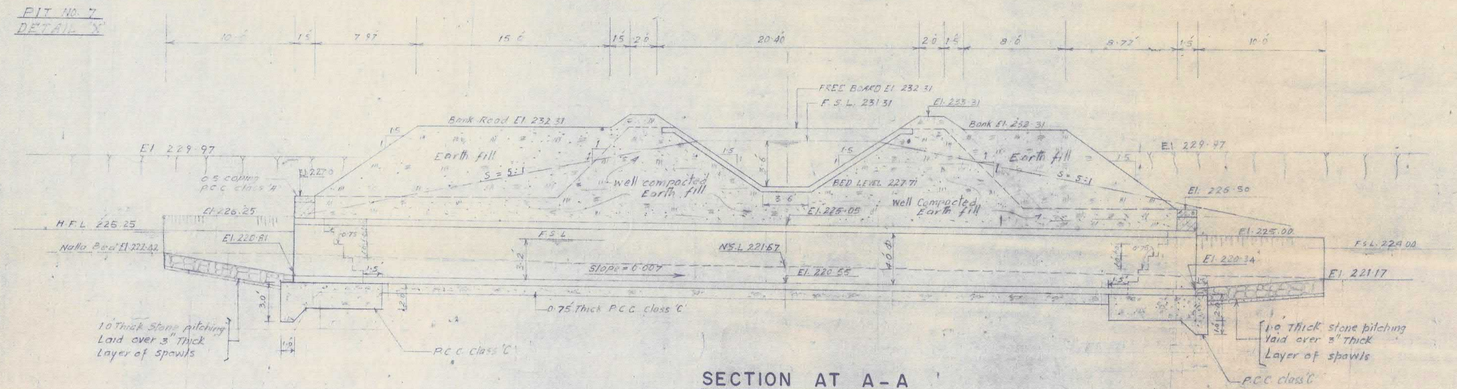


U/S. X-SECTION OF NALLA
SCALE:- 1" = 5'

PLAN
SCALE:- 1" = 5'



PIT No. 7
DETAIL 'X'



SECTION AT A-A
SCALE:- 1" = 5'

NOTES:—

1. Strength of various classes of concrete at 28 days.
   (i) Class - A 3000 Lbs. P.S.I. cylinder strength.
   (ii) Class 'C' 1500 lbs " " "
2. The depth of cut-off walls should be as shown, unless encountered by sound rock before that depth is achieved, in which case, the cut-off walls should be carried to the depth at which the rock is encountered, and proper bond should be established between rock surface and wall footing.
3. Precast R.C.C. pipes will conform to A.S.T.M. specification C76-61T class 2 wall B. These will be designed for a working Head of 100 ft. of water and a test pressure of 200 ft. of water.
4. Pipe joints will be bell and spigot type, as shown on the drawing.
5. The invert of the concrete cradle shall be left about 1/8" lower than the finished level throughout and after the R.C.C. pipe has been laid and levelled thereon, the space between the underside of the pipes and invert of the cradle shall be carefully grouted solid with a thin grout consisting of 1:1½ cement mortar, in such a manner that no void shall be left, and the pipe shall rest throughout their length and breadth on the cradle. The cradle will be shaped appropriately at the joints.
6. The concrete cradle shall be allowed to set for at least 3 days before any pipe is placed on it.
7. Backfilling around the pipe will be done in 6" layers to a depth of 2 ft. above the pipe. Each layer will be watered and tamped carefully.
8. Concrete Design and Construction shall conform to the Provision of A.C.I. Building Code (A.C.I. - 318-63).
9. Safe bearing capacity has been assumed as 1.5 T/□'.
10. Stone shall be laid in horizontal courses not less than 6" height. All stones in course shall be equal height unless otherwise specified, but no course shall be thicker than the course below it. All stone shall be set full in specified mortar in bed and joint.
11. The stone shall be square on all joints in masonry. The beds shall be hammer or chisel dressed true and square for at least 3" back from face, and the joints for at least 1½". The face of the stone shall be hammer dressed and bushing not to project more than 1½".
12. All sides joints shall be vertical and beds horizontal and no joint shall be more than 3/8" in thickness. No pinning shall be allowed.
13. No face stone shall be less in breadth than its height nor shall it be laid into the work to a length lesser than its height. 1/3rd of the stone stone shall be laid into the work, at least twice its height or in wall thicker than three times of its height.
14. Through stones shall be inserted 5 ft. to 6 ft. apart in every course and shall run right through the wall 2 ft. thick. When the wall is more than 2 ft. thick a line of two or more headers shall be laid from face to back which overlap each other atleast 6", the headers shall have a length of atleast 3 times of its height.
15. Stone shall break joint by atleast half the height of the course.
16. Mortar used for stone masonry work shall be 1:4 cement sand mortar.
17. The contractor for structure will also complete the excavation and lining of canal portion within structure limits.

NO.	DATE	BY	DESCRIPTION	APPVD.

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)
DRAINAGE CROSSING AT CH. 29+57
Q = 110 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

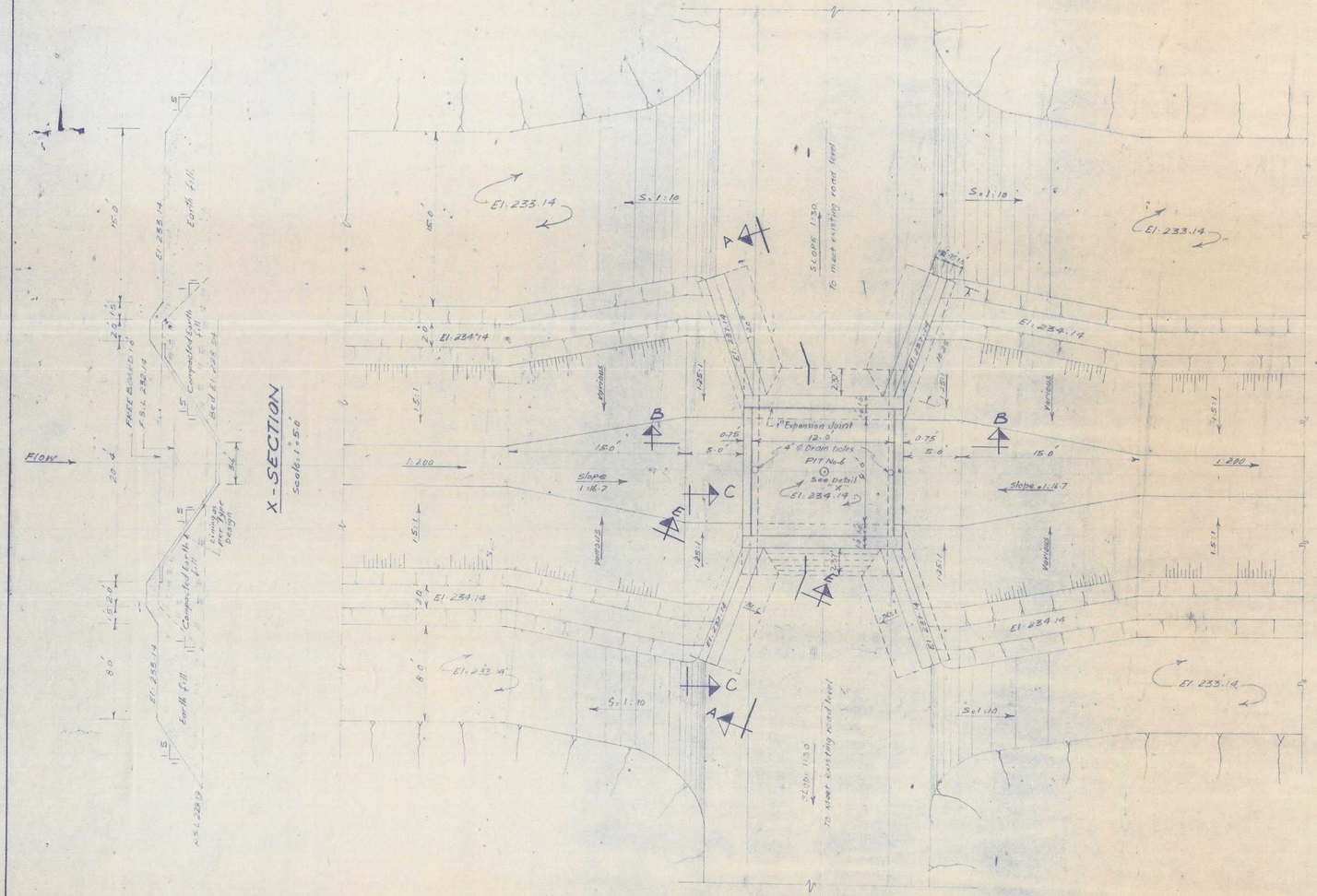
110-4A-C-465	SECTION & JOINTS OF PRECAST PIPE
WS/451 R-1 WS/452	L-SECTION OF CANAL
WS/455 R-1	TYPICAL SECTIONS OF LINING
DRG. NO.	TITLE

REFERENCE DRAWINGS

DSN
DWN Munir Ahmad Rao D.M.
TRD
CKD
REVD 20-x-79

SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE 18-11-79	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O (W) 110-4A-C-464



PLAN
Scale: 1"=5'0"

NOTES:-

1. The bridge has been designed for I.R.C Class A loading
2. Reinforced Cone should have min. compressive strength of 3000 P.S.I as per A.S.T.M.C.39.61 where necessary A.S.T.M.C.42.61
3. All reinforcement bars shall conform to A.S.T.M.A.15.60 intermediate grade with deformation conforming to A.S.T.M.A.305.65 with a min. yield stress of 40000 lbs/□".
4. Overlaps shall be provided where necessary if not detailed out in the drawing. The lap length shall not be less than 24 bar ϕ.
5. All construction joints in R.C.C shall be air and sand blasted. A neat cement layer be applied before fresh concreting.
6. Safe bearing capacity has been assumed as 1.5 T/□'.
7. Stone shall be laid in horizontal course not less than 4" height. All stone in course shall be of equal height, unless otherwise specified. But no course shall be thicker than the course below it. All stones shall be set full in specified mortar in bed and joints.
8. The face stone shall be square on all joints in masonry. The beds shall be hammer orchisel-dressed, true and square for at least 3 inches back from the face and the joints for at least 1½". The face of the stone shall be hammer-dressed.
9. All side joints shall be vertical and beds Horizontal and no joints shall be more than 3/8" in thickness. No pinning shall be allowed on face.
10. No face stone shall be less in breadth than its height, nor shall it be laid into the work to a length less than its height, 1/3 of the stone shall laid in to the work at least twice its height or in walls thicker than 2' three times its height.
11. Through stones shall be inserted 5 to 6 feet apart in every course and shall run right through the wall, not more than 2 feet thick. when the wall is more than 2' thick, a line of two or more headers shall be laid from face to back which overlap each other at least 6". The headers shall have a length of at least 3 times the height.
12. Stone shall break joint by at least half the Height of the Course.
13. Mortar used for stone masonry shall be (1:4) Cement Sand mortar.

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL (210 CUSECS)
PLAN OF VILLAGE ROAD CULVERT
AT CH. 28 + 17

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

W.S. 451 R-1 W.S. 452	L - SECTION OF CANAL
W.S. 455-R-1	TYPICAL SECTION OF LINING
110-4A-C-463	VILLAGE ROAD CULVERT AT CH. 28+17 REINFORCEMENT DETAILS & SECTIONS
DRAWING NO.	TITLE OF DRAWING
REFERENCE DRAWING	

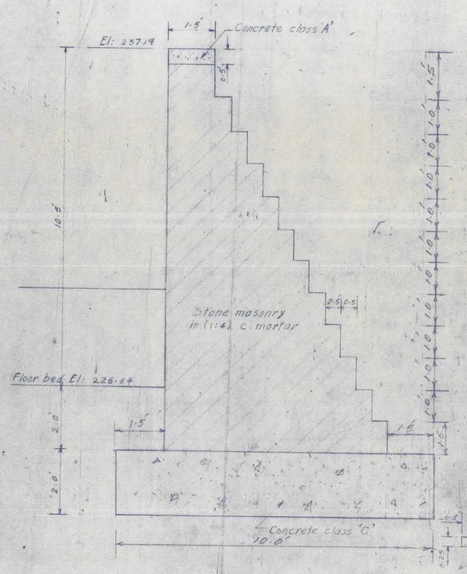
DSN
DWN MOHAMMAD RIAZ
TRD
CKD
REVD

SUBMITTED
DEPUTY DIRECTOR

RECOMMENDED
DIRECTOR DESIGN

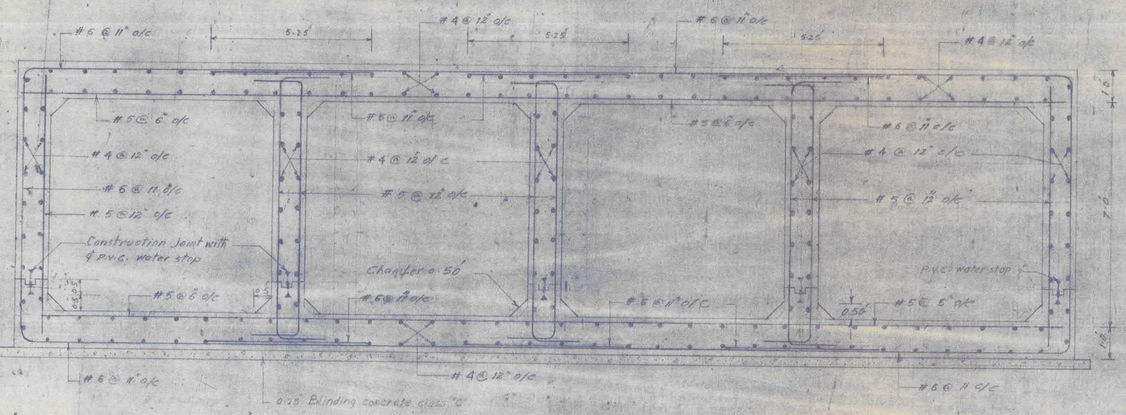
APPROVED
CHIEF ENGINEER DESIGN

DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W.DES	C.D.O (W) 110-4A-C-462

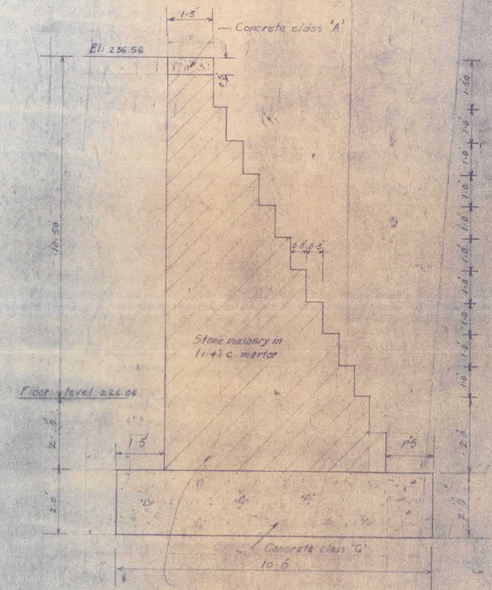


DETAIL OF U/S WING WALL

SCALE: 1/2" = 1'-0"

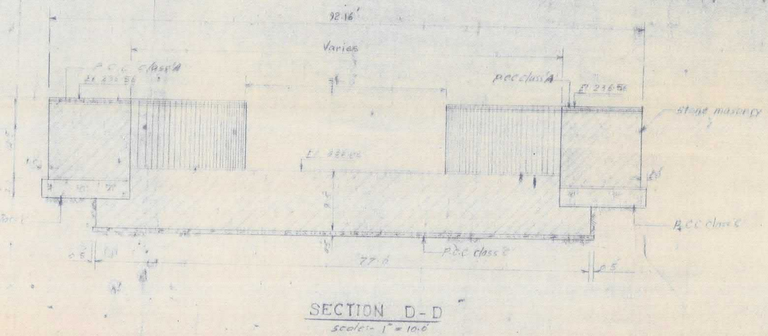


DETAILS OF R.C.C. CONDUIT (4 BARELS)



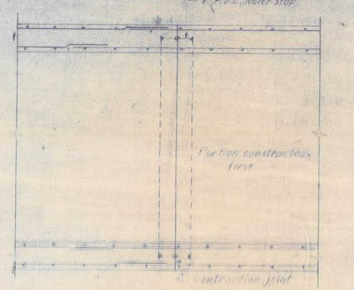
DETAIL OF D/S WING WALL

SCALE: 1/8" = 1'-0"



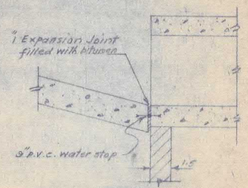
SECTION D-D

scale: 1" = 10'-0"



DETAIL OF CONSTRUCTION JOINT

TO BE PROVIDED BY CONTRACTOR AT HIS DISCRETION



DETAIL OF EXPANSION JOINT

(not to scale)

W.S./461 & 462	L-SECTION OF CANAL
W.S./455	TYPICAL SECTION OF LINING
110-4A-C-458	PLAN OF DRAINAGE X-INGS AT CH. 5+30
110-4A-C-460	DETAIL OF CONDUIT AND WING WALLS
DRAWING NO.	TITLE OF DRAWING

REFERENCE DRAWING

REV. NO.	DATE	DESCRIPTION	BY	CKD.	APPVD.

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING, SECTIONS, DETAIL OF CONDUIT AND WING WALL AT CH. 15+00 Q = 2750 CUSECS

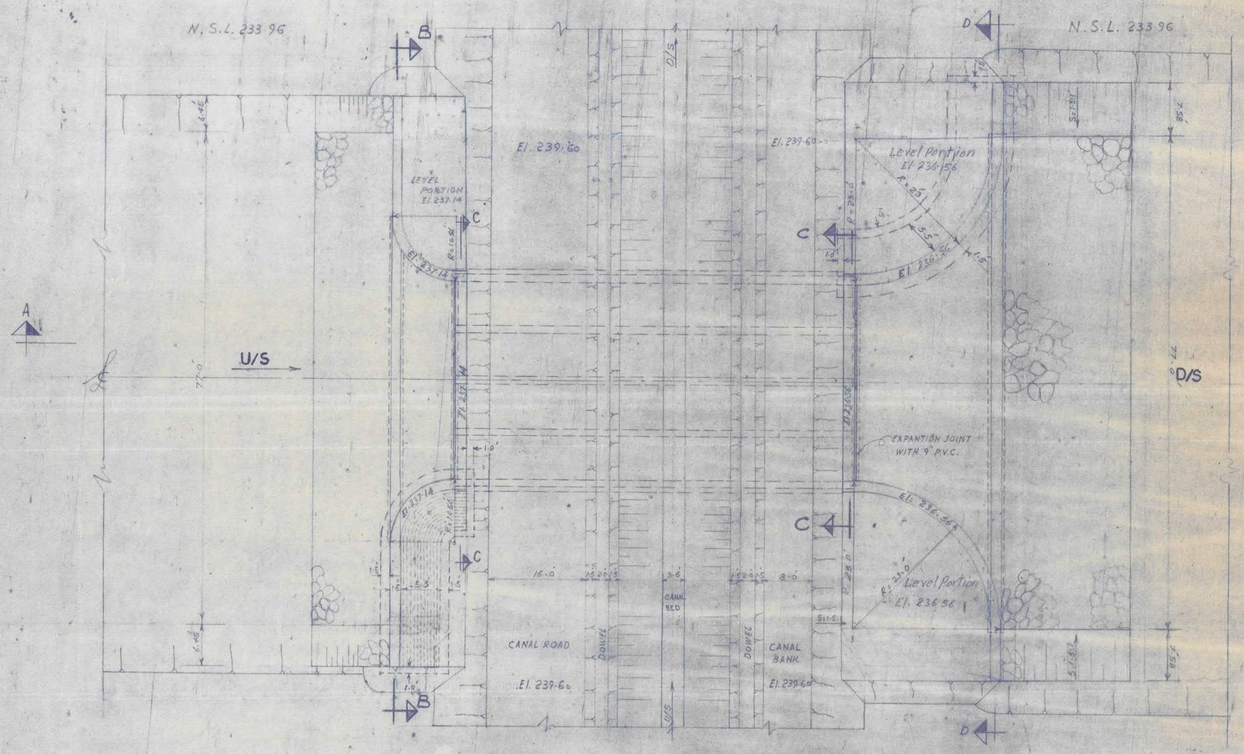
WATER AND POWER DEVELOPMENT AUTHORITY

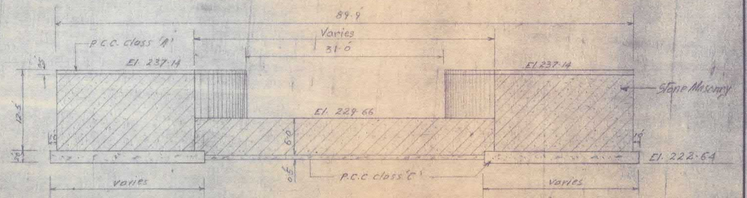
PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

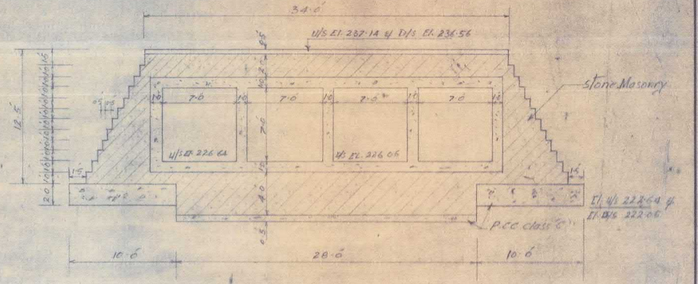
DSN		SUBMITTED	RECOMMENDED
DWN	S.I.H.		
TRD.		DEPUTY DIRECTOR	DIRECTOR DESIGN
CKD		APPROVED	
REVD.		CHIEF ENGINEER DESIGN	

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	WW. DES.	C.D.O. (W) 110-4A-C-461





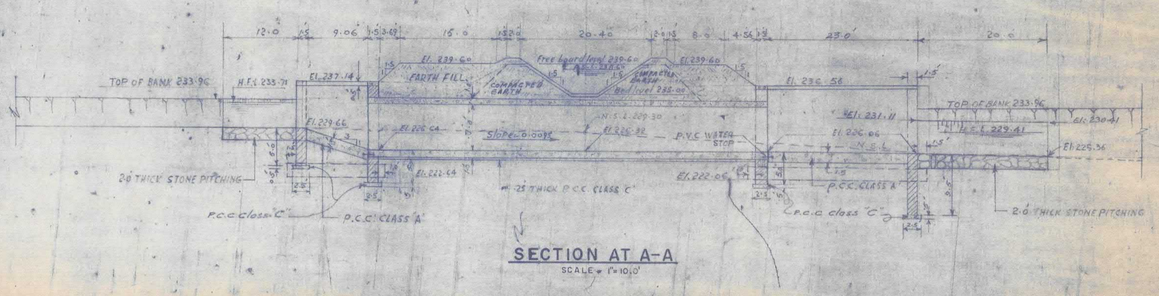
SECTION B-B
Scale:- 1"=10.0



SECTION C-C
Scale:- 1"=10.0

NOTES

See drawing No. C.D.O.(W) 110-4A-C-458



SECTION AT A-A
SCALE= 1"=10.0'

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL 210 CUSECS

DRAINAGE CROSSING AT CH 15+00

DISCHARGE OF NALA 2750 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY

PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

WS/451 & 452	L.-SECTION OF CANAL
WS/455	TYPICAL SECTION OF LINING
110-4A-C-458	PLAN OF DRAINAGE X-ING AT CH. 5+30
110-4A-C-461	DETAIL OF CONDUIT & WING WALLS.
DRAWING NO	TITLE OF DRAWING
REFERENCE DRAWING	

DSN. ---

DWN. MUHAMMAD NAZIR (MINOR RKD) C.H.D

TRD. ---

CKD. ---

REVD. ---

SUBMITTED / RECOMMENDED

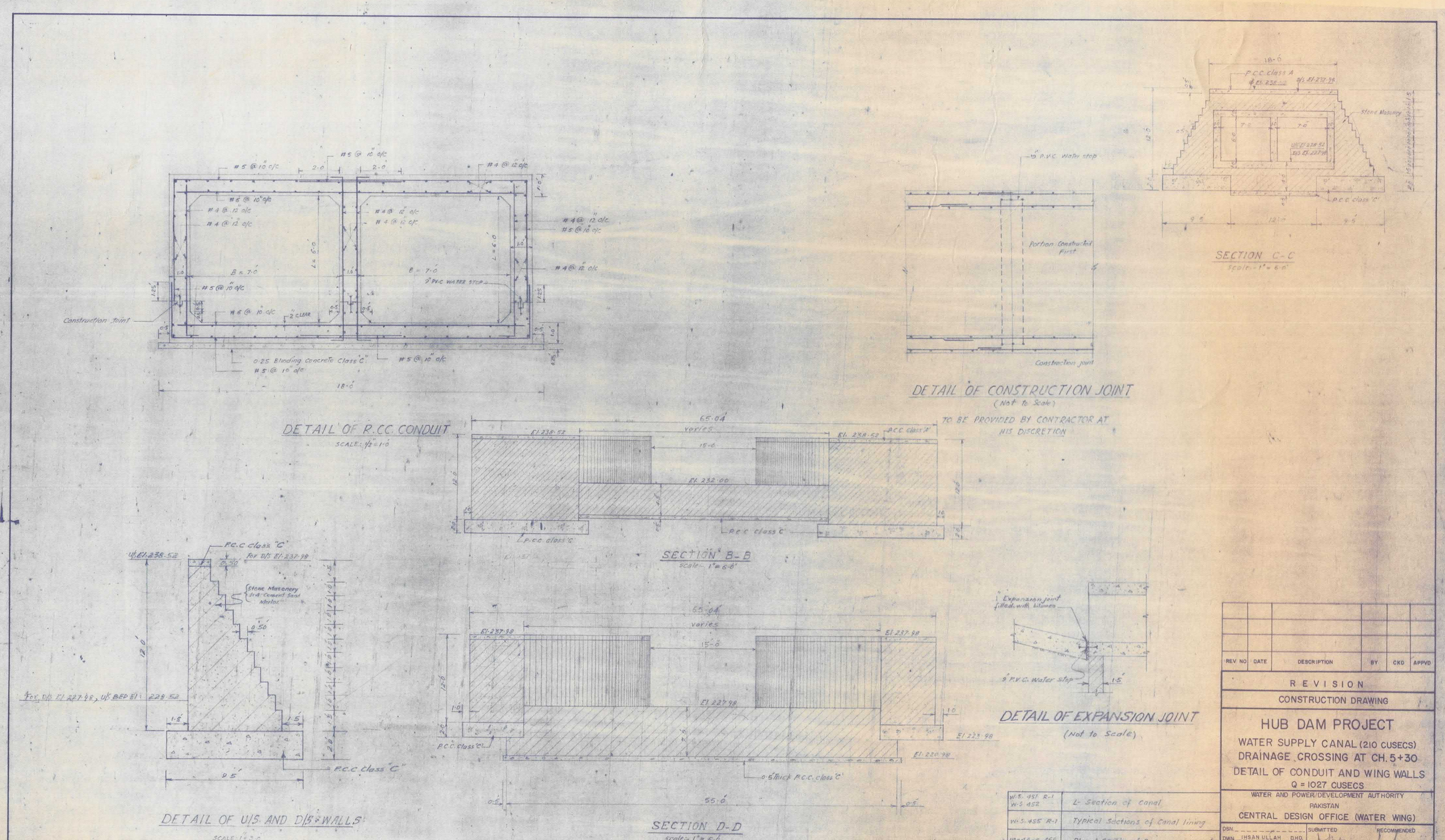
DEPUTY DIRECTOR / DIRECTOR DESIGN

APPROVED

CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO	FILE NO.	DRAWING NO.
24-11-79	110	4-A	WW DES	C.D.O. (W) 110-4A-C-460

LAHORE PAKISTAN



REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)
DRAINAGE CROSSING AT CH. 5+30
DETAIL OF CONDUIT AND WING WALLS
Q = 1027 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

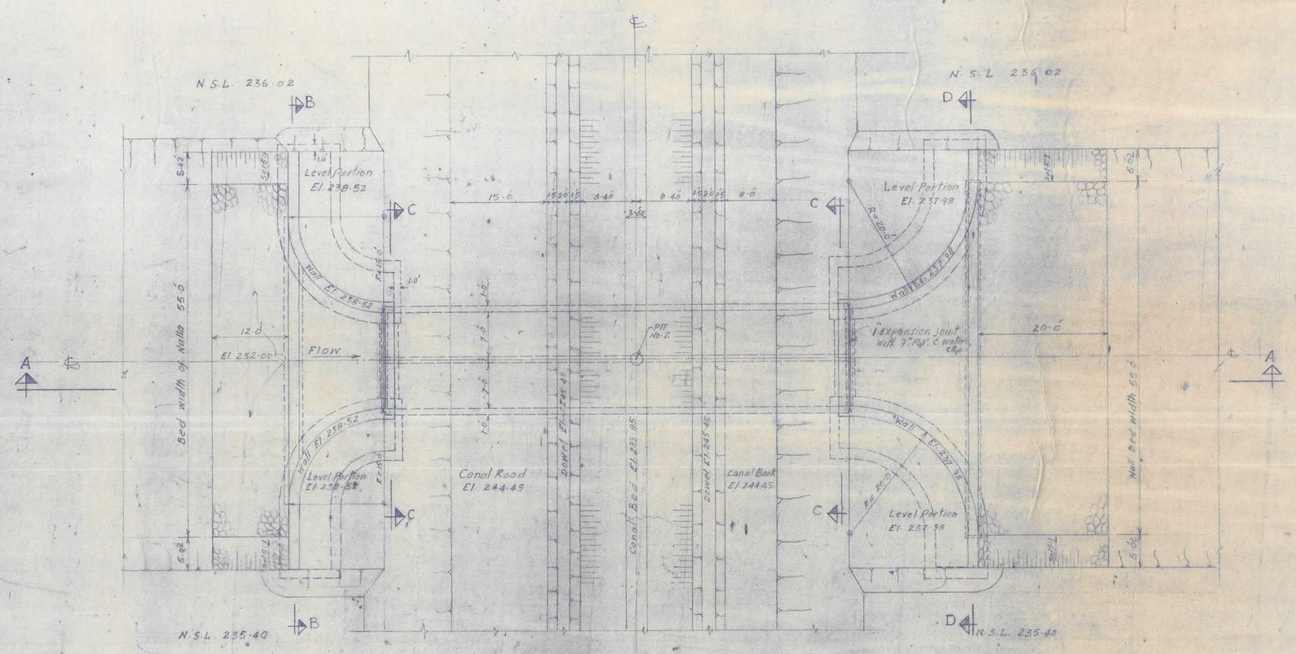
DRAWING NO	TITLE OF DRAWING
W.S. 451 R-1 / W.S. 452	L- Section of Canal
W.S. 455 R-1	Typical Sections of Canal lining
110-4A-C-458	Plan & Section of Drainage x-ing at Ch. 5+30

REFERENCE DRAWING

DSN. ---
DWN. IHSAN ULLAH DHD. MUNIR KAB
TRD. ---
CKD. [signature]
REVD. ---

SUBMITTED: DEPUTY DIRECTOR
RECOMMENDED: DIRECTOR DESIGN
APPROVED: CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
24-11-1979 LAHORE PAKISTAN	110	4-A	W.W. DES.	C.D.O. (W) 110-4A-C-459



PLAN

scale:- 1"=10'

STRUCTURE LIMIT FROM CH. 3+00 TO CH. 7+60

PIT No. 2

SECTION A-A

scale:- 1" =10'

NOTES

1. Strength of various classes of concrete at 28 days.
   (i) Class 'A' 3000 Lbs. P.S.I.
   (ii) Class 'C' 1500 Lbs. P.S.I.
2. The depth of cut-off walls should be as shown unless encountered by sound rock before that depth is achieved, in which case the cut-off walls should be carried to the depth at which the rock is encountered and proper bond should be established between rock rock surface and wall footing.
3. Concrete design and construction shall conform to the Provision of A.C.I. Building Code (A.C.I. 318-63)
4. All reinforced concrete shall be class 'A' and shall have a minimum compressive strength of 3000 Lbs. P.S.I. after 28 days.
5. All bars are deformed bars conforming to of A.S.T.M. designation A-315 (f.y = 40,000 Lbs. P.S.I.)
6. Unless otherwise shown place reinforcement so that the clear distance between the face of the concrete and the nearest reinforcement is 2"
7. All splices shall be 24 ϕ of the bars.
8. Safe bearing capacity has been assumed as 1½ T/□'.
9. Stone shall be laid in horizontal courses not less than 6" height. All stone in course shall be of equal height, unless otherwise specified, but no course shall be thicker than the course below it. All stones shall be set full in specified mortar in beds and joints.
10. The face stone shall be square on all joints in masonry. The beds shall be hammer or otherwise dressed true and square for at least 3" back from the face, and joint for atleast 1½". The face of the stone shall be hammer-dressed and bushing not to project more than ½".
11. All side joints shall be vertical and beds horizontal and no joint shall be more than ¾" in thickness. No pining shall be allowed on face.
12. No face stone shall be lesser in breadth than its height nor shall it be laid into the work to a length lesser than its height Yard of the stone shall be laid into the work atleast twice its height or in wall thicker than 2 feet three fibres of its height.
13. Through stones shall be inserted 6" ϕ 6 feet apart in every course, and shall run right through the wall, not more than 2' thick. When the wall is more than 2' thick, a line of two or more headers shall be laid from face to back which overlaps each other atleast 6". The header shall have a length of atleast (3 times the height).
14. Stone shall break joint by atleast half the height of the course.
15. Mortar used for stone masonry shall be (1-4) cement sand mortar.
16. R.C.C. precast pipe shall conform to specification A.S.T.M.

REV. NO.	DATE	DESCRIPTION	BY	CKD.	APPVD.

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

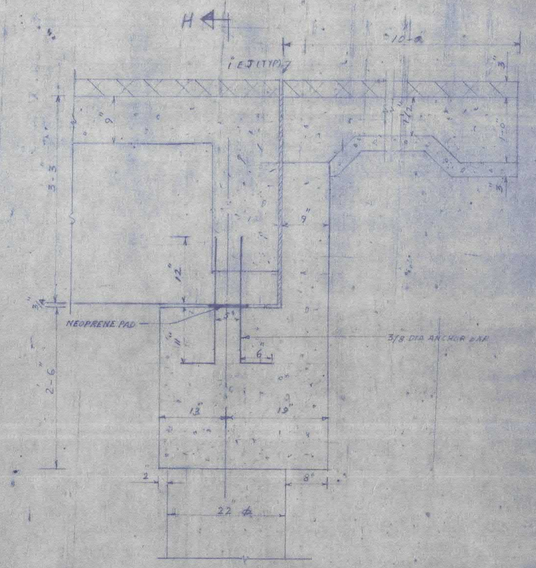
PLAN & SECTION OF DRAINAGE CROSSING AT CH. 5 + 30 Q = 1027 CUSECS

W.S. 451, R-1 W.S. 452	L-SECTION OF CANAL
W.S. 455-R-1	TYPICAL SECTION OF LINING
110-4-A-C-459	DETAIL OF CONDUIT AND WING WALLS
DRAWING NO.	TITLE OF DRAWING
REFERENCE DRAWING	

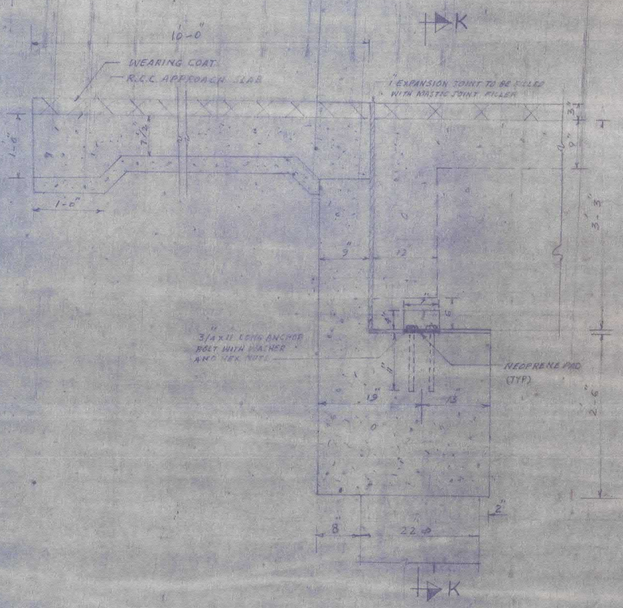
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.		SUBMITTED	RECOMMENDED
DWN. M. AHMAD RAO		DEPUTY DIRECTOR	DIRECTOR DESIGN
TRD.		APPROVED	
CKD.		CHIEF ENGINEER DESIGN	
REVD.			

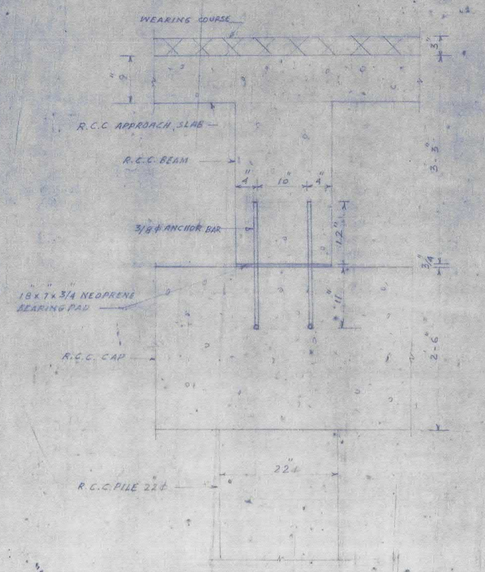
DATE:	JOB NO.	INDEX NO	F.I.E. NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES.	C.D.O.(W) 110-4-A-C-458



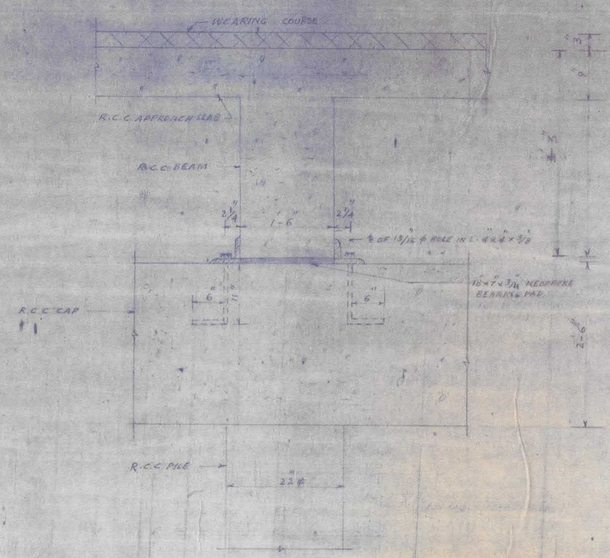
FIXED END DETAIL
SCALE 1"=1'-0"



FREE END DETAIL
SCALE 1"=1'-0"



SECTION H-H
SCALE 1"=1'-0"



SECTION K-K
SCALE 1"=1'-0"

NOTE
FOR GENERAL NOTES SEE DRAWING NO. 402-5-T-496

402-5-T-500	V.R. BRIDGE CH: 28+42 PILES, ABUTMENT AND PILES CAP REINFORCEMENTS DETAILS
402-5-T-498	V.R. BRIDGE CH: 28+42 DECK SLAB AND GIRDER REINFORCEMENT DETAILS
402-5-T-497	V.R. BRIDGE CH: 28+42 SECTIONS
402-5-T-496	V.R. BRIDGE CH: 28+42 PLAN
402-5-T-495	V.R. BRIDGE CH: 28+42 LOCATION PLAN
DRAWING NO.	TITLE OF DRAWING

REFERENCE DRAWING

TENDER DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL
VILLAGE ROAD BRIDGE CH: 28+42
DETAILS & SECTIONS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

REV. NO	DATE	DESCRIPTION	CK'D.	BY	APPR'D.

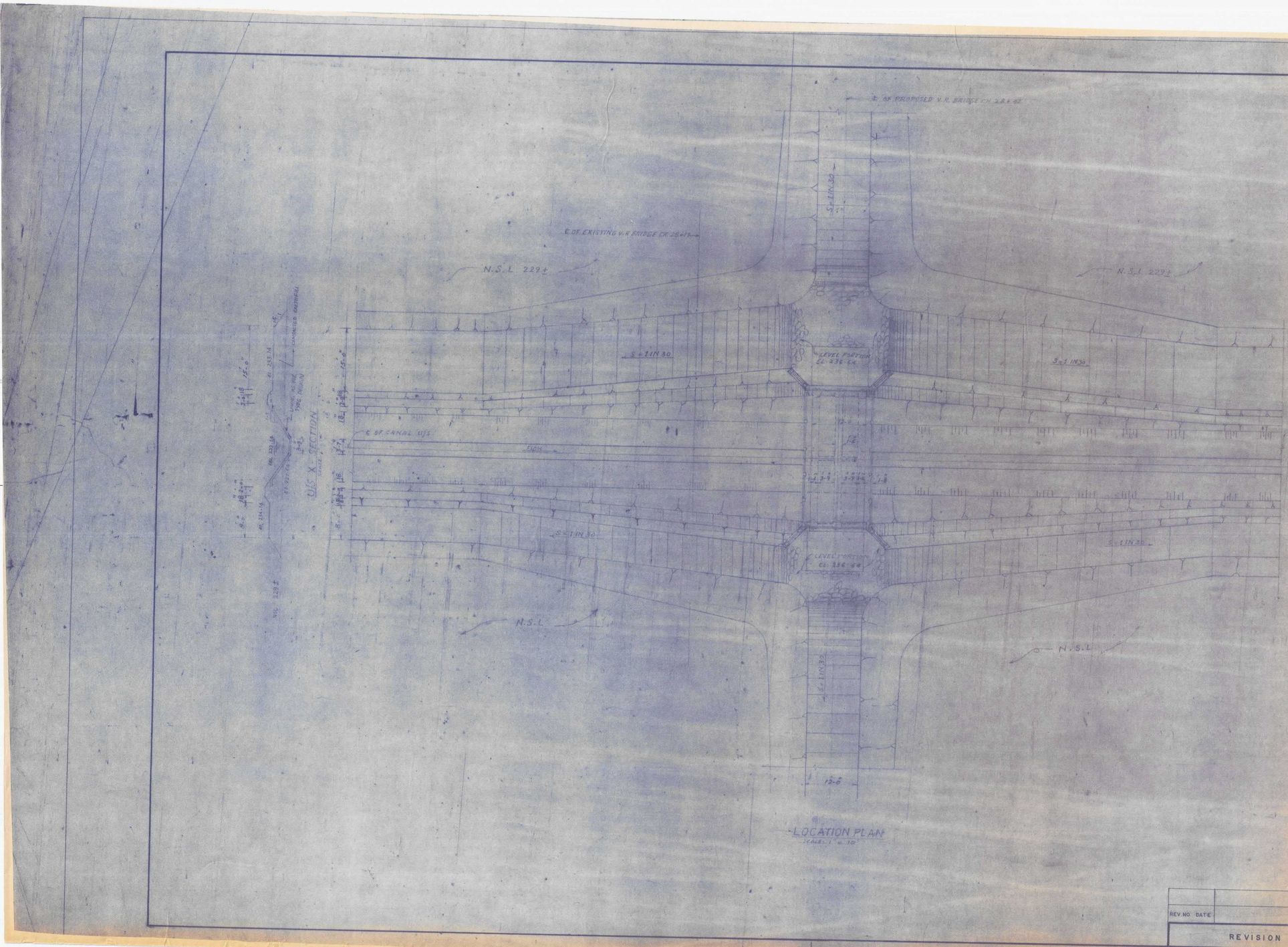
REVISION

DESIGN
DRAWN AZIZ NIZAMI D/M
TRACED
CHECK'D

SUBMITTED RECOMMENDED
DEPUTY DIRECTOR DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

COMM. DATE
COMP. DATE 12-12-90

JOB NO.	INDEX NO.	DRG. NO. CDO(W)
402	5	402-5-T-499



NOTE
FOR GENERAL NOTES SEE DRAWING NO. 402-S-T-496

DRAWING NO.	TITLE OF DRAWING
REFERENCE DRAWING	
402-S-T-501	V.R. BRIDGE CH 28+42 PILES, ABUTMENT & PIERS CAP REINFORCEMENTS DETAILS
402-S-T-499	V.R. BRIDGE CH. 28+42, DEPAILS & SECTIONS
402-S-T-498	V.R. BRIDGE CH. 28+42 DECK SLAB AND GIRDER REINFORCEMENT DETAILS
402-S-T-497	V.R. BRIDGE CH. 28+42 SECTIONS
402-S-T-496	V.R. BRIDGE CH. 28+42 PLAN

TENDER DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL

VILLAGE ROAD BRIDGE CH: 28+42

LOCATION PLAN

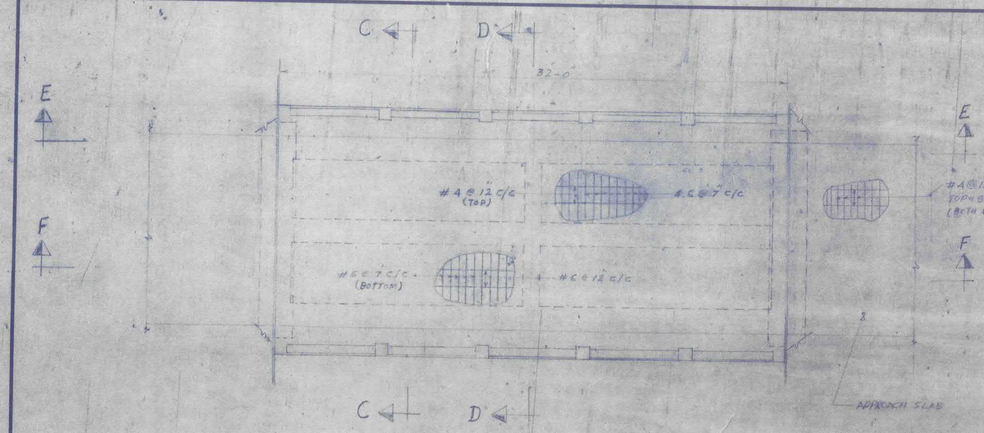
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.		SUBMITTED	RECOMMENDED
DWN. AZIZ NIZAMI. D/M			
TRD.		DEPUTY DIRECTOR	DIRECTOR DESIGN
CKD.		APPROVED	
REVD.		CHIEF ENGINEER DESIGN	
DATE. 12-12-90 LAHOR, PAKISTAN	JOB NO. 402	INDEX NO 5	FILE NO. W.W. DSN C.D.(W)402-S-T-495

DRAWING NO.

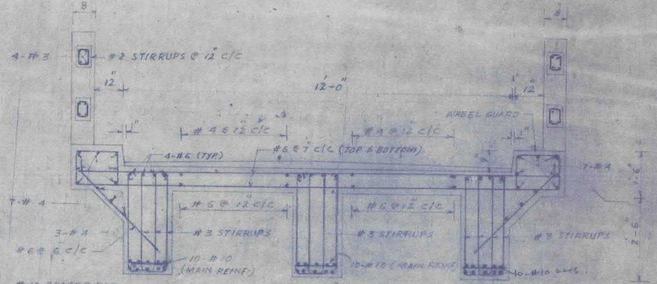
REV. NO.	DATE	BY	CKD.	APPVD.

REVISION



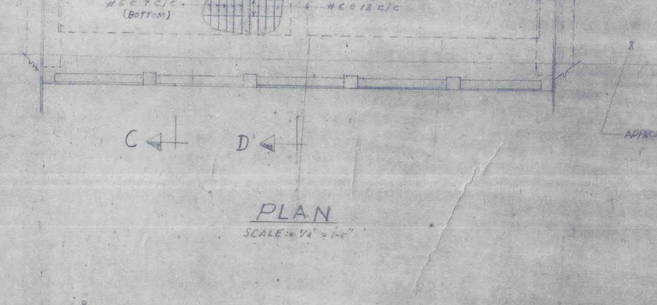
PLAN

SCALE: 1/4" = 1'-0"



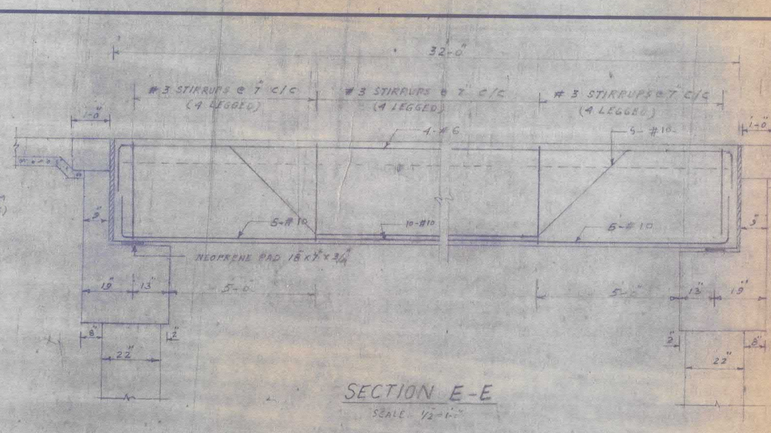
SECTION C-C

SCALE: 1/2" = 1'-0"



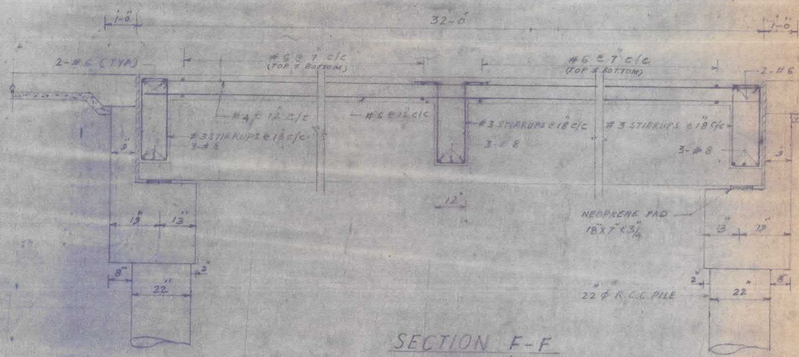
SECTION D-D

SCALE: 1/2" = 1'-0"



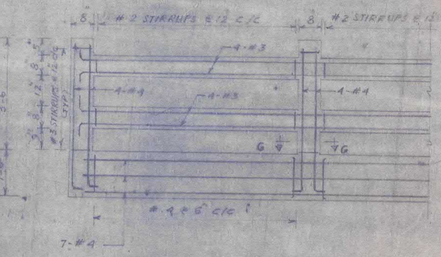
SECTION E-E

SCALE: 1/2" = 1'-0"



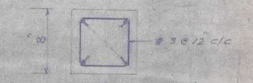
SECTION F-F

SCALE: 1/2" = 1'-0"



DETAIL OF R.C.C. RAILING

SCALE: 1/2" = 1'-0"



SECTION G-G

SCALE: 1 1/2" = 1'-0"

NOTES

1. FOR GENERAL NOTES SEE DRAWING NO. 402-S-T-496

DRG. NO.	TITLE OF DRAWING
402-S-T-500	V.R. BRIDGE CH: 28+42 PILES ABUTMENT AND PILES CAP REINF. DETAILS
402-S-T-497	V.R. BRIDGE CH: 28+42 DETAILS & SECTIONS
402-S-T-497	V.R. BRIDGE CH: 28+42 SECTIONS
402-S-T-496	V.R. BRIDGE CH: 28+42 PLAN
402-S-T-495	V.R. BRIDGE CH: 28+42 LOCATION PLAN

REFERENCE DRAWINGS

TENDER DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL
VILLAGE ROAD BRIDGE CH: 28 + 42
DECK SLAB & GIRDER REINFORCEMENT DETAILS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

REV. NO.	DATE	DESCRIPTION	BY	CKD.	APPVD.

REVISIONS

DESIGN
DRAWN AZIZ NIZAMI D/M
TRACED
CHECKD Malaclaw Lahore

SUBMITTED
DEPUTY DIRECTOR DESIGN

RECOMMENDED
DIRECTOR DESIGN

APPROVED
CHIEF ENGINEER DESIGN

COMM. DATE
COMP. DATE 12-12-90
LAHORE PAKISTAN

JOB NO. 402 | INDEX NO. 5 | DRG. NO. CDO(W) 402-5-T-498

NOTES
FOR GENERAL NOTES SEE DRAWING NO. 402-S-T-436

REV. NO	DATE	DESCRIPTION	CKD.	BY	APPVD

REVISION

DRAWING NO. TITLE OF DRAWING

REFERENCE DRAWING

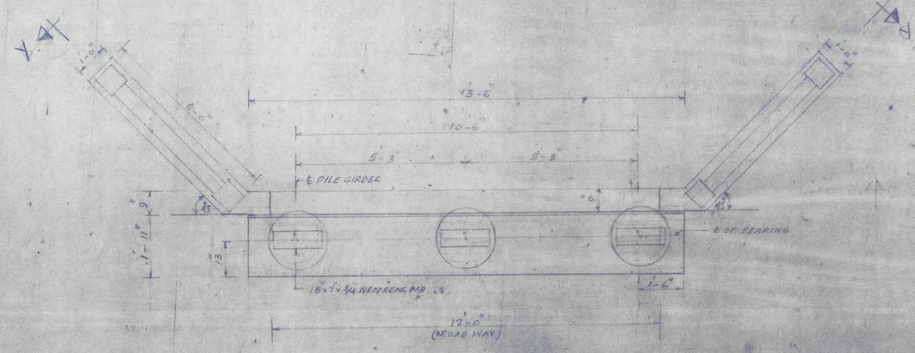
TENDER DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL
VILLAGE ROAD BRIDGE CH: 28 + 42
SECTIONS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

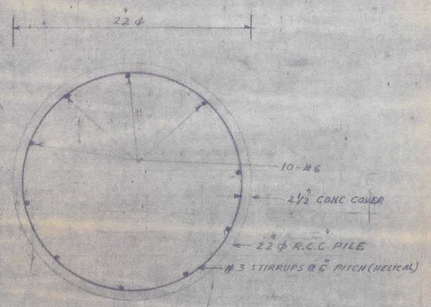
DSN. [illegible] SUBMITTED [illegible] RECOMMENDED
DWN. AZIZ NIZAMI D/M
TRD.
CKD. [illegible] DEPUTY DIRECTOR DIRECTOR DESIGN APPROVED
NEVD.
CHIEF ENGINEER DESIGN

DATE 13-12-76 LAHORE PAKISTAN | JOB NO. 402 | INDEX NO. 5 | FILE NO. | DRAWING NO. C.D.O.(W) 402-S-T-437



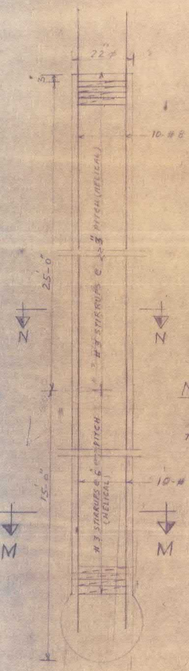
ABUTMENT PLAN

SCALE: 1/2"=1'-0"



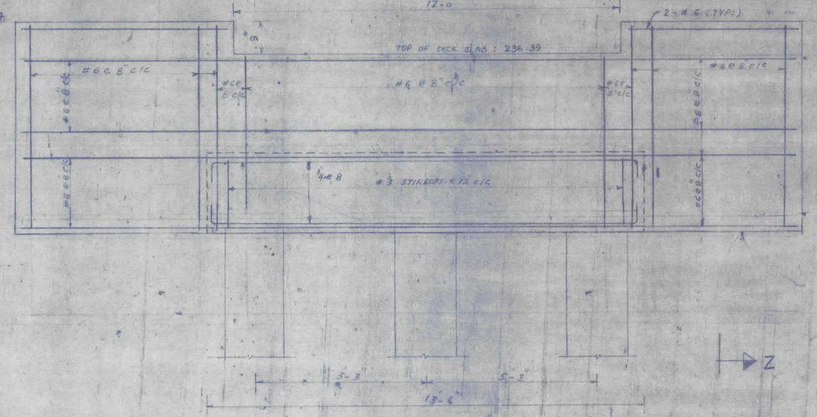
SECTION M-M

SCALE: 2"=1'



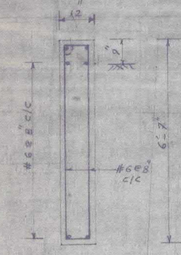
NOTE

PROVIDE 10 #8 BARS UPTO 25' FROM THE TOP AND BELOW THAT 10 #6 BARS.



SECTION Y-Y

SCALE: 1/2"=1'-0"

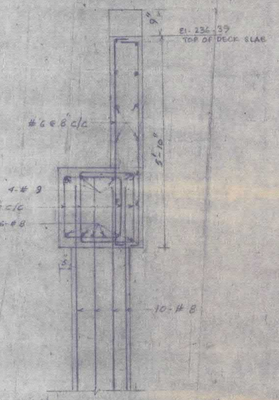


SECTION Z-Z

SCALE: 1/2"=1'-0"

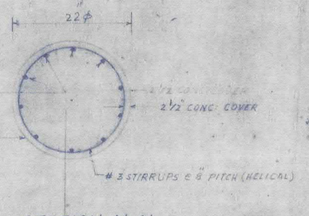
DETAIL OF PILE

SCALE: 1/2"=1'-0"



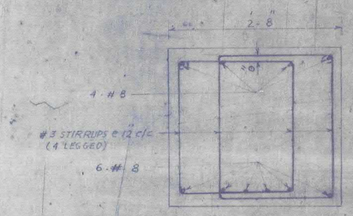
SECTION X-X

SCALE: 1/2"=1'-0"



SECTION N-N

SCALE: 1"=1'-0"



REINFORCEMENT DETAIL OF CAP

SCALE: 1"=1'-0"

NOTES:
FOR GENERAL NOTES SEE DRAWING NO. 402-5-T-496

402-5-499	V-R BRIDGE CH: 28+42 DETAILS AND SECTIONS
402-5-498	V-R BRIDGE DECK SLAB & GIRDER REINF. DETAILS
402-5-T-497	V-R BRIDGE CH: 28+42 SECTIONS
402-5-T-496	V-R BRIDGE CH: 28+42 PLAN
402-5-T-495	V-R BRIDGE CH: 28+42 LOCATION PLAN

DRG NO.	TITLE OF DRAWING

REFERENCE DRAWINGS

TENDER DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL
VILLAGE ROAD BRIDGE CH: 28+42
PILES, ABUTMENTS AND PILE CAP REINFORCEMENT DETAILS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

REV. NO.	DATE	DESCRIPTION	BY.	CKD.	APPVD.
REVISION					

DESIGN
DRAWN AZIZ NIZAMI, D/M
TRACED
CHECKED
REVD
COMPL. DATE
COMP. DATE 12-12-90
LAHORE, PAKISTAN

SUBMITTED — DEPUTY DIRECTOR
RECOMMENDED — DIRECTOR DESIGN
APPROVED — CHIEF ENGINEER (DESIGN)

JOB NO. 402 | INDEX NO. 5 W.W.DEP. | DRG. NO. CDO-(W) 402-5-T-500

PIT NO 21

FINE SILTY SAND, LOOSE, DRY, LIGHT BROWNISH

SAND WITH GRAVELS SAND IS MEDIUM TO COARSE GRAINED AND GRAVELS ARE MOSTLY FINE. THESE ARE MOSTLY WELL COMPACTED BY CALCAREOUS CEMENT VERY DIFFICULT TO EXCAVATE WITH NORMAL TOOLS. IN PLACE CONDITION IN THE BOTTOM BEARING LIME ROCK FOUNDATION.

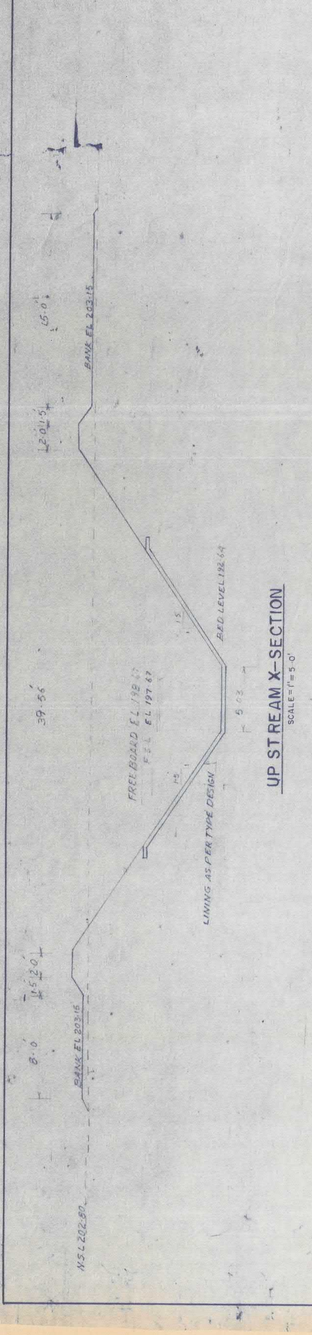
PIT COULD NOT BE EXCAVATED FURTHER DUE TO HARDNESS AND COMPACTNESS OF SAND - GRAVELS.

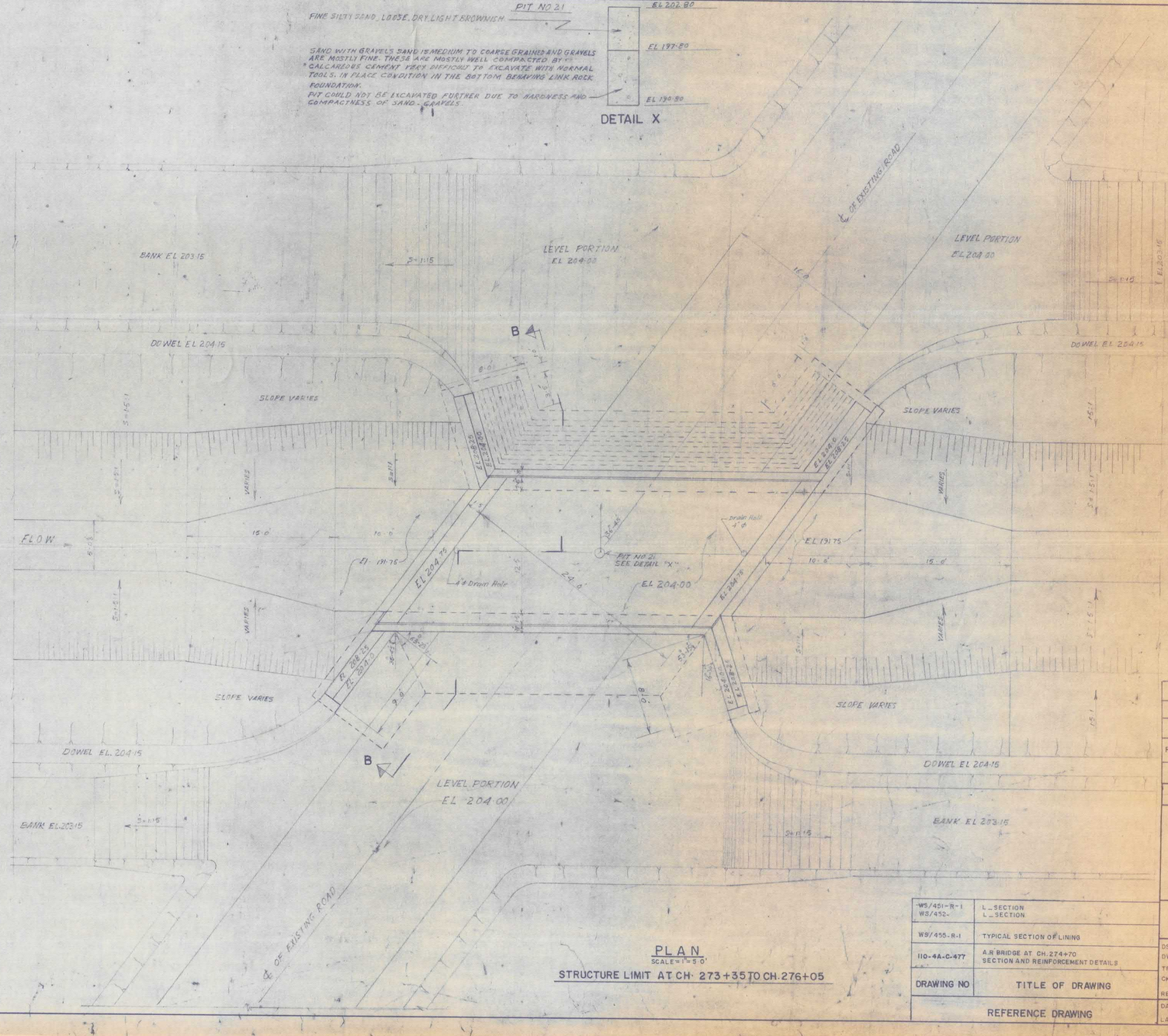
EL 202.80

EL 197.80

EL 190.80

DETAIL X





PLAN
SCALE: 1"=50'

STRUCTURE LIMIT AT CH. 273+35 TO CH. 276+05

NOTES

1. CEMENT CONCRETE OF VARIOUS CLASSES SHALL HAVE MINIMUM CYLINDER STRENGTH AT 28 DAYS.
   CLASS 'A' = 3000 P.S.I
   " 'B' = 2000 P.S.I
   " 'C' = 1500 P.S.I
2. THE BRIDGE HAS BEEN DESIGNED FOR IRC CLASS A LOADING.
3. REINFORCED CONCRETE SHOWN HAVE MINIMUM COMPRESSIVE STRENGTH OF 3000 P.S.I AS PER ASTM C 39-61 UNLESS NECESSARY. A.S.T.M. C 42-61
4. ALL REINFORCEMENT BARS SHALL CONFORM TO ASTM A 16-61 INTERMEDIATE GRADE WITH DEFORMATION CONFORMING TO A.S.T.M. A 305-65 WITH A MINIMUM YIELD STRESS OF 60000 LBS/IN²
5. OVERLAPS SHALL BE PROVIDED WHERE NECESSARY IF NOT DETAILED OUT IN THE DRAWINGS THE LAP LENGTH SHALL NOT BE LESS THAN 24 X BARS ϕ.
6. ALL CONSTRUCTION JOINTS IN R.C.C SHALL BE AIR AND SAND BLASTED & NEAT CEMENT LAYER BE APPLIED BEFORE FRESH CONCRETING.
7. SAFE BEARING CAPACITY HAS BEEN ASSUMED AS 15 T/S.F
8. STONE SHALL BE LAID IN HORIZONTAL COURSE NOT LESS THAN 6" HEIGHT. ALL STONE IN COURSE SHALL BE OF EQUAL HEIGHT UNLESS OTHERWISE SPECIFIED BUT NO COURSE SHALL BE THICKER THAN THE COURSE BELOW IT. ALL STONES SHALL BE SET FULL IN SPECIFIED MORTAR IN BED AND JOINTS.
9. THE FACE STONE SHALL BE SQUARE ON ALL JOINTS IN MASONRY. THE BEDS SHALL BE HAMMER DRESSED, DRESSED TRUE AND SQUARE FOR AT LEAST 3 INCHES BACK FROM THE FACE AND THE JOINTS FOR AT LEAST ½ THE FACE OF THE STONE THEY BE HAMMER DRESSED
10. ALL SIDE JOINTS SHALL BE VERTICAL AND BEDS HORIZONTAL AND NO JOINTS SHALL BE MORE THAN ¾" IN THICKNESS. NO PINING SHALL BE ALLOWED ON FACE.
11. NO FACE STONE SHALL BE LESS IN BREADTH THAN ITS HEIGHT, NOR SHALL IT BE LAID IN THE WORK TO A LENGTH LESS THAN ITS HEIGHT. ONE THIRD OF THE STONE SHALL BE LAID IN THE WORK AT LEAST TWICE ITS HEIGHT OR IN WALLS THICKER THAN 2.0 THREE TIMES OF ITS HEIGHT.
12. THROUGH STONE SHALL BE INSERTED 4 TO 6 FEET APART IN EACH COURSE AND SHALL RUN RIGHT THROUGH THE WALL NOT MORE THAN 12 FEET THICK WHEN THE WALL IS MORE THAN 2' THICK, ALL OF TWO OR MORE HEADERS SHALL BE LAID FROM FACE TO BACK WHICH SHALL OVERLAP EACH OTHER AT LEAST 6" THE HEADER SHALL HAVE A LENGTH OF AT LEAST 3 TIMES THE WIDTH OF THE COURSE.
13. STONE SHALL BREAK JOINT BY AT LEAST HALF THE WIDTH OF THE COURSE.
14. MORTAR USED FOR STONE MASONRY SHALL BE 1:4:8 CEMENT SAND MORTAR.

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

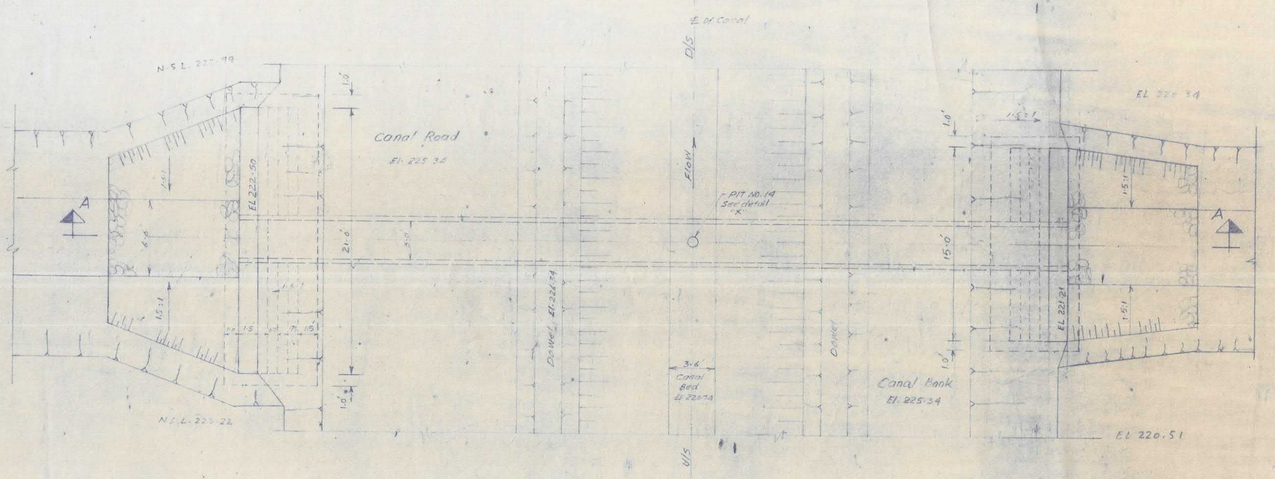
WATER SUPPLY CANAL (210 CUSECS)
A.R. BRIDGE AT CH 274+70
PLAN AND SECTION

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

WS/451-R-1 WS/452-	L_SECTION L_SECTION
WS/455-R-1	TYPICAL SECTION OF LINING
110-4A-C-477	A.R BRIDGE AT CH. 274+70 SECTION AND REINFORCEMENT DETAILS
DRAWING NO	TITLE OF DRAWING
REFERENCE DRAWING	

DSN		SUBMITTED	RECOMMENDED
DWN M. SIDDIQUE			
TRD		DEPUTY DIRECTOR	DIRECTOR DESIGN
CKD		APPROVED	
REVD		CHIEF ENGINEER DESIGN	

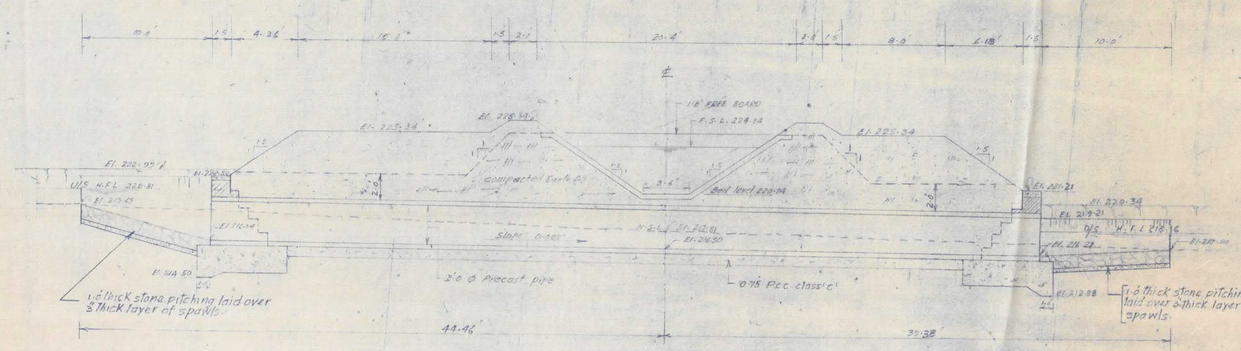
DATE	JOB NO.	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	119	4-A	WW.DES	C.D.O.(W)110-4A-C-476



PLAN

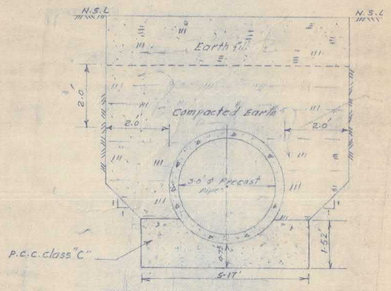
SCALE:- 1"=30'

STRUCTURE LIMIT FROM CH. 42+08 TO CH. 44+41

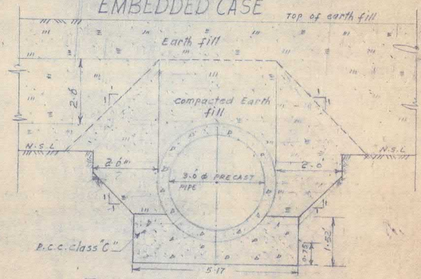


L-SECTION AT A-A

Scale:- 1"=5'-0

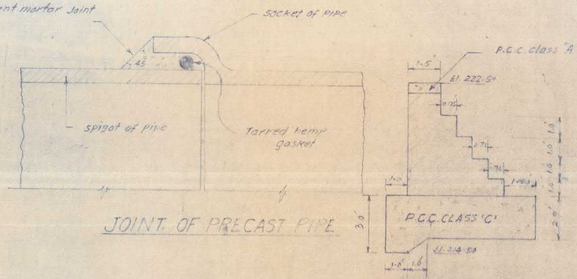


TYPICAL SECTION OF PIPE EMBEDDED CASE



TYPICAL SECTION OF PIPE PROJECTING CASE

Scale:- 1"=3'-0"



JOINT OF PRECAST PIPE

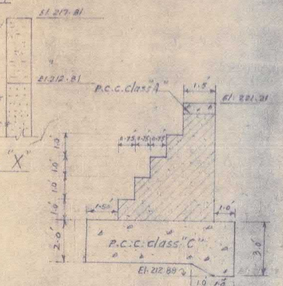
DETAIL OF U/S HEAD WALL

Scale:- 1"=3'-0"

PIT NO. 14

fine grained silty sand Light brown, dry, slightly moist from 4.0 to 50

Calcareous Sand Stone



DETAIL "X"

DETAIL OF D/S HEAD WALL

Scale:- 1"=3'-0"

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD.

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CS.)

DRAINAGE CROSSING AT CH. 43+51

Q = 42·0

W.S/451R-1	L-Section
W.S/452	L-Section
W.S/455 R-1	Typical Sections of Lining
HO-4A-C-464	Drainage X-ing at Ch. 25+57
DRAWING NO	TITLE OF DRAWING

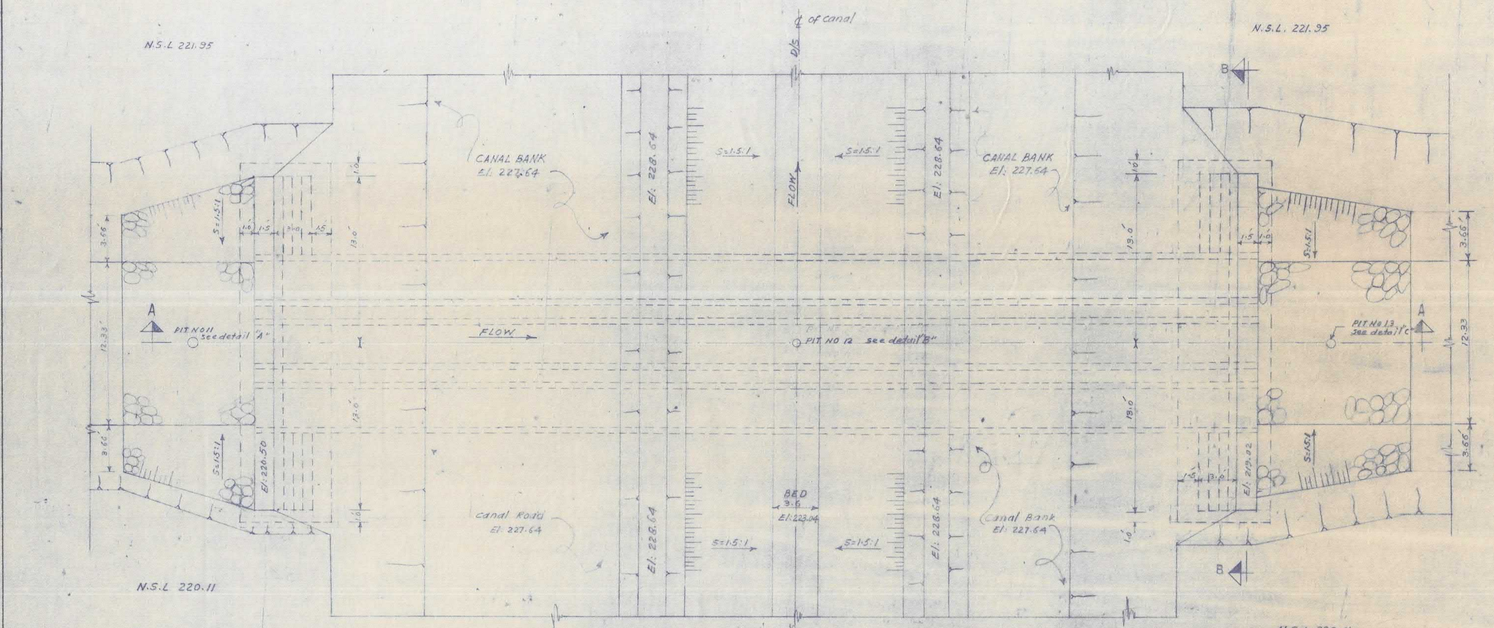
REFERENCE DRAWING

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN
DWN M. SATTAR GHULAM MUSTAFA
TRD
CKD
REVD

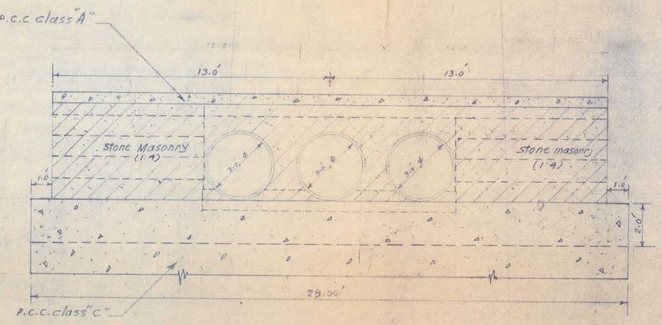
SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE LAHORE PAKISTAN | JOB NO 110 | INDEX NO 4-A | FILE NO W.W.DES | DRAWING NO. C.D.O. (W) 110-4A-C-470



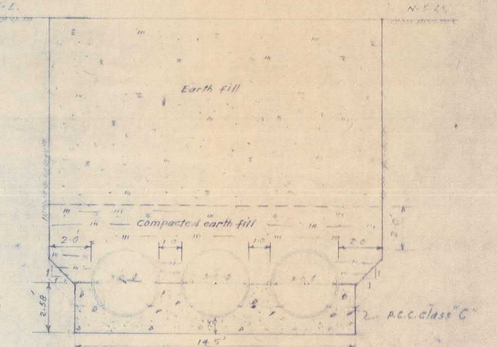
PLAN

STRUCTURE LIMIT FROM CH. 37+67 TO 39+92



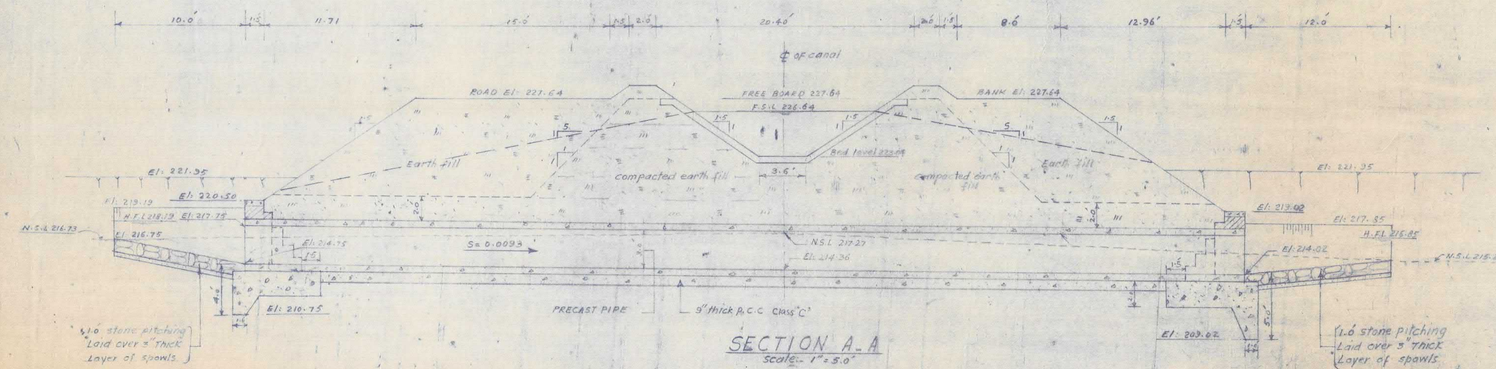
SECTION B.B

Scale:- 1"=5.0'



TYPICAL SECTION OF PIPE EMBEDDED CASE

SCALE 1"=30



SECTION A-A

Scale:- 1"=5.0'

W3/451 R-1 W5/452	L. SECTION OF CANAL
W5/455 R-1	TYPICAL SECTIONS OF LINING
110-4A-C-464	DRAINAGE CROSSING AT CH. 39+57
110-4A-C-469	DETAIL OF HEAD WALL & JOINT OF PRECAST PIPE
DRAWING NO	TITLE OF DRAWING

REFERENCE DRAWING

Sheet 1 of 2

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 38+92

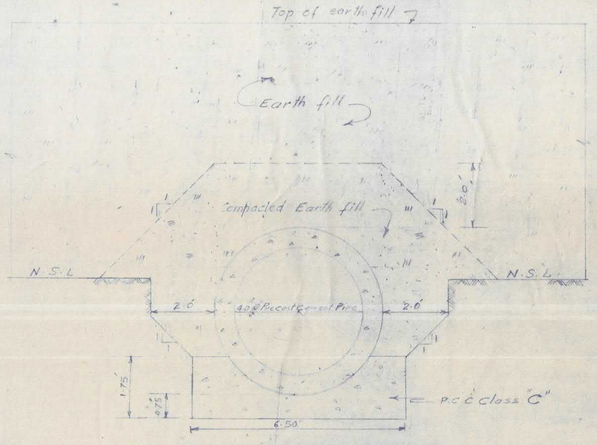
DISCHARGE OF NALA 150 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

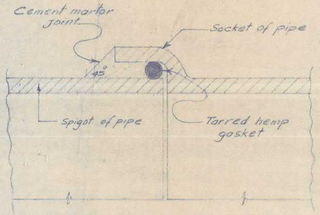
DSN.
DWN. SHULAM MUSTAFA
TRD
CKD. [illegible]
REVD.

SUBMITTED: DEPUTY DIRECTOR
RECOMMENDED: DIRECTOR DESIGN
APPROVED: CHIEF ENGINEER DESIGN

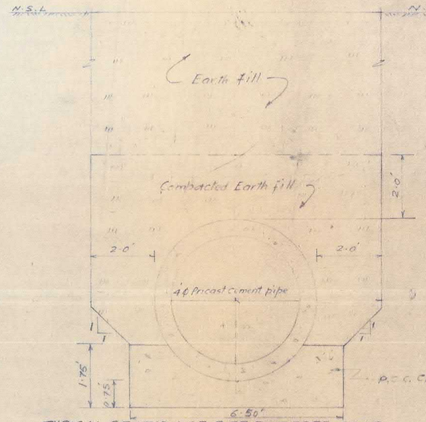
DATE	JOB. NO.	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN.	110	4-A	W. W DES	C.D.O.(W)110-4A-C-466



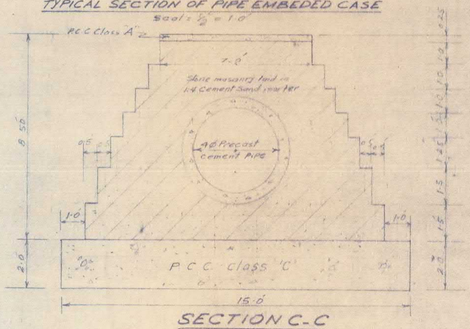
TYPICAL SECTION OF PIPE
PROJECTING CASE
Scale = ½" = 1.0'



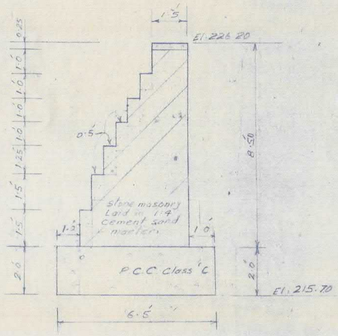
JOINT OF PRECAST PIPE



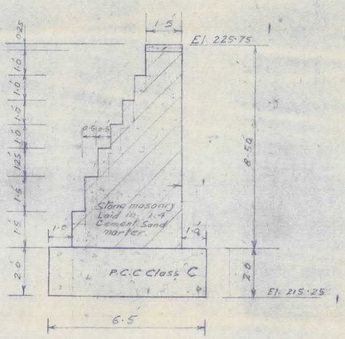
TYPICAL SECTION OF PIPE EMBEDED CASE
Scale = ½" = 1.0'



SECTION C-C
Scale, 1" = 3.0'



TYPICAL SECTION OF WING WALL U/S
Scale = ½" = 1.0'

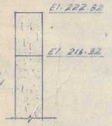


TYPICAL SECTION OF WING WALL D/S
Scale = ½" = 1.0'

PIT NO. 9

Silty sand, fine, loose, moist 4'-6"

Sand Stone, dirty grey, fine grained, moist low bandness. There are loose pockets, but moderately consolidated in patches.



DETAIL "X"

W.S. 451R-I W.S. 452	L-SECTION OF CANAL
W.S. 455R-I	TYPICAL SECTION OF LINING
110-4A-C-464	DRAINAGE X-ING AT CH. 29+57
110-4A-C-466	DRAINAGE X-ING AT CH. 33+72
DRAWING NO.	TITLE OF DRAWING
REFERENCE DRAWING	

REV. NO	DATE	DESCRIPTION	BY	CK'D	APPV'D

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 33+72
DETAIL OF JOINT AND WING WALLS
DISCHARGE OF NALA 87 CUSECS

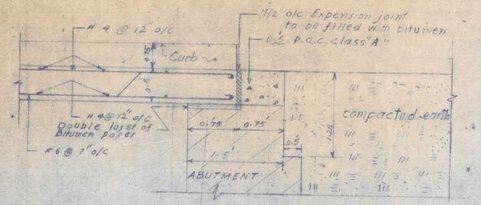
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.
DWN. MUHAMMAD RIAZ D/M
TRD.
CK'D.
REV'D.

SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

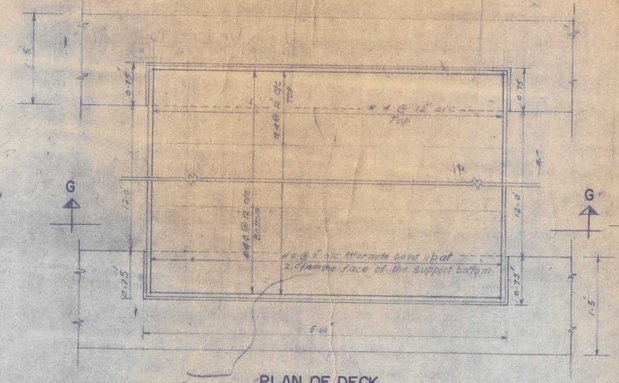
DATE 9-12-79 | JOB NO. 110 | INDEX NO. 4-A | FILE NO. W.W. DES | DRAWING NO. C.D.O.(W) 110-4A-C-467

LAHORE PAKISTAN



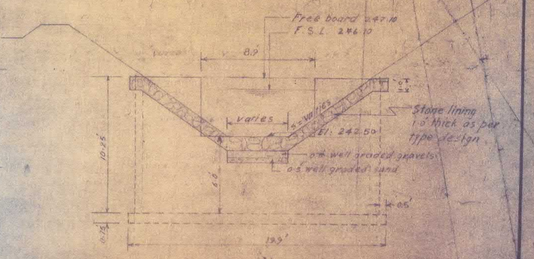
DETAIL SHOWING JUNCTION OF R.C.C. SLAB AND ABUTMENT

SCALE: 1" = 1-0"



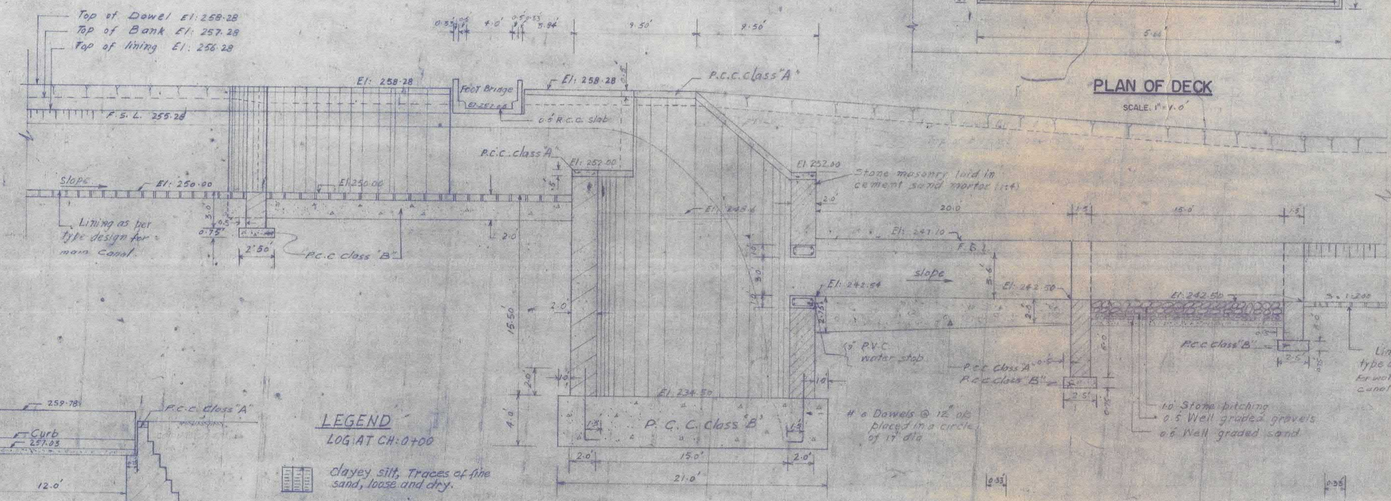
PLAN OF DECK

SCALE: 1" = 1-0



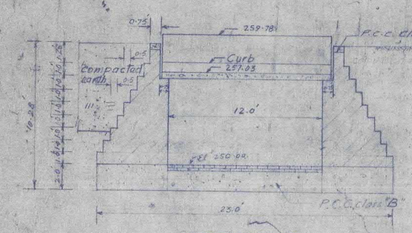
SECTION F-F

SCALE: 1"=5'0"



LONGITUDINAL SECTION AT A-A

SCALE: 1" = 5'0"



SECTION D-D

SCALE: 1" = 5'0"

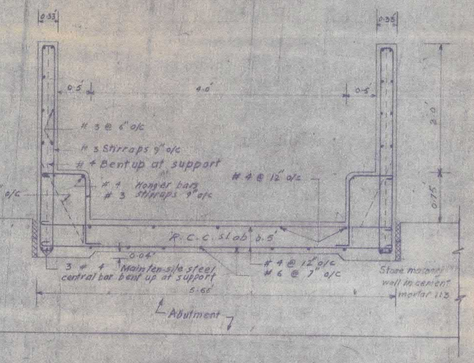
LEGEND

LOG AT CH: 0+00

clayey silt, Traces of fine sand, loose and dry.

Weathered portion of under lying clayey silt stone.

clayey silt stone with inter-bedded thin clayey layers upto 2'0". Then (from 5'6" to 11'5") it is clay / shale with few thin silty layers.

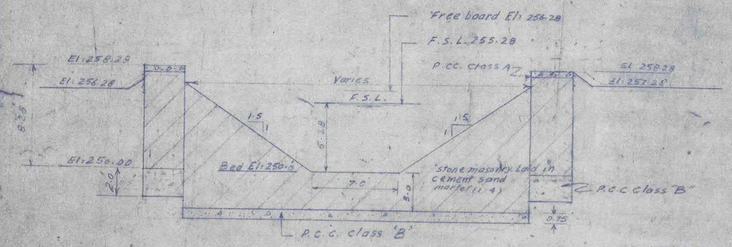


SECTION G-G

SCALE: 1" = 5'0"

NOTES:-

1. Plain concrete class "A" shall have a minimum cylinder strength of 3600 lbs/sq inch after 28 days.
2. Plain concrete class "B" shall have a minimum cylinder strength of 2500 lbs/sq inch after 28 days.
3. All reinforced concrete shall be class "A" and have a minimum cylinder strength of 3000 lbs/sq inch after 28 days unless otherwise shown.
4. Sand and gravel filter layers may be compacted to minimum 95% relative density. The dimensions shown in drawing are the final compacted depth of each layer.
5. All bars are deformed bars conforming to A.S.T.M. Designation A 305-49T, 40,000 lbs. p.s.i.
6. Unless otherwise shown, place reinforcement so that the clear distance between the face of the concrete and the nearest reinforcement is 2"
7. All splices shall be 24 ø of the bars.
8. Stone masonry to consist ruble masonry (1:4 class) and shall conform to the specification laid down in the West Pakistan Building Rules Examination Section No. 2 volume II part II para 22 B.



SECTION B-B

SCALE: 1" = 5'0"

LOG AT CH 0+00

N.S.L El: 252.34

El: 250.34

El: 242.34

El: 241.09

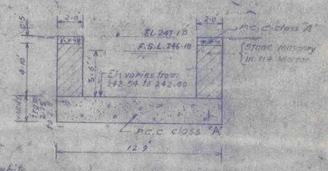
LEGEND

LOG AT CH. 00+38 D/S

Clayey silt with traces of fine sand, moderately compacted, some white Calcareous concretions which are loose.

Weathered portions of clayey silt stone.

Argillaceous (clayey) silt stone light buff, not very compact, slightly moist, disintegrates into small pieces with light hammer blow



SECTION E-E

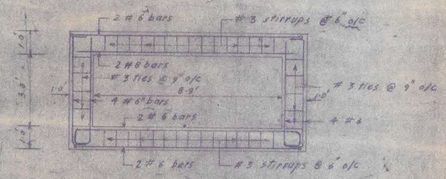
SCALE: 1" = 5'0"

LOG AT CH: 00+38 D/S

N.S.L El: 252.88

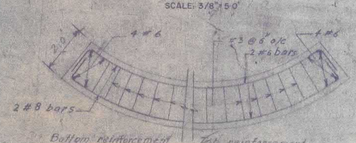
El: 250.88

El: 242.88



REINFORCMENT DETAIL OF OPENING

SCALE: 3/8" = 1'0"



TOP BEAM

SCALE: 3/8" = 1'0"

REV NO.	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

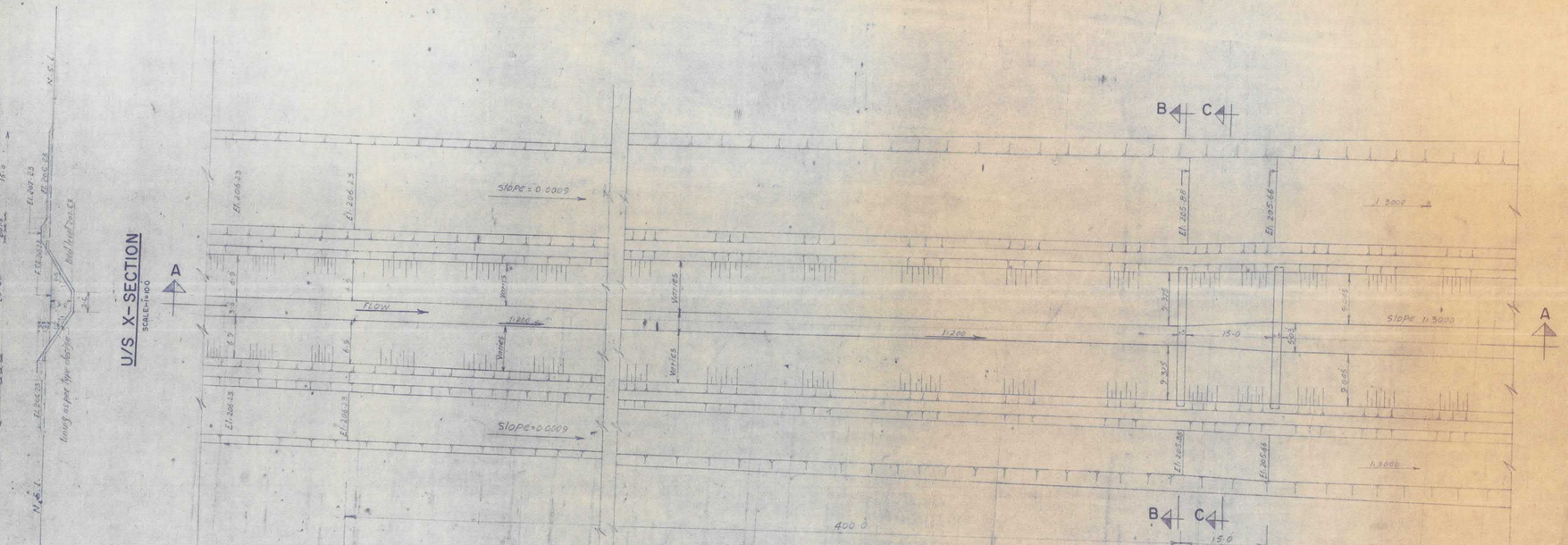
WATER SUPPLY CANAL (210 CUSECS)
SECTIONS & OTHERS DETAILS OF
9.18 Ft. WELL FALL AT CH. 0+00

WS/451, 452	L-SECTION OF WATER SUPPLY CANAL
WS/455	TYPICAL SECTION OF CANAL LINNING
110-4A-C-456	PLAN OF 9.18 Ft. WELL FALL AT CH. 0+00
NO. OF DRG.	T I T L E
REFERENCE DRAWINGS	

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.	SUBMITTED	RECOMMENDED
DWN. S. Irshad Hussain	DEPUTY DIRECTOR	DIRECTOR DESIGN
TRD. G. Mustafa	APPROVED	
CKD.	CHIEF ENGINEER DESIGN	
REVD.		

DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO
LAHORE PAKISTAN	110	4-A	WW DESIGN	C.D.O. (W)

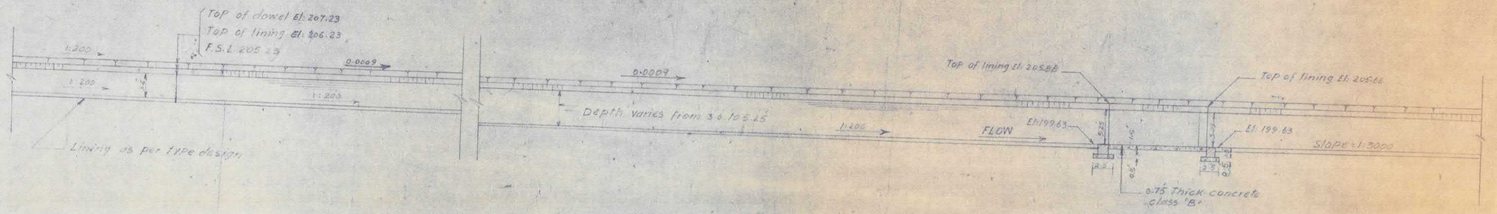


PLAN
SCALE-1"=10'-0"

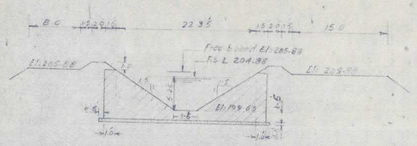
STRUCTURE LIMITS AT CH 60+87 TO 65+87

U/S X-SECTION
SCALE-1"=10'-0"

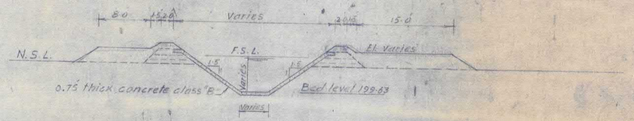
D/S X-SECTION
SCALE-1"=10'-0"



SECTION A-A
SCALE-1"=10'-0"



SECTION B-B
SCALE-1"=10'-0"



SECTION C-C
SCALE-1"=10'-0"

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

TRANSITION AT CH. 64 + 87

PLAN AND SECTIONS

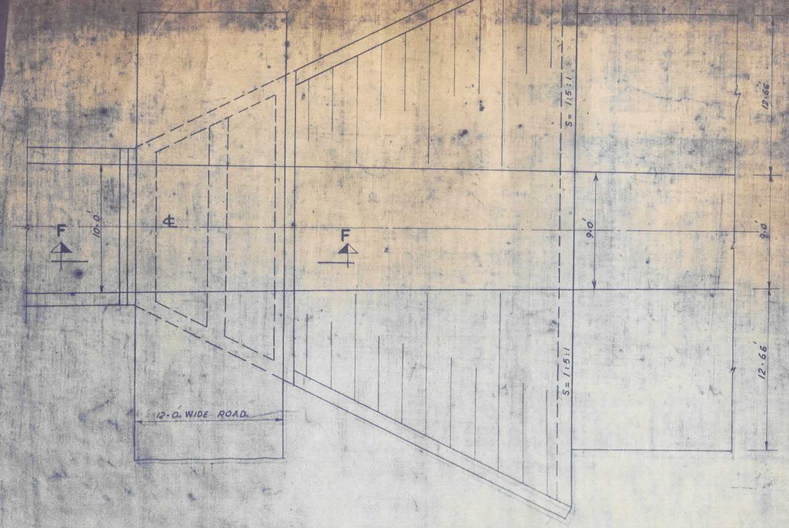
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

W-4A-C-458	PLAN OF DRAINAGE X-ING AT CH. 5+30
W.S.451 R-I W.S.452	L-SECTION OF WATER SUPPLY CANAL
WS/455 R-I	TYPICAL SECTION OF LINING
DRG. NO	TITLE

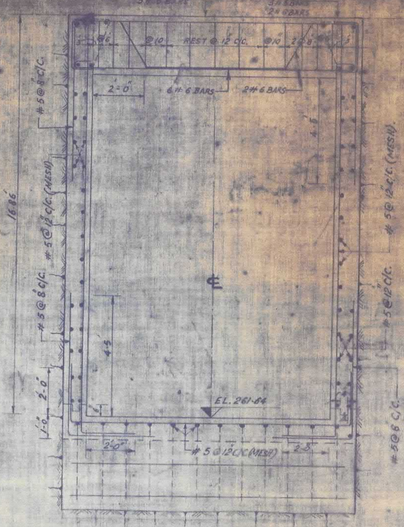
REFERENCE DRAWING

DSN. _____ SUBMITTED _____ RECOMMENDED _____
DWN. REHMAT BARI TRACER DEPUTY DIRECTOR DIRECTOR DESIGN
TRD. _____
CKD. _____ APPROVED _____
REVD. _____ CHIEF ENGINEER DESIGN

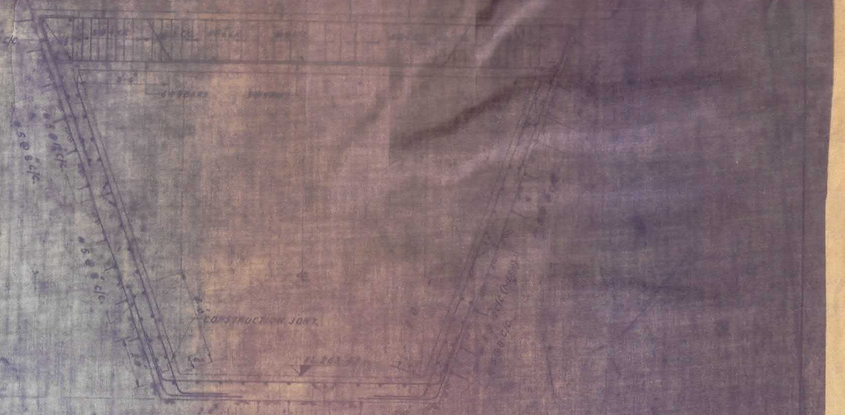
DATE: 2-12-1979	JOB NO.	INDEX NO	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W.DES.	C.D.O. (W)110-4A-C-474



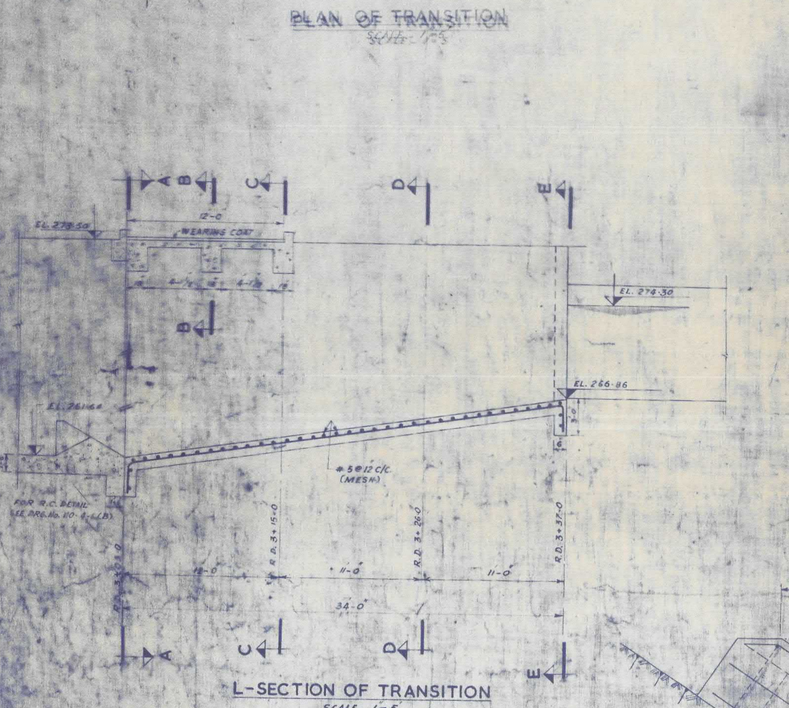
PLAN OF TRANSITION
SCALE: 1/5



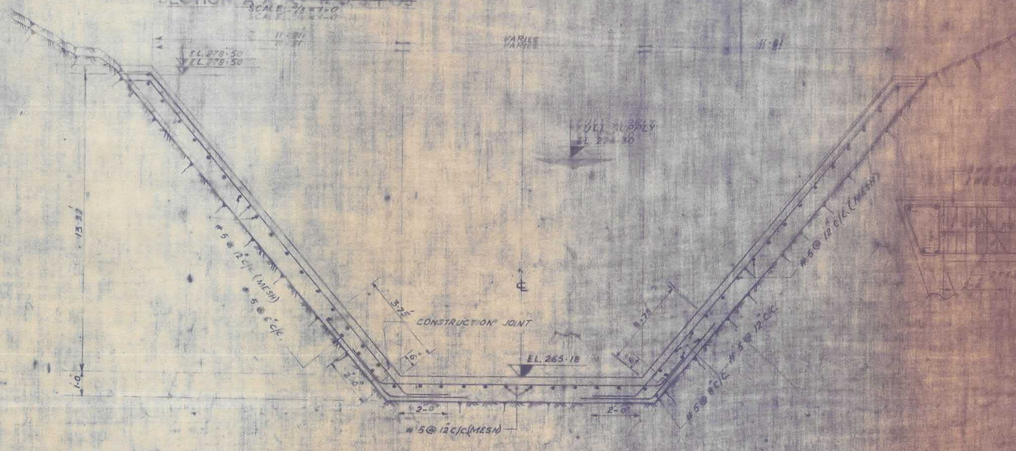
SECTION A-A AT R.D. 3+03
SCALE: 3/8"=1'-0"



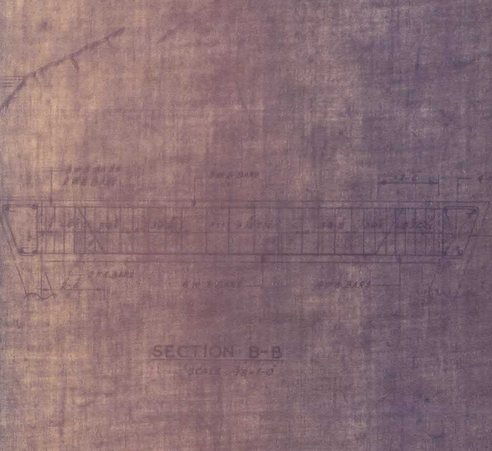
SECTION C-C AT R.D. 3+15
SCALE: 3/8"=1'-0"



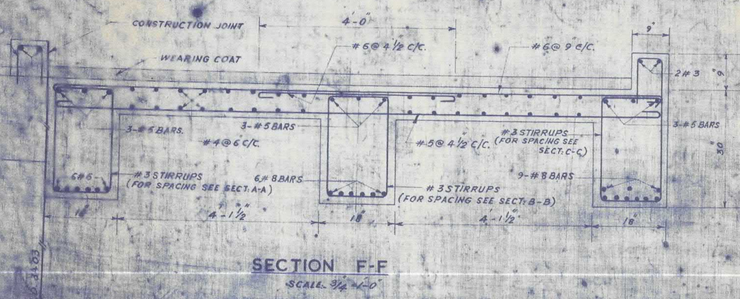
L-SECTION OF TRANSITION
SCALE: 1=5



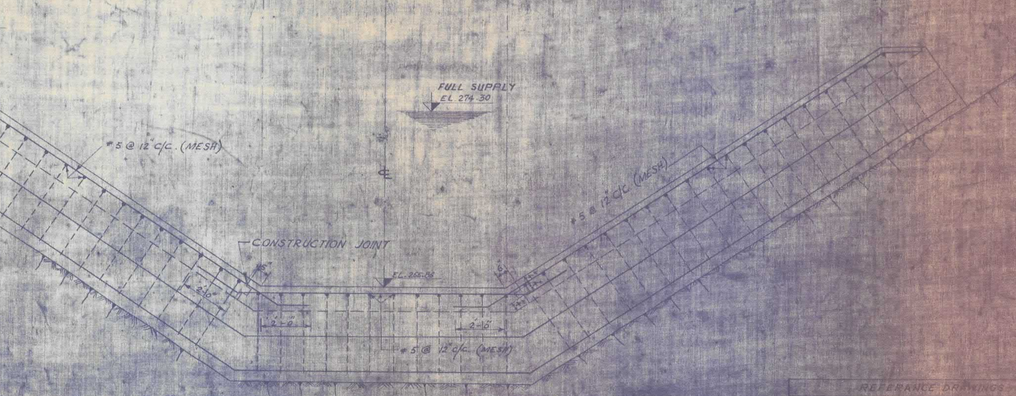
SECTION D-D AT R.D. 3+26
SCALE: 3/8"=1'-0"



SECTION B-B
SCALE: 3/8"=1'-0"



SECTION F-F
SCALE: 3/4"=1'-0"



SECTION E-E AT R.D. 3+37
SCALE: 3/8"=1'-0"

NOTES

1. FOR STRUCTURAL NOTES REFER DRG. No. 10-4-C.D.
2. ALL THE LEVELS ARE WITH REFERANCE TO THE BENCH MARK AS ADOPTED ORIGINALLY IN M.I.S. ALL THESE LEVELS HAVE BE RECONCILED WITH LEVELS OF SURVEY OF PAKISTAN STATION TO ACCOUNT FOR DIFFERANCE.
3. THE BENCH MARK DATUM ON WHICH LEVELS SHOWN ON THIS DRG. ARE BASED IS 8·3 HIGHER THAN R.L. DATUM USED FOR OTHER DRAWINGS OF IRRIGATION MAIN CANAL SYSTEM.

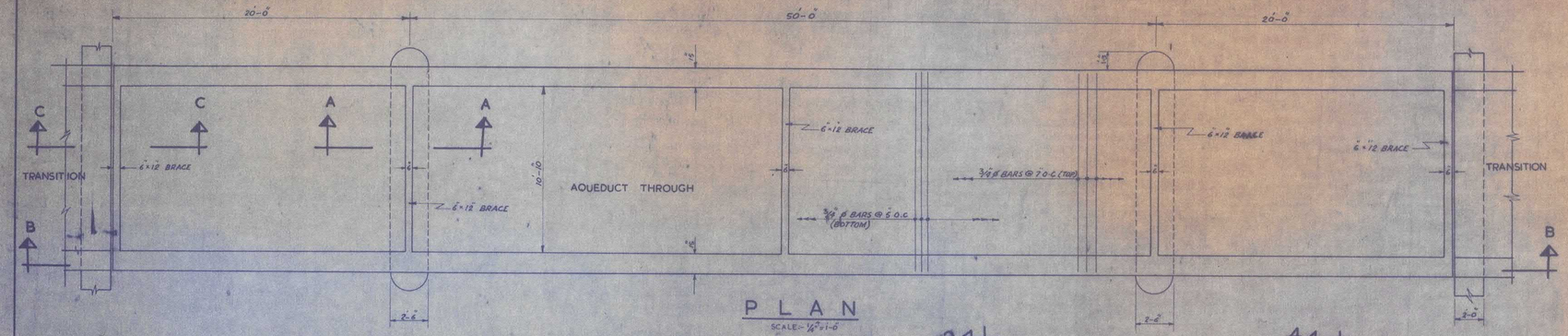
REFERANCE DRAWINGS

NO.	TITLE
1.	SINGLE BARREL IRRIGATION SLUICE PLAN AND L. SECTION.
2.	R.C. DETAIL OF RADIAL GATE STRUCTURE CLEAR OPENING BASE STONE 4 GATE 30

WEST PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY
DESIGNS DIRECTORATE
HUB DAM PROJECT
TRANSITION AT D/S END OF CONTROL SLUICE
PLAN, L-SECTION & X-SECTION SHOWING R.C. DETAILS

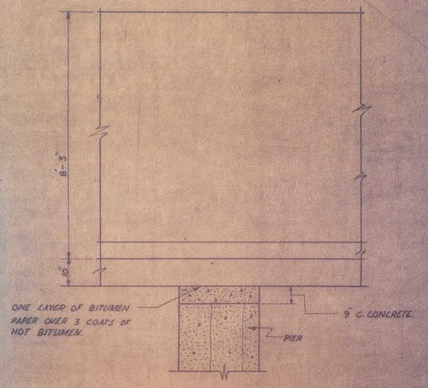
DESIGNED	TRACED	CHECKED	APPROVED

DATE	REVISION	BY



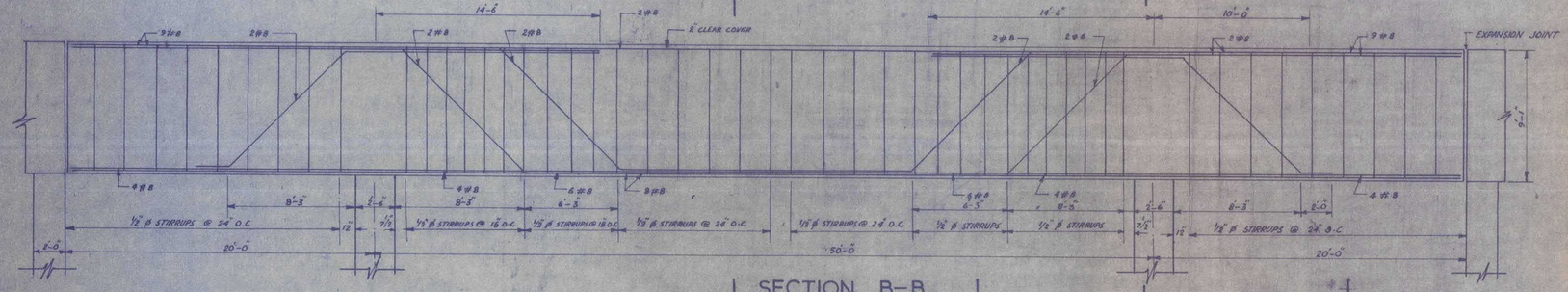
PLAN

SCALE:- 1/8" = 1'-0"



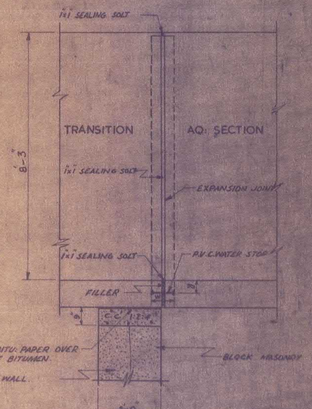
SECTION A-A

SCALE:- 1/2" = 1'-0"



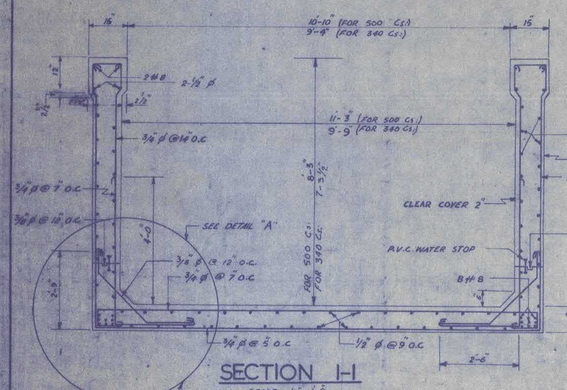
SECTION B-B

SCALE:- 1/4" = 1'-0"



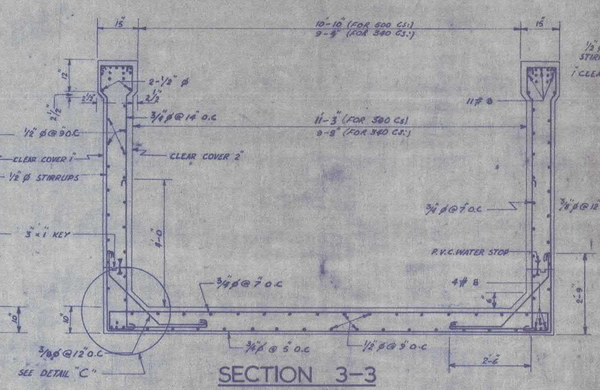
SECTION C-C

SCALE:- 1 1/2" = 1'-0"



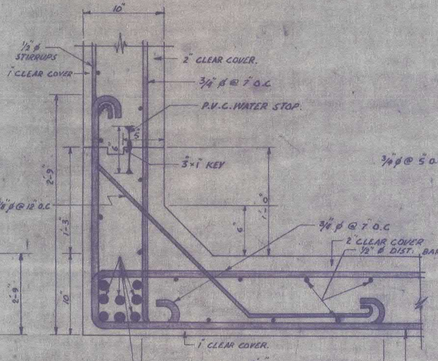
SECTION 1-1

SCALE:- 1/2" = 1'-0"



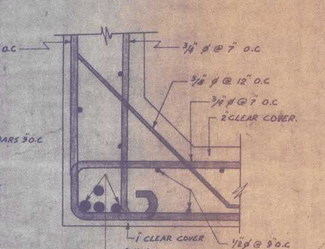
SECTION 3-3

SCALE:- 1/2" = 1'-0"



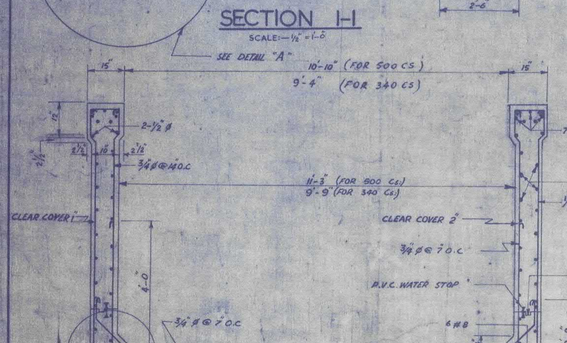
DETAIL "A"

SCALE:- 1 1/2" = 1'-0"



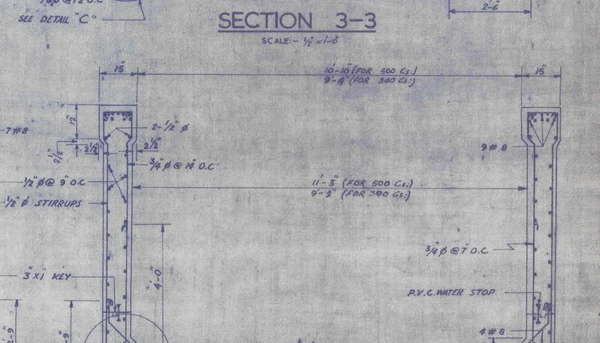
DETAIL "D"

SCALE:- 1 1/2" = 1'-0"



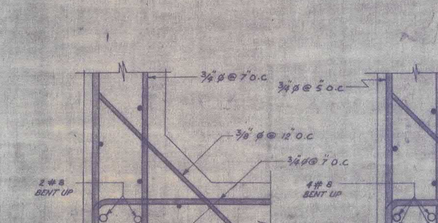
SECTION 2-2

SCALE:- 1/2" = 1'-0"



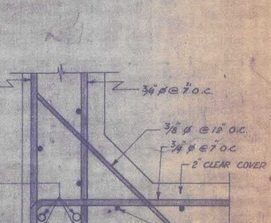
SECTION 4-4

SCALE:- 1/2" = 1'-0"



DETAIL "B"

SCALE:- 1 1/2" = 1'-0"



DETAIL "C"

SCALE:- 1 1/2" = 1'-0"

NOTES:-

1. THE CONCRETE IN REINFORCED WOR SHALL BE OF RATIO 1:2:4 AND MUST SHOW A MIN. STRENGTH OF 3000 LBS/SQ.IN AT 28 DAYS.
2. FOR PIER AND RETAINING WALL DETAILS SEE DRG. No. 110-4-43 & 44 AND 110-4-44
3. FOR BRACE DETAILS SEE DRG. No. 110-4-28.
4. ALL REINFORCEMENT LESS THAN 1" DIA. SHALL BE PLAIN BARS CONFORMING TO ASTM A-615 AND THAT 1" DIA OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM A-615

REVISION	
DATE:- 9-1-71	SCALE:- 1/2"=1'-0", 1/4"=1'-0", 1"=1'-0"

WATER AND POWER DEVELOPMENT AUTHORITY

DIRECTORATE OF DESIGNS

HUB DAM PROJECT

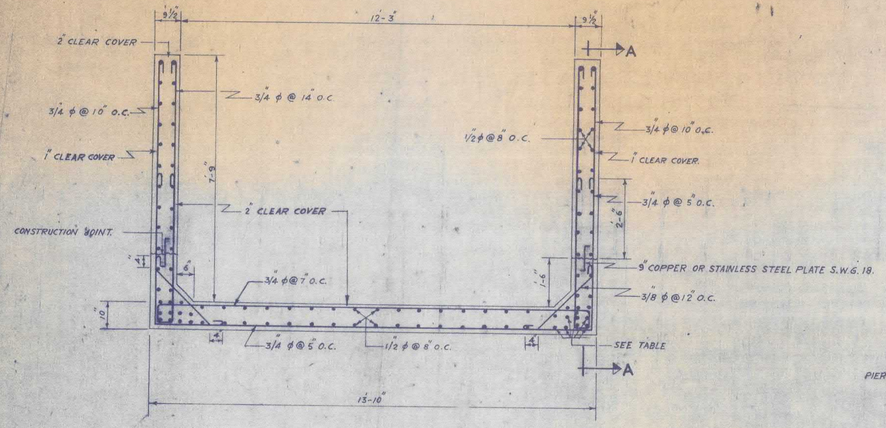
STRUCTURAL DETAILS OF AQUEDUCT

(OVER NALLAH AT CH: 276+00, 607+00)

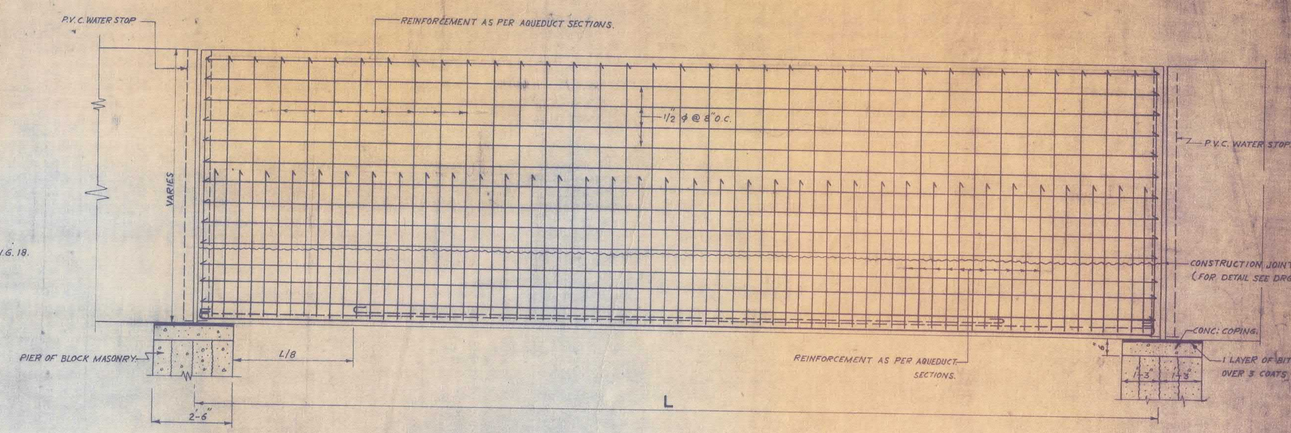
AQUEDUCT SPAN 90 FT.

DRAWN:- M. SALEEM	DESIGNED:-
TRACED:- MOHD SHAFI JOSH	SUBMITTED:-
CHECKED:- 17.5.72	RECOMMENDED:-
APPROVED:-	DRG. No:- 110-4-22

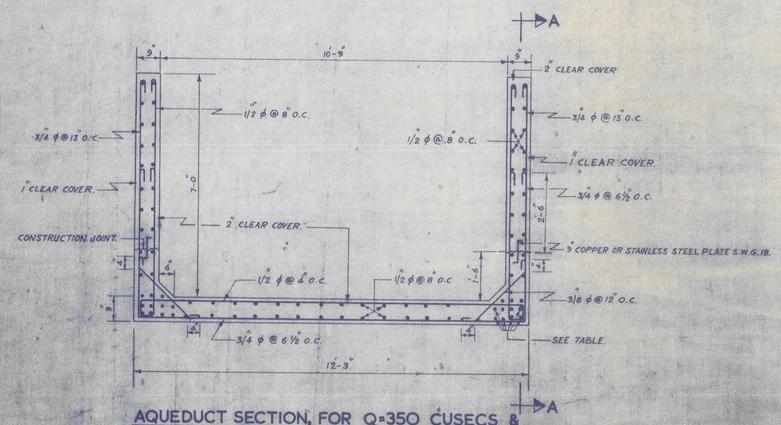
JOB NO.
SER: NO.



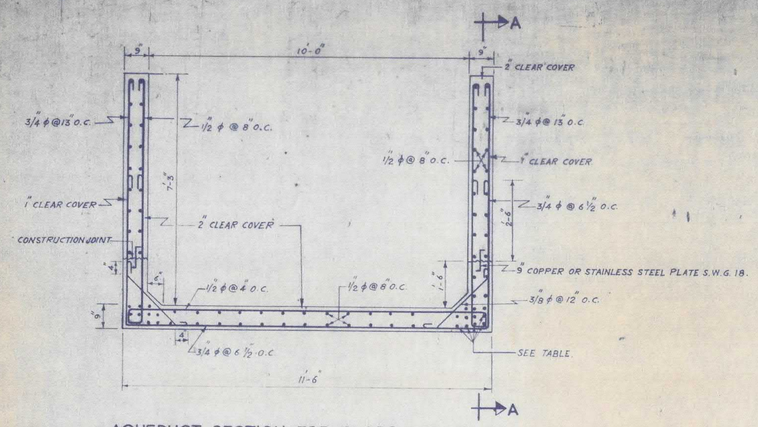
AQUEDUCT SECTION FOR Q= 500 CUSECS
(UPTO LASBELA OFFTAKE)



TYPICAL SECTION A—A.

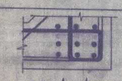


AQUEDUCT SECTION, FOR Q=350 CUSECS &
CANAL SECTION IN SOIL
(UPTO LASBELA OFF TAKE)



AQUEDUCT SECTION FOR Q=350 CUSECS &
CANAL SECTION IN ROCK
(UPTO LASBELA OFFTAKE)

REINFORCEMENT TABLE FOR BEAMS

Q DISCHARGE IN CUSECS	SECTION IN	SPAN (FT.)	STEEL	NO. OF LAYERS	DETAILS	REMARKS
500	SOIL	30 20 10	9–1" ϕ 6–1" ϕ 2–1" ϕ	3 LAYERS 2 LAYERS 1 LAYER	 3–LAYERS	THIRD LAYER BARS SHOULD BE CURTAILED AT L/8.
350	SOIL	30 20 10	8–1" ϕ 5–1" ϕ 3–3/4 ϕ	2 LAYERS 2 LAYERS 1 LAYER	2 LAYERS	
350	ROCK	30 20 10	9–1" ϕ 5–1" ϕ 3–3/4 ϕ	3 LAYERS 2 LAYERS 1 LAYER	1 LAYER	

NOTES:-
UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWING.
1- THE CONCRETE IN REINFORCED WORKS SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 LBS/□ AT 28 DAYS.
2- MINIMUM LAP IN THE BARS SHALL BE 40 BAR DIA.
3 ALL REINFORCING STEEL SHALL BE M.S. ROUND BARS HAVING A MIN: YIELD STRENGTH OF 36,000 P.S.I.

110-4-16	TYPICAL AQUEDUCTS (R.C.C. DETAILS) WING WALLS
110-4-15	TYPICAL AQUEDUCTS (PLAN & SECTIONS)
110-4-18	JOINT & SUPPORT DETAILS
110-4-10	TYPICAL SECTIONS & LINING DETAILS.

REFERENCE DRAWINGS

REVISION

DATE:- 1.11.89. SCALE:- ½"=1'-0"

WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS

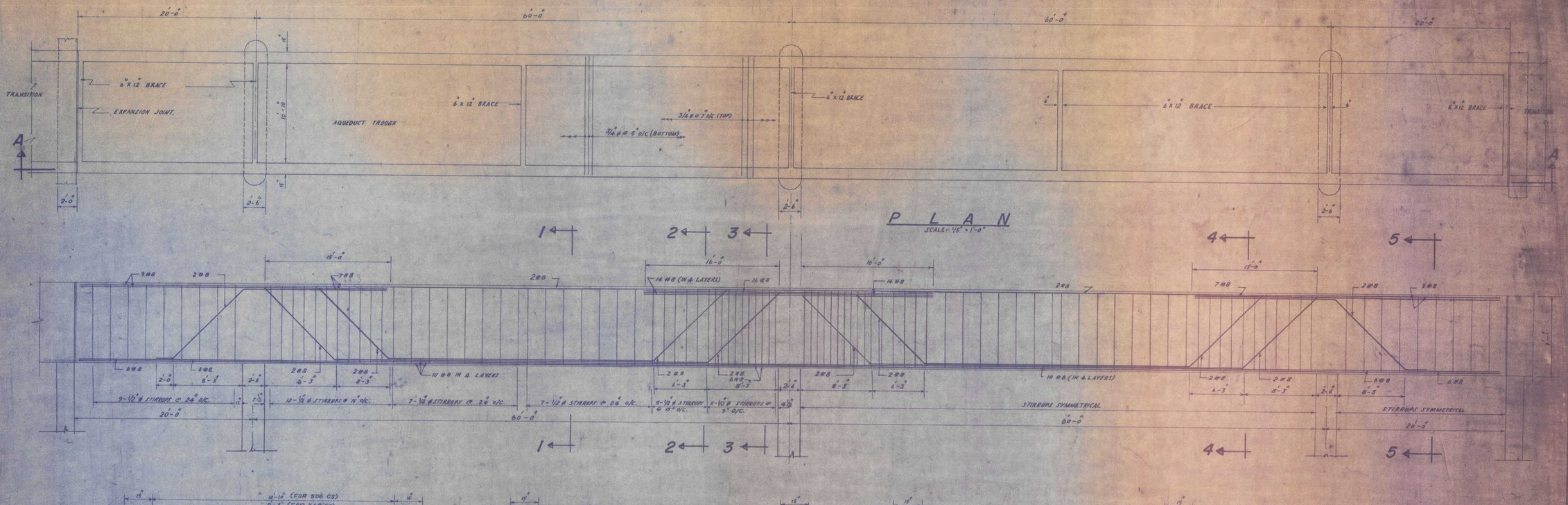
HUB DAM PROJECT

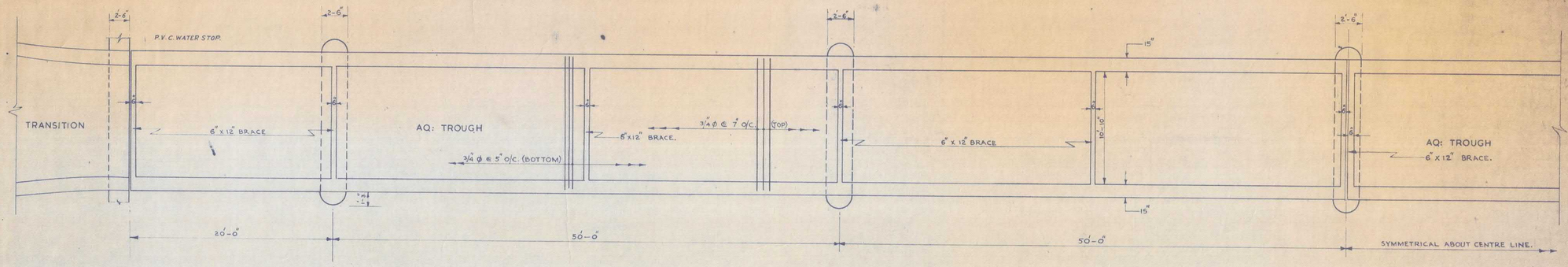
MAIN CANAL HEAD REACH REINFORCEMENT DETAILS OF AQUEDUCTS

DRAWN MOHD ASLAM TRACER
TRACED MOHD ASLAM TRACER
CHECKED
APPROVED
D.G.

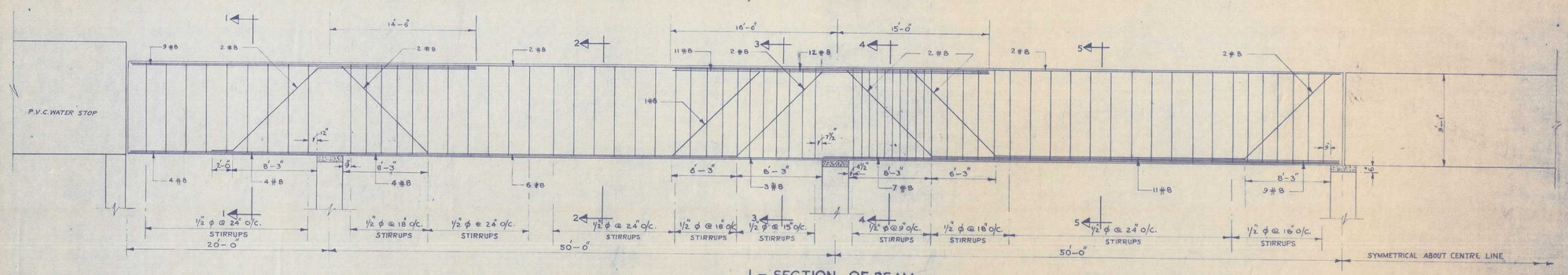
DESIGNED
SUBMITTED
RECOMMENDED

DRG: NO. 110-4-17 (1)

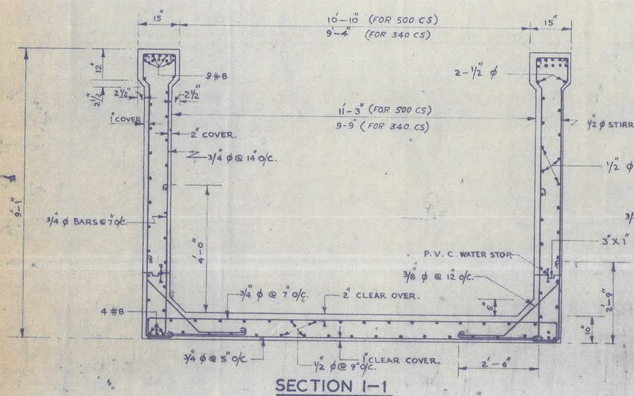

20'-0"
60'-0"
60'-0"
20'-0"
TRANSITION
6"X12" BRACE
EXPANSION JOINT
AQUEDUCT TROUGH
6"X12" BRACE
3/4"ø @ 7" O/C (TOP)
3/4"ø @ 5" O/C (BOTTOM)
6"X12" BRACE
6"X12" BRACE
6"X12" BRACE
TRANSITION
A
A
10'-10"
2'-0"
2'-6"
2'-6"
2'-6"
2'-6"
1
2
3
4
5
PLAN
SCALE:- 1/8" = 1'-0"
15'-0"
16'-0"
10'-0"
15'-0"
9#8
2#8
7#8
14 #8 (IN 4 LAYERS)
16 #8
16 #8
2#8
7#8
2#8
9#8
10 #8 IN 4 LAYERS
10 #8 (IN 4 LAYERS)
6#8
2#8
6#8
2#8
6#8
2#8
6#8
2#8
6#8
6#8
2'-0"
6'-3"
2'-6"
6'-3"
2'-6"
6'-3"
2'-6

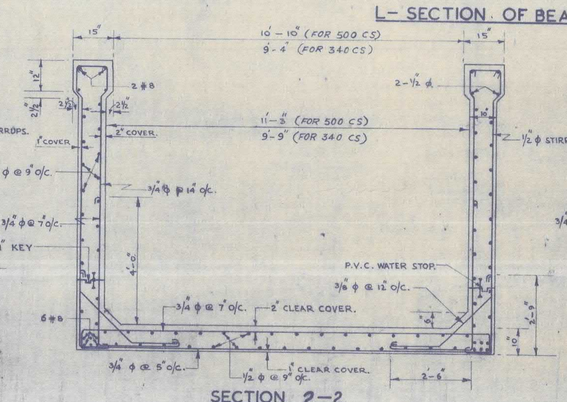


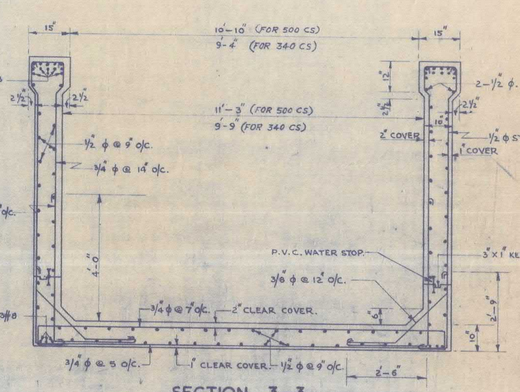
PLAN
(SCALE: 1" = 5'-0")

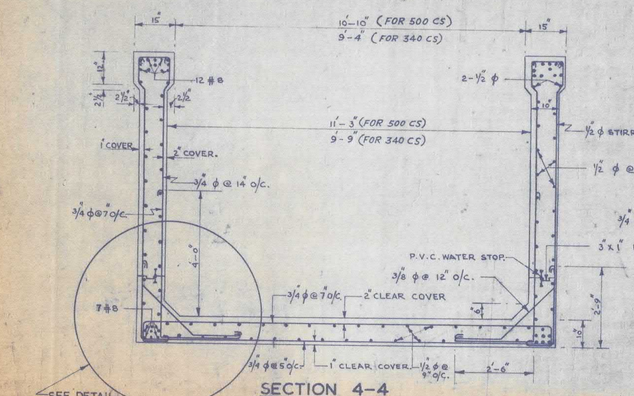


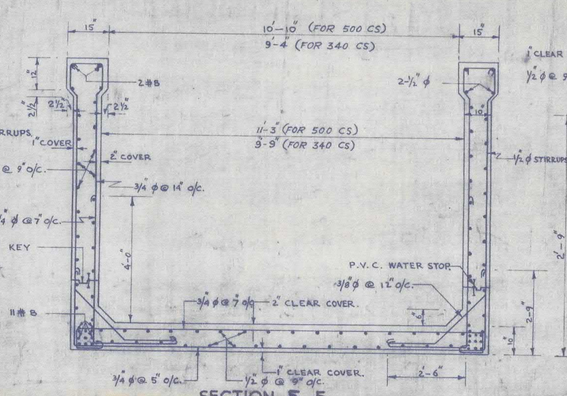
L- SECTION OF BEAM

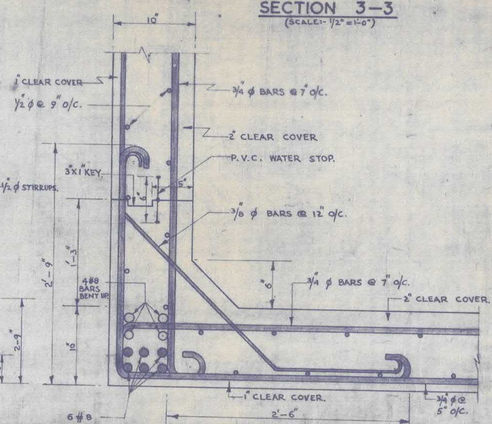












NOTES:-

1. THE CONCRETE IN REINFORCED WORK SHALL BE OF RATIO 1:2:4 AND MUST SHOW A MINIMUM CRUSHING STRENGTH OF 3000 LBS./IN² AT 28 DAYS.
2. FOR COL: AND ABUTMENT WALL DETAILS SEE DRG: NO.
3. FOR EXPANSION JOINT AND SUPPORT DETAILS SEE DRG:NO.110-4-32
4. FOR BRACE DETAILS SEE DRAWING NO. 110-4-28.

REVISION	
DATE:- 13-11-70	SCALE:- ½" = 1'-0"

WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS

HUB DAM PROJECT

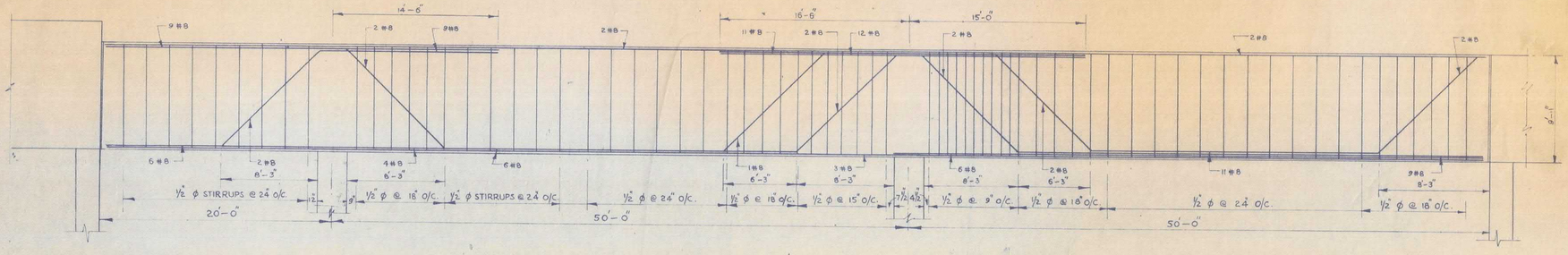
STRUCTURAL DETAILS OF AQUEDUCT

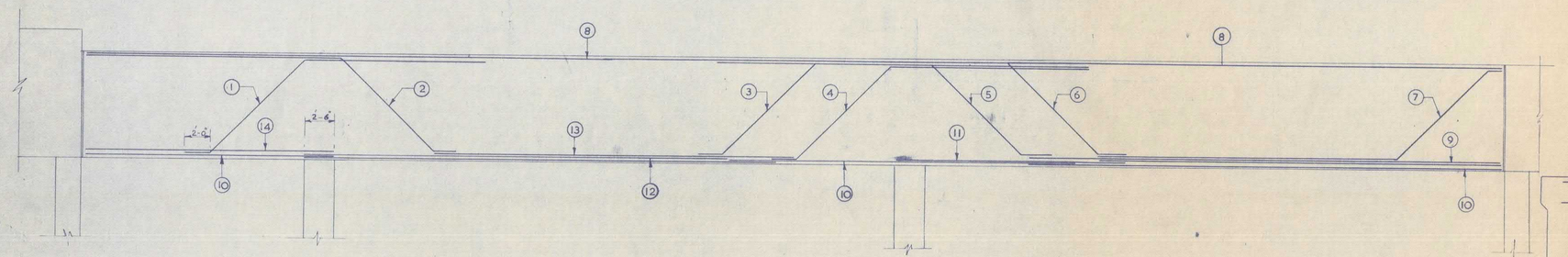
(OVER NALLAHS AT CH: 31+90; 139+00; 508+00)

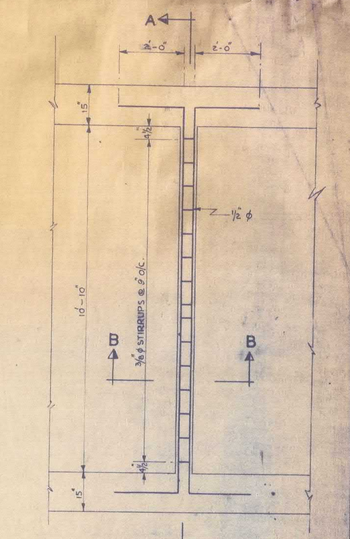
AQUEDUCT SPAN 240 FT.

DRAWN:- M. NAZIR	DESIGNED:-
TRACED:- MOHD HUSSAIN KHAWER	SUBMITTED:-
CHECKED:-	RECOMMENDED:-
APPROVED:-	DRG:NO. 110-4-27

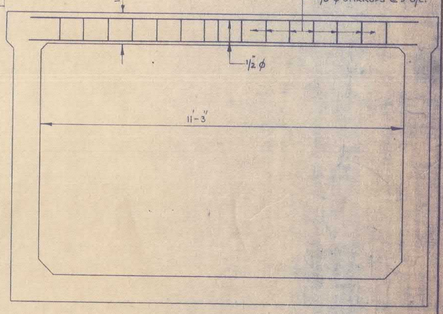
DRG: NO.	TITLE
	REFERENCE DRAWINGS



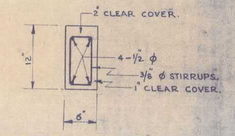




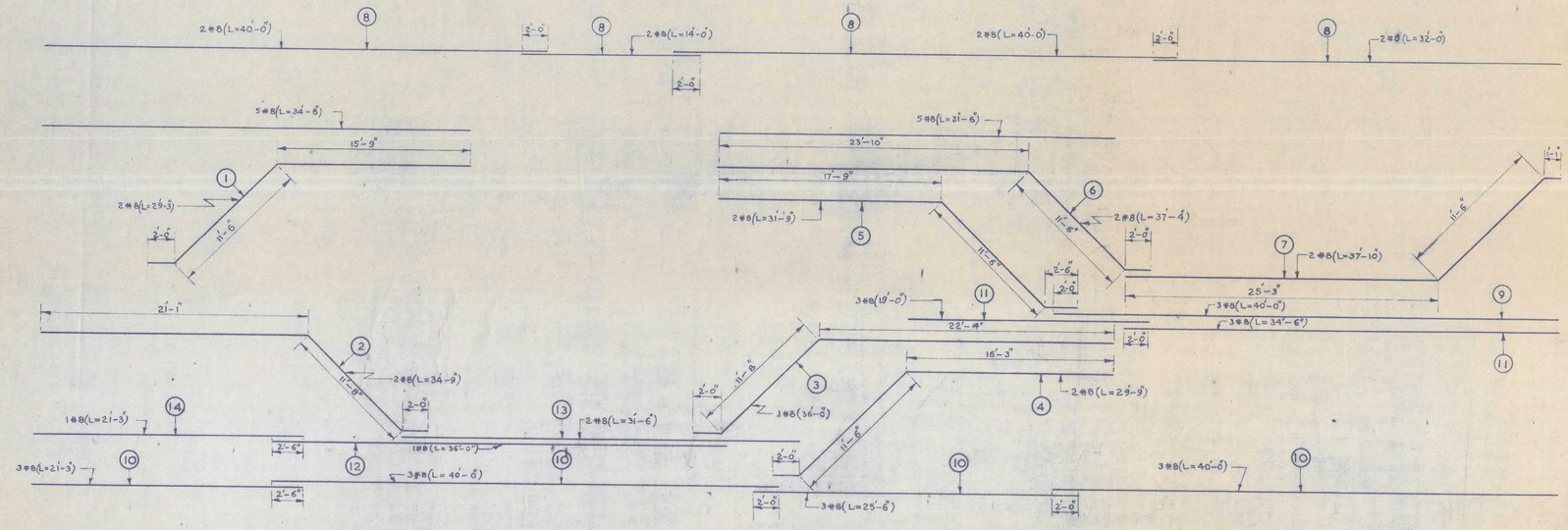
DETAIL OF BRACE
SCALE :- 1/2" = 1'-0"



SECTION A—A
SCALE :- 1/2" = 1'-0"



SECTION B—B
SCALE 1-1" = 1'-0"

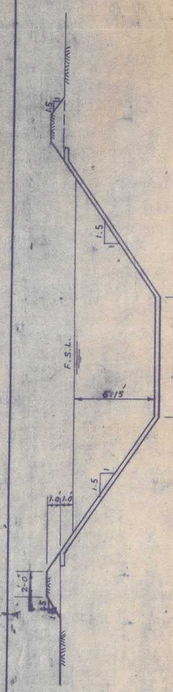


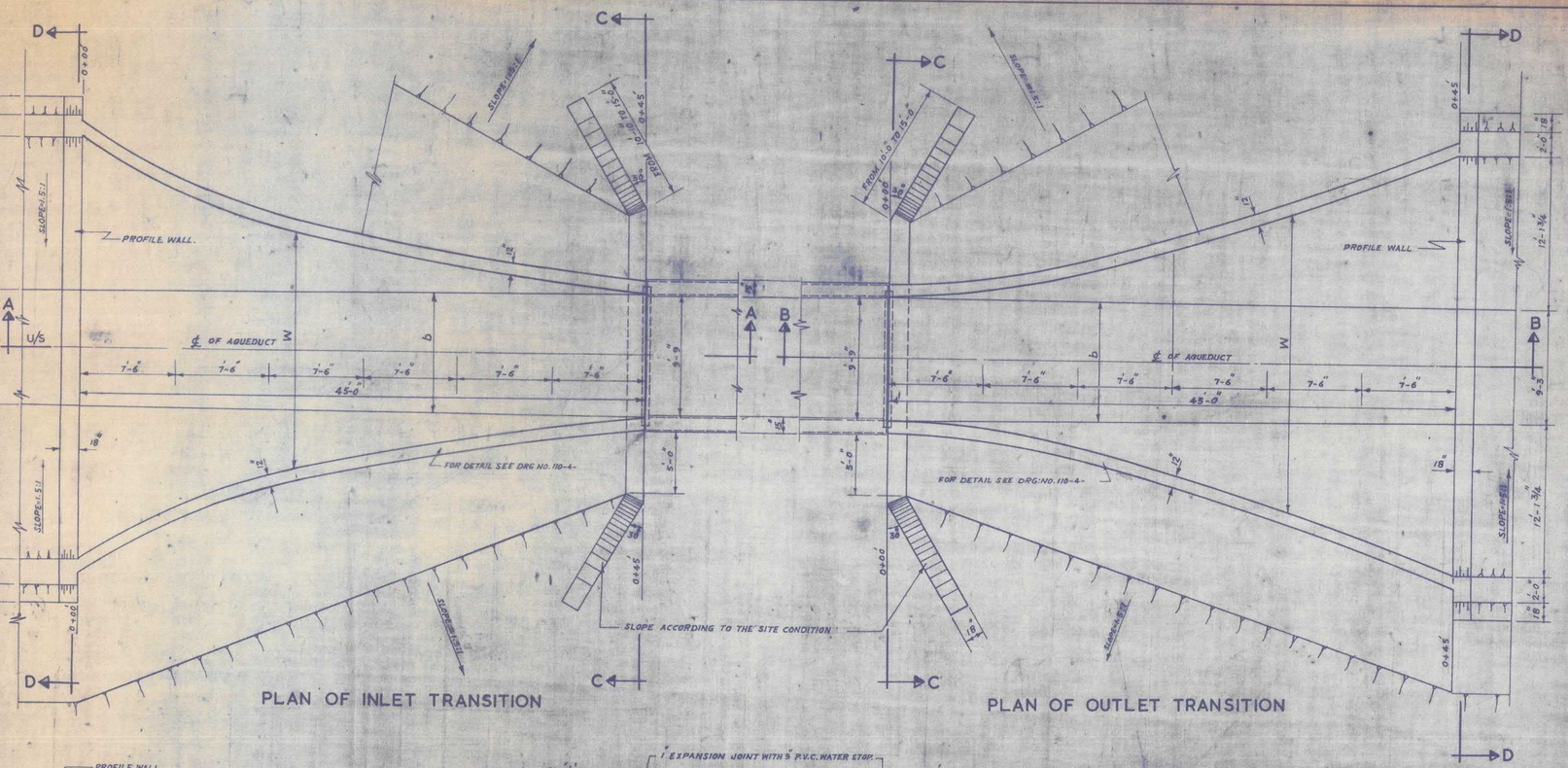
WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS

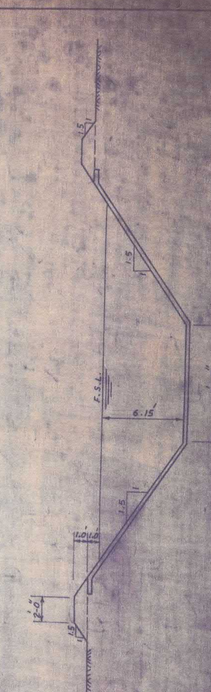
HUB DAM PROJECT

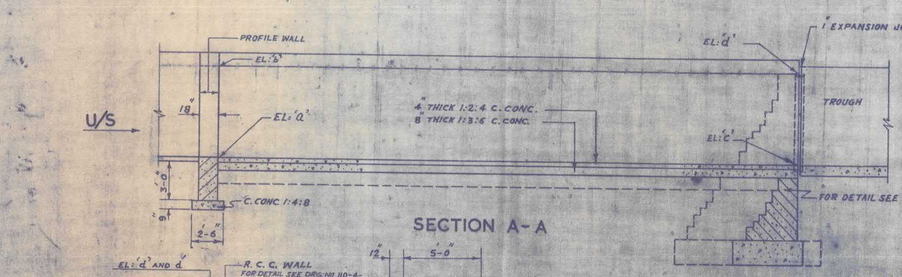
TYPICAL REINFORCEMENT AND LAP DETAILS AQUEDUCT SPAN 240 FT.

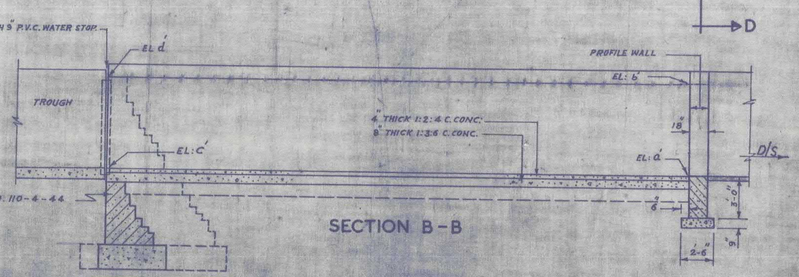
DRAWN: M. SALEEM	DESIGNED:
TRACED: MOHD. HUSSAIN KHAWER	SUBMITTED:
CHECKED:	RECOMMENDED:
APPROVED:	DRG: NO. 110-4-28

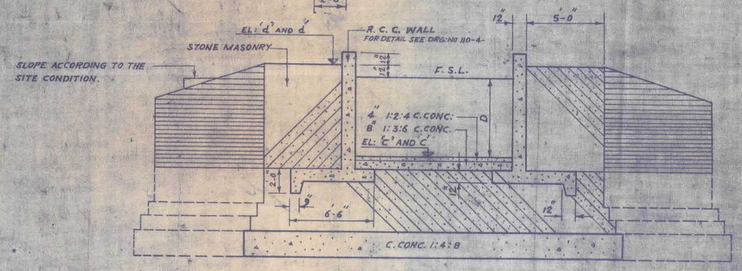


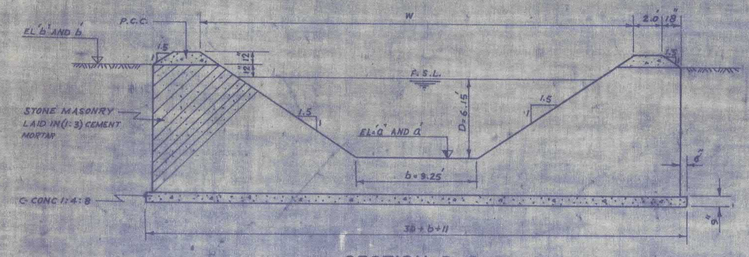












GENERAL STRUCTURAL NOTES:-

1. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE (A.C.I. 318-63)
2. ALL REINFORCED CONCRETE SHALL BE OF 1:2:4 MIX AND SHALL HAVE A MIN: COMPRESSIVE STRENGTH OF 3000 Lbs/in IN 28 DAYS UNLESS OTHERWISE NOTED.
3. ALL REINFORCEMENT LESS THAN 1" DIA: SHALL BE PLAIN BARS CONFORMING TO ASTM A-15 AND THAT 1" DIA OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM A-305 (fy = 40,000 Lbs/in²)
4. UNLESS OTHERWISE SHOWN, PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN THE FACE OF CONCRETE AND NEAREST REINFORCEMENT IS 2" EXCEPT PROVIDE A CLEAR DISTANCE OF 3" FROM THE FACE OF CONCRETE PLACED AGAINST EARTH.
5. ALL SPLICES SHALL BE LAPPED 48 BAR DIA FOR PLAIN BARS AND 24 BAR DIA: FOR DEFORMED BARS.
6. ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2,500 Lbs/in².
7. ALL CONC: CONSTRUCTION WHERE EVER HAVE CONSTRUCTION JOINTS WILL ALSO BE PROVIDED WITH P.V.C. OR RUBBER WATER STOPS OR COPPER STOP.
8. A BLINDING LAYER OF 3" THICK CONCRETE IS TO BE LAID UNDER ALL REINFORCED CONCRETE.
9. UNLESS SHOWN OTHERWISE, ALL EXPANSION JOINTS SHALL BE OF 1" SIZE AND SHALL BE PROVIDED WITH P.V.C. WATER STOP, APPROVED JOINT FILLER AND APPROVED JOINT SEALER.

CO-ORDINATES OF INLET TRANSITION

STATION	b	W
0+00	9'-3"	33'-10¼"
0+7·6	9'-4"	25'-2¾"
0+15·0	9'-5"	19'-11½"
0+22·6	9'-6"	15'-6⅞"
0+30·0	9'-7"	13'-8⅛"
0+37·6	9'-8"	11'-11⅜"
0+45·0	9'-9"	9'-9"

CO-ORDINATES OF OUTLET TRANSITION

STATION	b	W
0+00	9'-9"	9'-9"
0+7·6	9'-8"	11'-3¾"
0+15·0	9'-7"	13'-6¼"
0+22·6	9'-6"	16'-2½"
0+30·0	9'-5"	20'-4½"
0+37·6	9'-4"	25'-0"
0+45·0	9'-3"	33'-6½"

R.DS.	U/S TRANSITION				D/S TRANSITION				REMARKS
	EL: 'a' BED LEVEL AT BEGINNING	EL: 'b' BANK LEVEL AT BEGINNING	EL: 'c' BED LEVEL AT END	EL: 'd' BANK LEVEL AT END	EL: 'd' BED LEVEL AT BEGINNING	EL: 'C' BED LEVEL AT BEGINNING	EL: 'b' BANK LEVEL AT END	EL: 'a' BED LEVEL AT END	
26990	259.52	266.67	259.39	266.19	266.03	259.23	266.35	259.20	ELEVATIONS SHOULD BE CHECKED AS PER APPROVED L. SECTION. IF THERE IS ANY CHANGE IN DESIGN OF CANAL AT SITE, TRANSITIONS SHOULD BE AMENDED ACCORDINGLY AND MATTER BE REFERED TO DESIGN OFFICE.
27600	259.13	266.28	259.00	265.80	265.71	258.91	266.03	258.88	
26100	258.83	265.98	258.70	265.50	265.38	258.58	265.72	258.57	
32100	257.93	265.08	257.80	264.60	264.48	257.68	264.80	257.65	
33800	257.67	264.72	257.44	264.34	264.12	257.32	264.34	257.19	
35150	257.10	264.25	256.97	263.95	SEE DRG. NO. 110-4-42				
40560	255.95	262.62	255.82	263.10	SEE DRG. NO. 110-4-42				
44200	255.05	262.20	254.92	261.72	261.55	254.76	261.68	254.73	
51000	253.64	260.79	253.51	260.31	260.07	253.27	260.39	253.24	
60800	251.64	258.79	251.51	258.31	258.22	251.42	258.54	251.39	

REFERENCE DRAWINGS

110-4-44	STANDARD SECTIONS OF RETAINING WALL.
110-4-33	U/S AND D/S AQUEDUCT TRANSITION

DATE: 15-12-1970 SCALE 1"= 5'-0"

WATER AND POWER DEVELOPMENT AUTHORITY

DIRECTORATE OF DESIGNS

HUB DAM PROJECT

U/S AND D/S AQUEDUCT TRANSITION (FOR Q=350 CS)

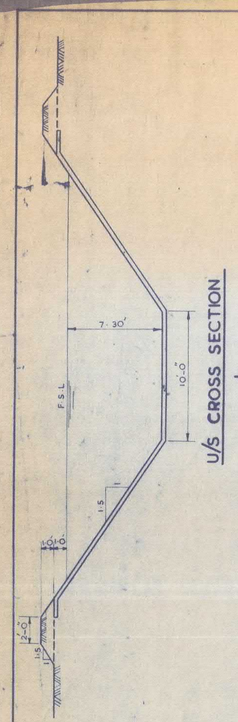
DRAWN: M. SALEEM DESIGNED:

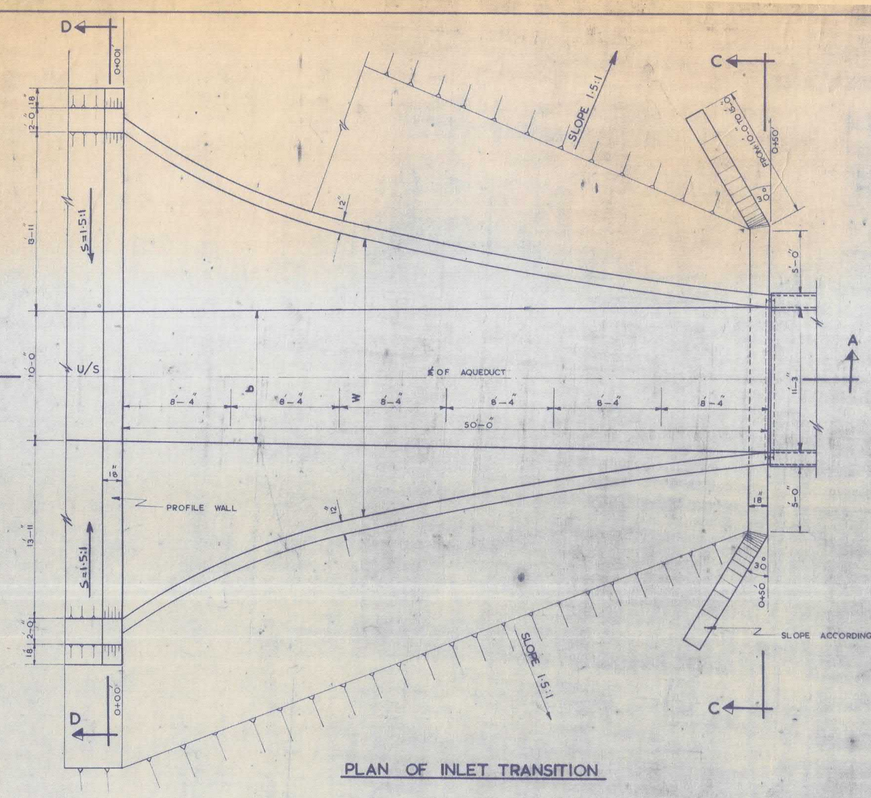
TRACED: MOHD ASLAM SUBMITTED:

CHECKED: SMITH RECOMMENDED:

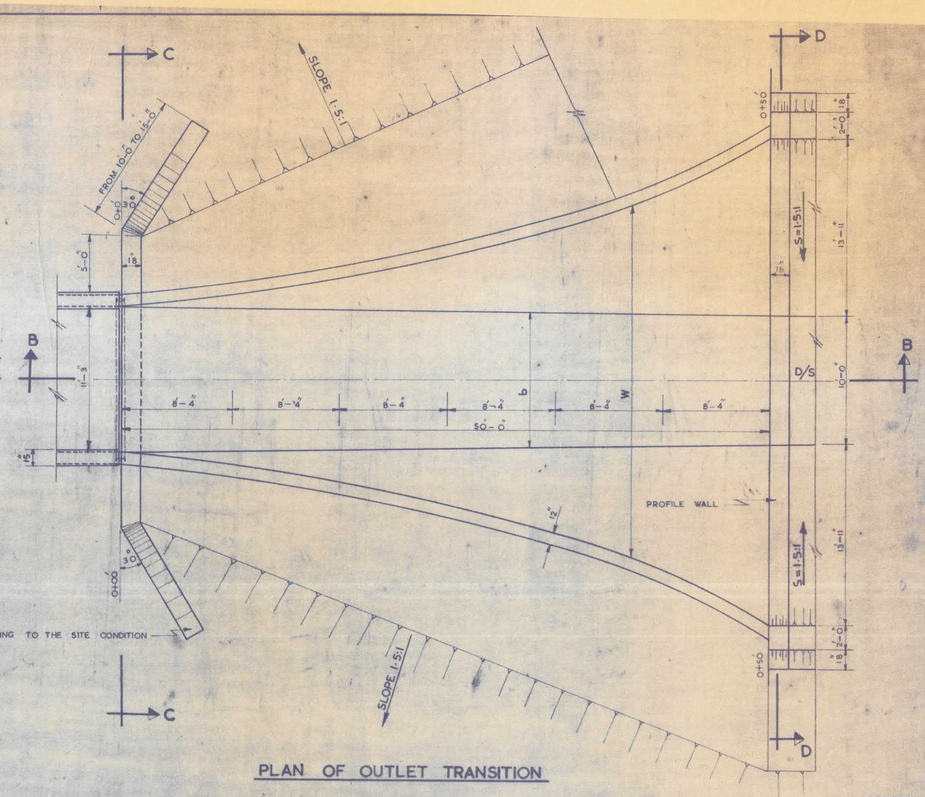
APPROVED: DIRECTOR GENERAL DESIGNS

DRG NO. 110-4-35

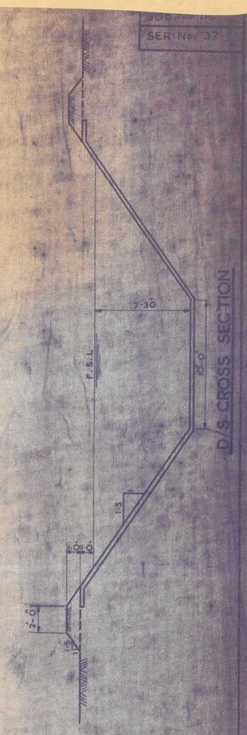




PLAN OF INLET TRANSITION



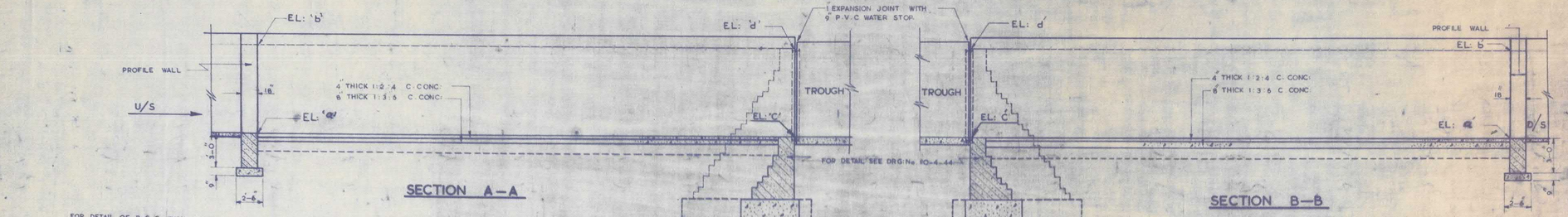
PLAN OF OUTLET TRANSITION



D/S CROSS SECTION

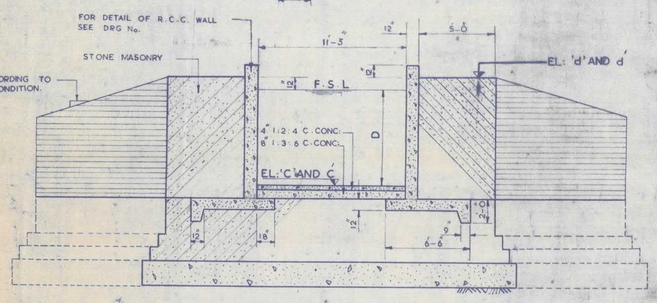
GENERAL STRUCTURAL NOTES:-

1. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE (A.C.I - 318 - 63)
2. ALL REINFORCED CONC: SHALL BE OF 1:2:4 MIX AND SHALL HAVE A MIN: COMPRESSIVE STRENGTH OF 3000 LBS/□" IN 28 DAYS UNLESS OTHERWISE NOTED.
3. ALL REINFORCEMENT LESS THAN ½ DIA: SHALL BE PLAIN BARS CONFORMING TO ASTM—A15 AND THAT ½ DIA: OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM—305 (f_y = 40,000 LBS/□")
4. UNLESS OTHERWISE SHOWN, PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN THE FACE OF CONC: AND NEAREST REINFORCEMENT IS 2 EXCEPT PROVIDE A CLEAR DISTANCE OF 3" FROM FACE OF CONCRETE PLACED AGAINST EARTH.
5. ALL SPLICES SHALL BE LAPPED 48 BAR DIA: FOR PLAIN BARS AND 24 DIA: FOR DEFORMED BARS.
6. ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2500 LBS/□"
7. ALL CONC: CONSTRUCTION WHERE EVER HAVE CONSTRUCTION JOINTS WILL ALSO BE PROVIDED WITH P.V.C. OR RUBBER WATERSTOPS OR COPPER STRIP.
8. A BLINDING LAYER OF 3" THICK CONCRETE G.10 TO BE LAID UNDER ALL REINFORCED CONCRETE.
9. UNLESS SHOWN OTHERWISE, ALL EXPANSION JOINTS SHALL BE OF 1" SIZE AND SHALL BE PROVIDED WITH P.V.C. WATER STOP, APPROVED JOINTS FILLER AND APPROVED JOINT SEALER.

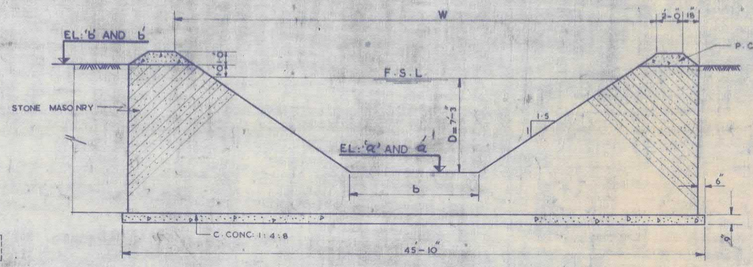


SECTION A—A

SECTION B—B



SECTION C—C



SECTION D—D

CO-ORDINATES OF INLET TRANSITION

STATION	b	W
0+00'	16'-0"	37'-10"
0+8-4"	16'-2½"	28'-4"
0+16-8"	16'-5"	22'-6"
0+25-0"	16'-7½"	18'-10½"
0+33-4"	10'-10"	16'-10"
0+41-8"	11'-0"	13'-3"
0+50-0"	11'-3"	11'-3"

CO-ORDINATES OF OUTLET TRANSITION

STATION	b	W
0+00	11'-3"	11'-3"
0+8-4"	11'-0"	13'-3"
0+16-8"	10'-10"	15'-11"
0+25-0"	10'-7½"	18'-10½"
0+33-4"	10'-5"	23'-6"
0+41-8"	10'-2½"	29'-4"
0+50-0"	10'-0"	37'-10"

R.D.S.	U/S TRANSITION				D/S TRANSITION				REMARKS
	EL: 'a' BED LEVEL AT BEGINING	EL: 'b' BANK LEVEL AT BEGINING	EL: 'C' BED LEVEL AT END	EL: 'd' BANK LEVEL AT END	EL: 'd' BANK LEVEL AT BEGINING	EL: 'C' BED LEVEL AT BEGINING	EL: 'b' BANK LEVEL AT END	EL: 'a' BED LEVEL AT END	
3165	264.40	272.70	264.38	272.13	271.89	264.14	272.26	264.96	ELEVATIONS SOULD BE CHECKED AS PER APPROVED L-SECTION. IF THERE IS ANY CHANGE IN DESIGN OF CANAL AT SITE TRANSITIONS SHOULD BE CHANGED ACCORDINGLY AND MATTER BE REFERRED TO DESIGN OFFICE.
7850	SEE DRG: No. 110-4-42				270.87	263.12	271.25	262.95	
14000	261.97	270.27	261.95	269.70	269.46	261.71	269.84	261.54	
18300	260.87	269.17	260.85	268.60	268.45	260.70	268.83	260.53	
19000	260.45	268.75	260.43	268.18	268.08	260.33	268.45	260.15	

110-4-44	STANDARD SECTIONS OF RETAINING WALL

REFERENCE DRAWINGS

DATE:— 12-6-71 | SCALE:— 1"=5'-0"

WATER AND POWER DEVELOPMENT AUTHORITY

DIRECTORATE OF DESIGNS

HUB DAM PROJECT

U/S AND D/S AQUEDUCT TRANSITION

(FOR Q=500 CS)

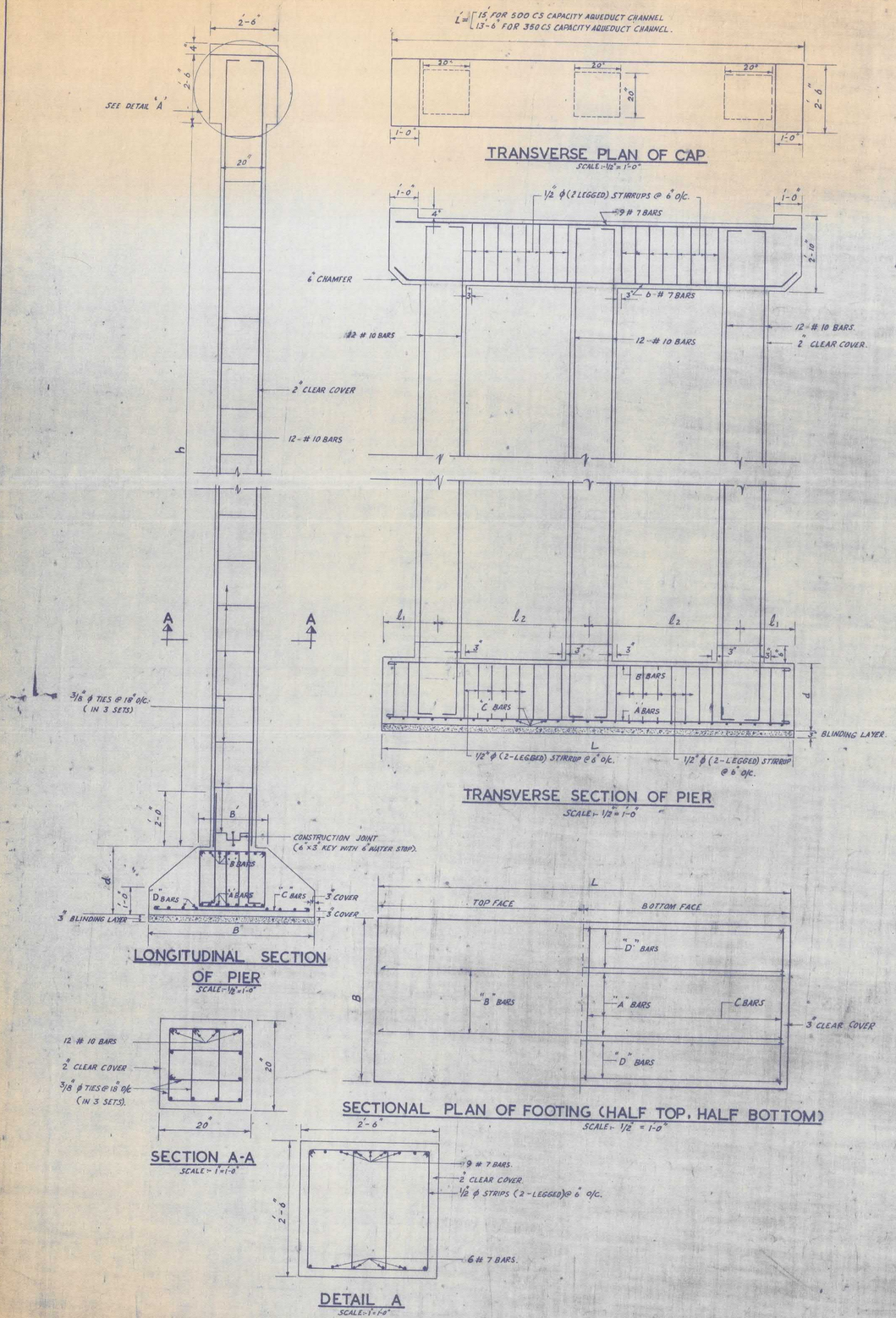
DRAWN:— MOHD SALEEM | DESIGNED:—

TRACED:— MOHD SHAFI JOSH | SUBMITTED:—

CHECKED:— | RECOMMENDED:—

APPROVED:— | DRG: No. 110—4—3

JOB No. 110
SER. No. 44



S.No.	R.D. OF AQUEDUCT	LENGTH OF PIER COLUMN (h) END PIER U/S	END PIER D/S	PENULTIMATE PIER U/S	PENULTIMATE PIER D/S	CENTRAL PIER	FOOTING DETAILS: FOOTING SIZE L	B	d	B'	l_1	l_2	REINFORCEMENT DETAIL 'A' BARS	'B' BARS	'C' BARS	'D' BARS	FOUNDATION MATERIAL
1	3165	8'	13'	13'	13'	13'	15'	7'	2'-6"	2'-6"	1'-10½"	5'-7½"	8-7A 14·6	8-7B 14·6	30-6C 6·6	18-6D 14·6	HARD SAND STONE
2	7850	4'	4'	–	–	8'	15'	7'	2'-6"	2'-6"	1'-10½"	5'-7½"	"	"	"	"	"
3	14000	SEE DRG. No. 110-4-A	11'	SEE DRG. No. 110-4-B	14'	SEE DRG. No. 110-4-41	15'	7'	2'-6"	2'-6"	1'-10½"	5'-7½"	"	"	"	"	"
4	18300	16'	16'	–	–	16'	18'	12'	3'-0"	3'-0"	4'-1½"	5'-7½"	10-9A 17·6	6-9B 17·6	53-6C 11·6	26-6D 17·6	SHALE
5	19000	–	–	–	–	13'	15'	7'	2'-6"	2'-6"	1'-10½"	5'-7½"	8-7A 14·6	8-7B 14·6	30-6C 6·6	18-6D 14·6	HARD SAND STONE
6	26990	16'	16'	–	–	16'	20'	20'	3'-6"	3'-0"	5'-1½"	4-10½"	10-9A 19·6	6-9B 19·6	79-6C 19·6	45-6D 19·6	LOOSE OVERBURDEN
7	27600	12'	12'	–	–	–	18'	12'	3'-0"	3'-0"	4'-1½"	4-10½"	10-9A 17·6	6-9B 17·6	53-6C 11·6	26-6D 17·6	SHALE
8	28100	14'	16'	–	–	16'	18'	12'	3'-0"	3'-0"	4'-1½"	4-10½"	"	"	"	"	"
9	32100	8'	8'	–	–	SEE DRG. No. 110-4-41	15'	7'	2'-6"	2'-6"	2'-7½"	4-10½"	8-7A 14·6	8-7B 14·6	30-6C 6·6	18-6D 14·6	HARD SAND STONE
10	33800	11'	6'	–	–	16'	15'	7'	2'-6"	2'-6"	"	"	"	"	"	"	"
11	35750	SEE DRG. No. 110-4-B	SEE DRG. No. 110-4-B	–	–	SEE DRG. No. 110-4-41	18'	12'	3'-0"	3'-0"	4'-1½"	4-10½"	10-9A 17·6	6-9B 17·6	53-6C 11·6	26-6D 17·6	SHALE
12	40500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	44200	12'	12'	–	–	16'	15'	7'	2'-6"	2'-6"	2'-7½"	4-10½"	8-7A 14·6	8-7B 14·6	30-6C 6·6	18-6D 14·6	HARD SAND STONE
14	51000	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15	60800	–	–	–	–	–	15'	7'	2'-6"	2'-6"	2'-7½"	4-10½"	"	"	"	"	"

DESIGNATION OF BARS NUMBER, SIZE, SHAPE AND LENGTH.
EXAMPLE..... 8-7A 14·6
NUMBER..... #8
SIZE..... #7
SHAPE..... A,
LENGTH..... 14·6"

GENERAL STRUCTURAL NOTES :-

1- CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE. (ACI. 318-63).
2- ALL REINFORCED CONCRETE SHALL BE OF 1:2:4 MIX: AND SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 P.S.I. IN 28 DAYS UNLESS OTHERWISE NOTED.
3- ALL REINFORCEMENT LESS THAN ¾" DIA SHALL BE PLAIN BARS CONFORMING TO ASTM A-15 AND THAT ¾" DIA. OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM - 305 (fy = 40,000 P.S.I.).
4- UNLESS OTHERWISE SHOWN PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN FACE OF CONCRETE AND NEAREST REINFORCEMENT IS 2" EXCEPT PROVIDE A CLEAR DISTANCE OF 3" FROM FACE OF CONCRETE PLACED AGAINST EARTH.
5- ALL SPLICES SHALL BE LAPPED 48 BARS DIAMETERS FOR PLAIN BARS & 24 DIAMETERS FOR DEFORMED BARS.
6- ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2500 P.S.I.
7- ALL CONCRETE CONSTRUCTIONS WHEREVER HAVE CONSTRUCTION JOINTS WILL ALSO BE PROVIDED WITH P.V.C. OR RUBBER WATERSTOPS OR COPPER STRIP.
8- A BLINDING LAYER OF 3" THICK CONCRETE IS TO BE LAID UNDER ALL REINFORCED CONCRETE.
9- LENGTHS OF THE COLUMNS (IN THE TABLE) ARE THE CLEAR HEIGHTS OF COLUMNS EXCLUDING THE DEPTHS OF CAP AND THE FOOTING.
10- A 2" THICK EXPANDED POLYSTYRENE PAD IS TO BE PLACED ON TOP OF PIER CAPS.
11- BARS DESIGNATED AS A, B, C, AND D IN THE TABLE ARE ALL STRAIGHT BARS.

NOTES :-

1- THE DESIGN AND DRAWINGS ARE BASED UPON THE GEOLOGICAL MAPPING OF SUBSOIL FOUNDATION AND THE BEARING CAPACITIES OF STRATA SUPPLIED BY THE P.D., K.I.P. VIDE HIS LETTER Nos. KIP/XEN-C/CANAL/GT/1292 DATED 3-6-70 AND KIP/XEN-C/A DATED 23-7-70.

REFERENCE DRAWINGS.

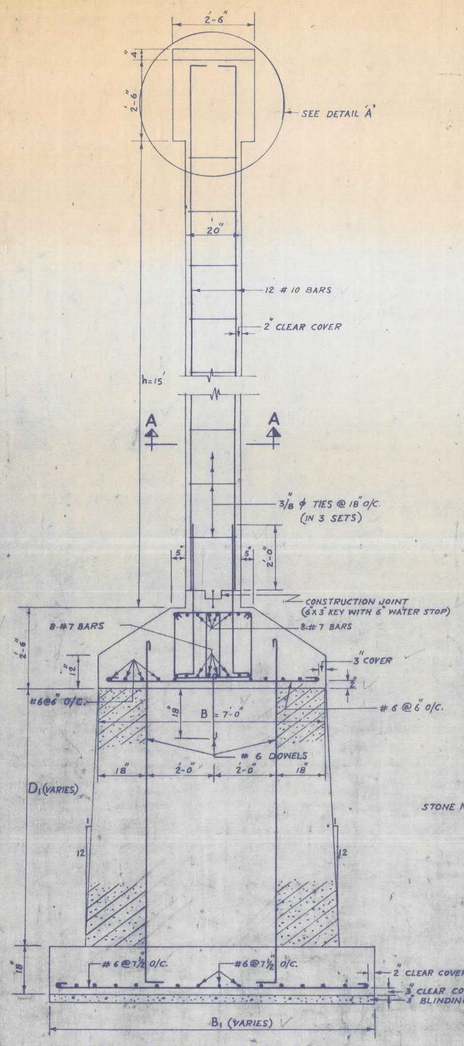
DATE :- 31-12-70. | SCALE :- AS SHOWN

WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS

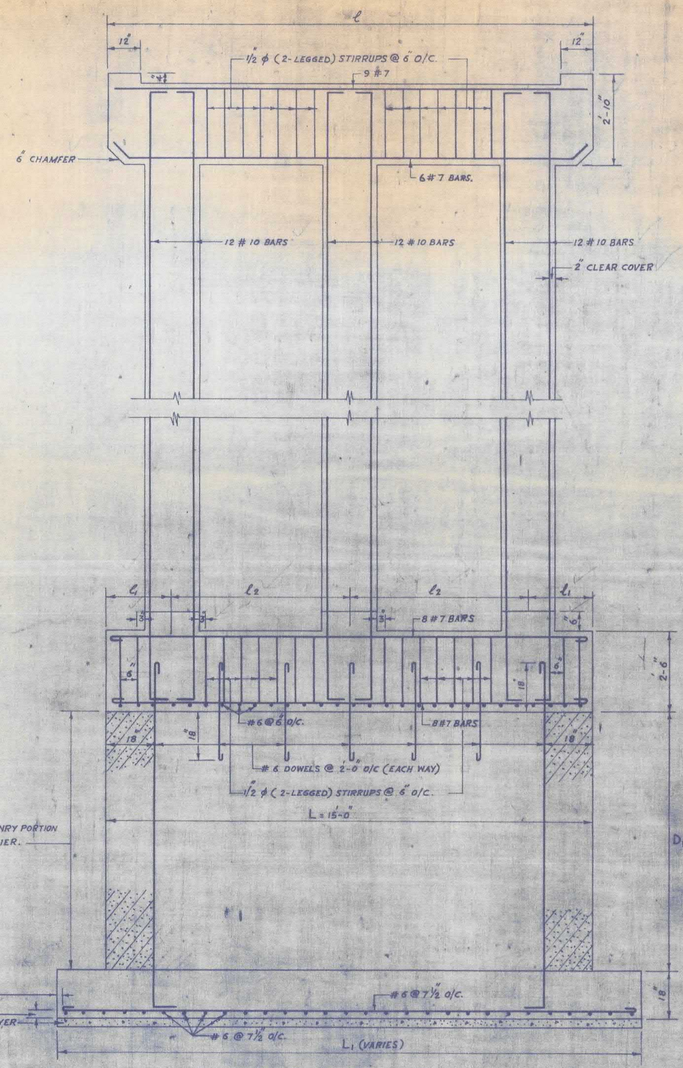
HUB DAM PROJECT
STRUCTURAL DETAILS OF PIERS FOR AQUEDUCTS

DRAWN RIAZ QADIR	DESIGNED
TRACED ZAHOOR AHMAD	SUBMITTED
CHECKED	RECOMMENDED
APPROVED	DRAWING No. 110-L-A.D

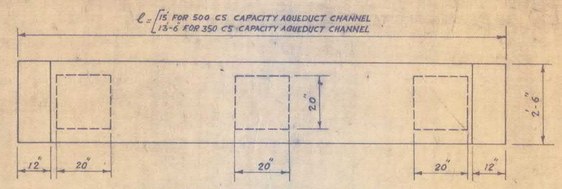
JOB No. 110
SER No. 45



LONGITUDINAL SECTION OF PIER
SCALE:- ½"=1'-0"

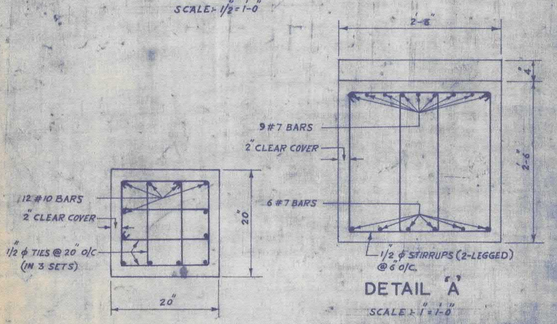


TRANSVERSE SECTION OF PIER
SCALE:- ½"=1'-0"



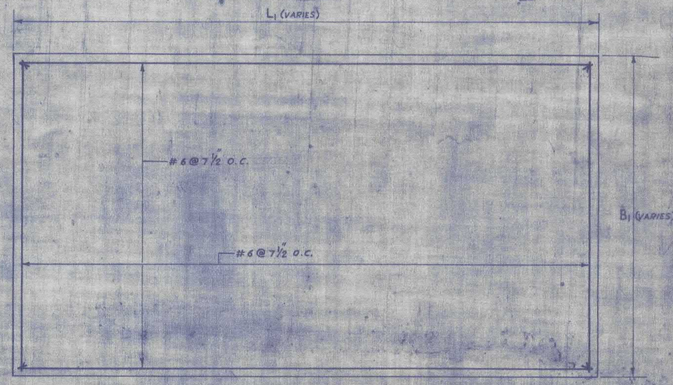
TRANSVERSE PLAN OF CAP
SCALE:- ½"=1'-0"

R. D. OF AQUEDUCT	DIMENSIONS OF PIER AND FOOTING ECT.																							
	END PIERS										PENNLTIMATE PIERS										CENTRAL PIER			
	U/S					D/S					U/S					D/S								
	D	L_1	B_1	ℓ_1	ℓ_2	D	L_1	B_1	ℓ_1	ℓ_2	D	L_1	B_1	ℓ_1	ℓ_2	D	L_1	B_1	ℓ_1	ℓ_2	D	L_1	B_1	ℓ_1	ℓ_2
13900	4'-6"	17'	9'	1'-10½"	5'-7½"	–	–	–	–	–	7'-0"	17'	9'	1'-10½"	5'-7½"	–	–	–	–	–	12'	16'	10'	1'-10½"	5'-7½"
32100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8'	20'	12'	2'-7½"	4'-10½"
35140	4'	19'	11'	2'-7½"	4'-10½"	4'	19'	11'	2'-7½"	4'-10½"	–	–	–	–	–	–	–	–	–	–	4'	19'	11'	2'-7½"	4'-10½"



SECTION A-A
SCALE:- 1"=1'-0"

DETAIL 'A'
SCALE:- 1"=1'-0"



SECTIONAL PLAN OF FOOTING
SCALE:- ½"=1'-0"

GENERAL STRUCTURAL NOTES

1. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE (A.C.I. 318-63).
2. ALL REINFORCED CONCRETE SHALL BE OF 1:2:4 MIX AND SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 P.S.I. IN 28 DAYS UNLESS OTHERWISE NOTED.
3. ALL REINFORCEMENT LESS THAN ¾" DIA SHALL BE PLAIN BARS CONFORMING TO ASTM A-15 AND THAT ¾" DIA OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM-305 (fy=40,000 P.S.I.)
4. UNLESS OTHERWISE SHOWN PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN FACE OF CONCRETE AND NEAREST REINFORCEMENT IS 2" EXCEPT PROVIDE A CLEAR DISTANCE OF 3" FROM FACE OF CONCRETE PLACED AGAINST EARTH.
5. ALL SPLICES SHALL BE LAPPED 48 BAR DIAMETERS FOR PLAIN BARS & 24 DIAMETERS FOR DEFORMED BARS.
6. ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2500 P.S.I.
7. ALL CONCRETE CONSTRUCTIONS WHEREVER HAVE CONSTRUCTION JOINTS WILL ALSO BE PROVIDED WITH P.V.C. OR RUBBER WATERSTOPS OR COPPER STRIP.
8. A BLINDING LAYER OF 3" THICK CONCRETE IS TO BE LAID UNDER ALL REINFORCED CONCRETE.
9. A 2" THICK EXPANDED POLYSTYRENE PAD IS TO BE PLACED ON TOP OF PIER CAPS.
10. STONE MASONRY WORK TO BE DONE IN CEMENT MORTAR OF 1:3 AND TO BE POINTED WITH CEMENT MORTAR 1:3.

NOTES

1. THE DESIGN AND DRAWINGS ARE BASED UPON THE GEOLOGICAL MAPPING OF SUBSOIL FOUNDATION AND THE BEARING CAPACITIES OF STRATA SUPPLIED BY THE P.D., K.I.P. VIDE HIS LETTER NOS. KIP/XEN-C/CANAL/61/1292 DT: 3-4-70 AND KIP/XEN-C/A DT: 23-7-70.

REFERENCE DRAWINGS.

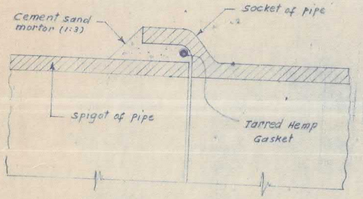
REVISION	
DATE 13-1-71	SCALE:- 1"=1'-0", ½"=1'-0"

WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS

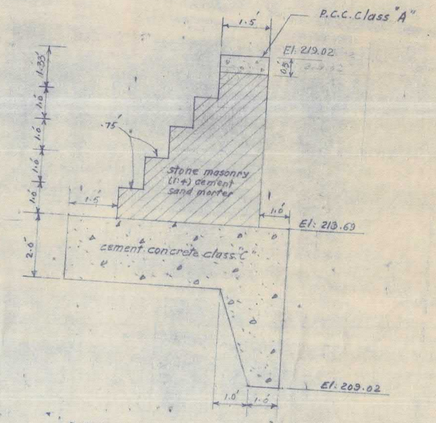
HUB DAM PROJECT

STRUCTURAL DETAILS OF PIERS FOR AQUEDUCTS

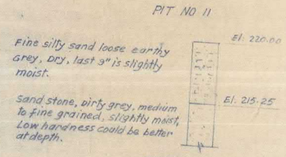
DRAWN RIAZ QADIR	DESIGNED
TRACED MIAN ASLAM	SUBMITTED
CHECKED	RECOMMENDED
APPROVED	DRAWING No. 110-K-41



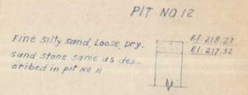
DETAIL OF PRECAST PIPE JOINT
NOT TO SCALE



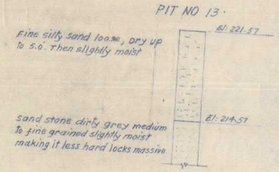
DETAIL OF D/S HEAD WALL
SCALE: 1/2" = 1.0'



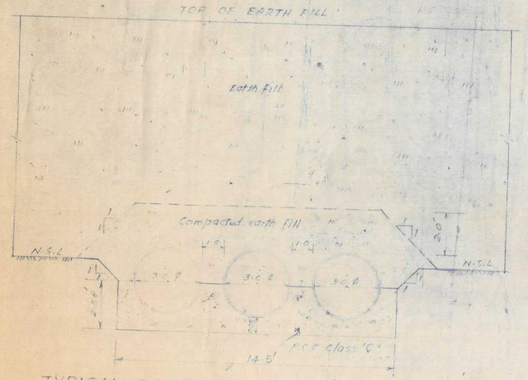
DETAIL "A"



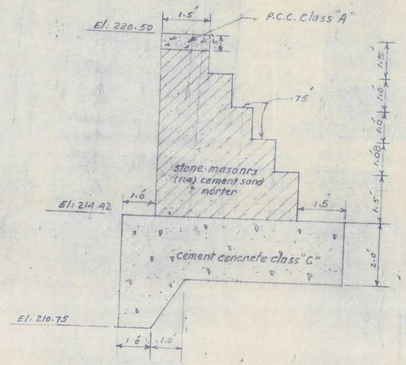
DETAIL "B"



DETAIL "C"



TYPICAL SECTION OF PIPE PROJECTION CASE
SCALE 1" = 3.0'



DETAIL OF U/S HEAD WALL
SCALE: 1/2 = 1.0

W.S. 451 R-1 W.S. 452	L. SECTION OF CANAL
W.S. 455 R-1	TYPICAL SECTIONS OF LINING
110-4A-C-464	DRAINAGE CROSSING AT CH: 29+57
110-4A-C-468	DRAINAGE X-ING PLAN & SECTION CH. 38+92
DRAWING NO	TITLE OF DRAWING
REFERENCE DRAWING	

Sheet 2 of 2

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 38+92

DETAIL OF JOINT AND HEAD WALLS
Q=150 CS.

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

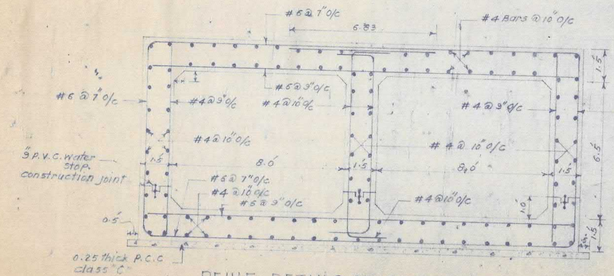
DSN.
DWN. GHULAM MUSTAFA
TRD. D.H.D
CKD.
REVD.

SUBMITTED
DEPUTY DIRECTOR

RECOMMENDED
DIRECTOR DESIGN

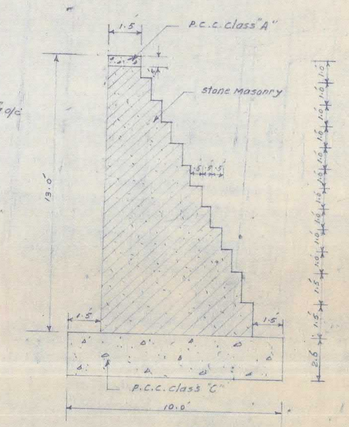
APPROVED
CHIEF ENGINEER DESIGN

DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O (W) 110-4A-C-...



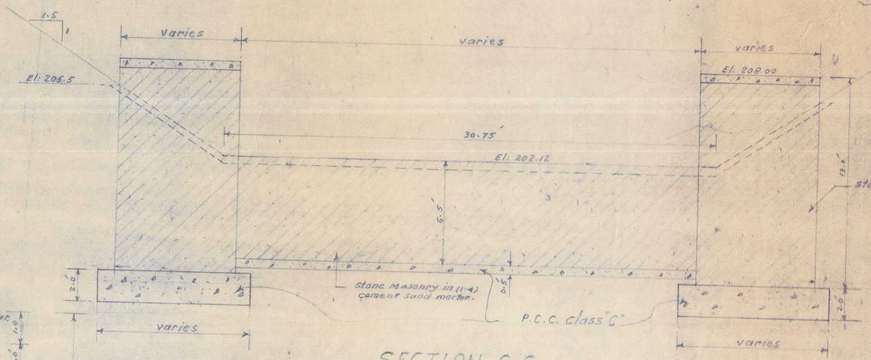
REINF. DETAILS OF DOUBLE BARREL

Scale:- 1" = 3.0'



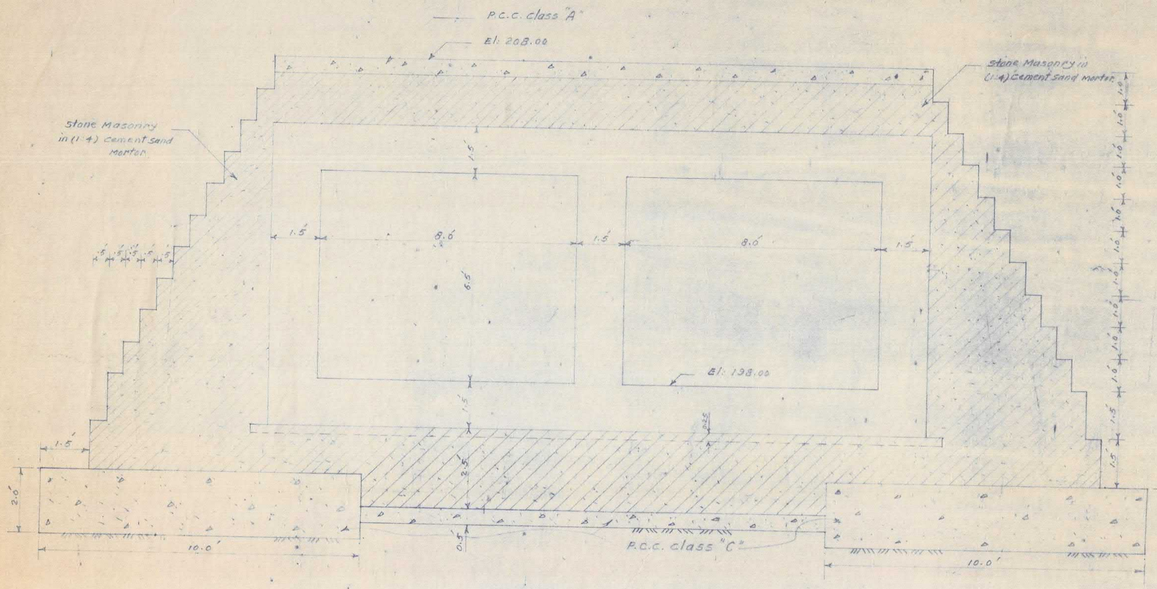
TYPICAL SECTION OF U/S & D/S WING WALL

Scale:- 1" = 3.0'



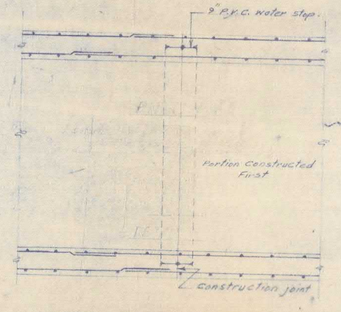
SECTION C.C

Scale:- 1" = 4.0'



SECTION B-B

Scale:- 1/2" = 1.0'



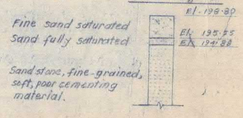
DETAIL OF CONSTRUCTION JOINT

TO BE PROVIDED BY CONTRACTOR AT HIS DISCRETION.

DETAIL OF EXPANSION JOINT

(Not to Scale)

PIT No 16



W.S. 451 R-1	L. SECTION OF CANAL
W.S. 452	
W.S. 455 R-1	TYPICAL SECTION OF CANAL LINING
110-4A-C-472	PLAN & SECTION OF DRAINAGE X-ING AT CH: 50+06
DRAWING NO	TITLE OF DRAWING

REFERENCE DRAWING

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

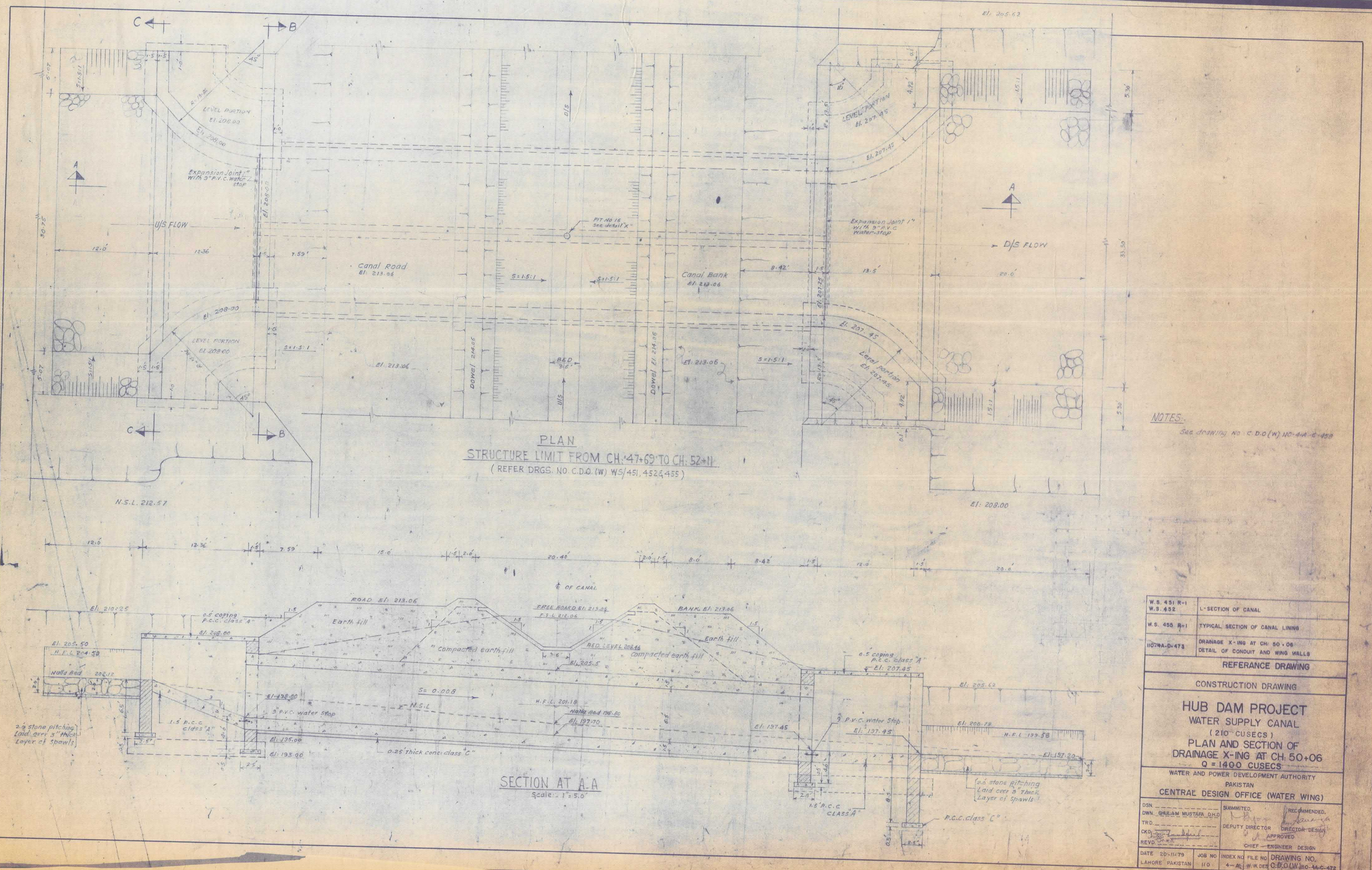
WATER SUPPLY CANAL (210 CUSECS)
DRAINAGE CROSSING AT CH. 50+06
DETAIL OF CONDUIT AND WING WALLS
Q = 1400 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN:-
DWN: SHULAM MUSTAFA D.H.D
TRD:-
CKD:-
REVD:-

SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O.(W) 110-4A-C-473



W.S. 451 R-1 W.S. 452	L-SECTION OF CANAL
W.S. 455 R-1	TYPICAL SECTION OF CANAL LINING
110-4A-C-473	DRAINAGE X-ING AT CH: 50+06 DETAIL OF CONDUIT AND WING WALLS

REFERANCE DRAWING

CONSTRUCTION DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL
(210 CUSECS)
PLAN AND SECTION OF DRAINAGE X-ING AT CH: 50+06
Q = 1400 CUSECS

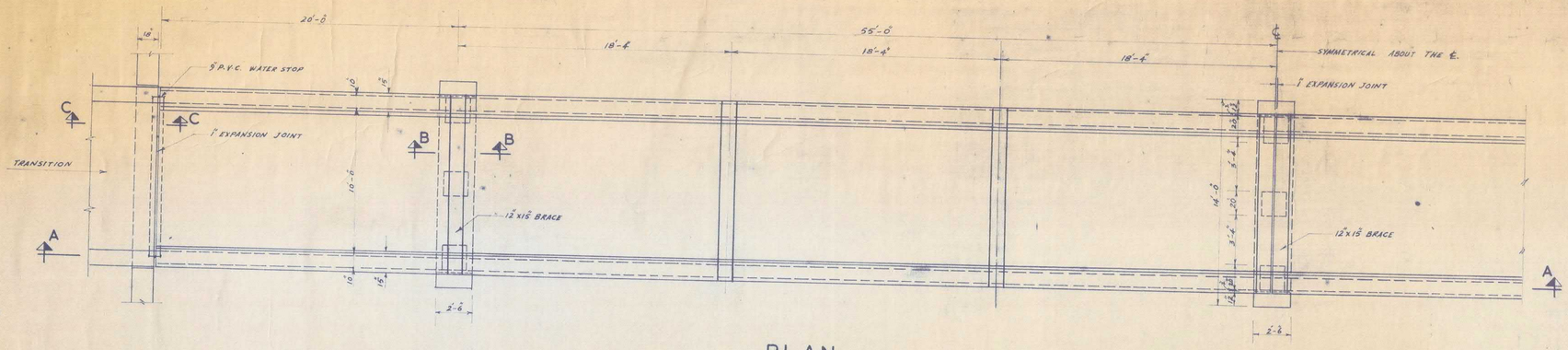
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.
DWN. GHULAM MUSTAFA D.H.D
TRD.
CKD.
REVD.

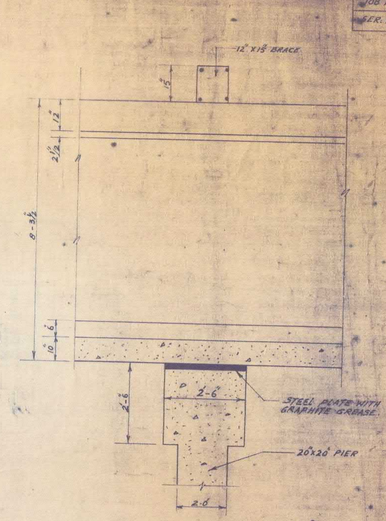
SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE 20-11-79	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O (W) 110-4A-C-472

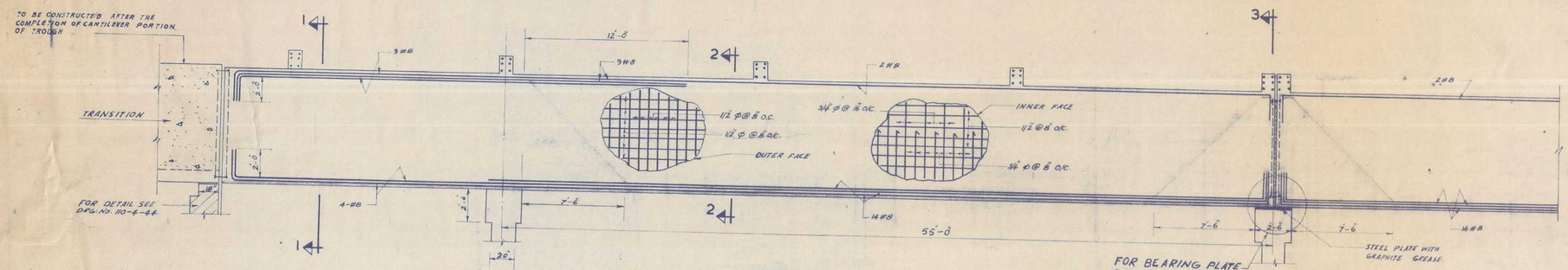
WDB No. 110
WER. No. 97



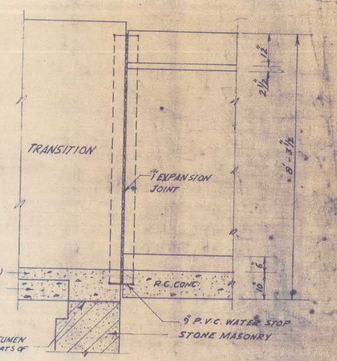
PLAN
SCALE - 1/4" = 1'-0"



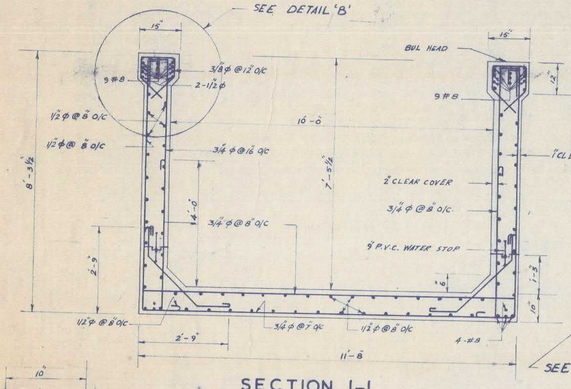
SECTION B-B
SCALE:- 1/2" = 1'-0"



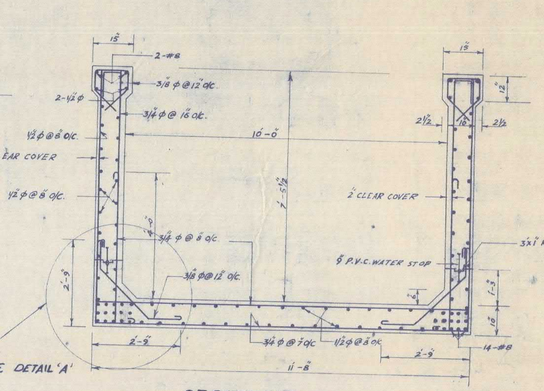
SECTION A-A
SCALE:- 1/16" = 1'-0"



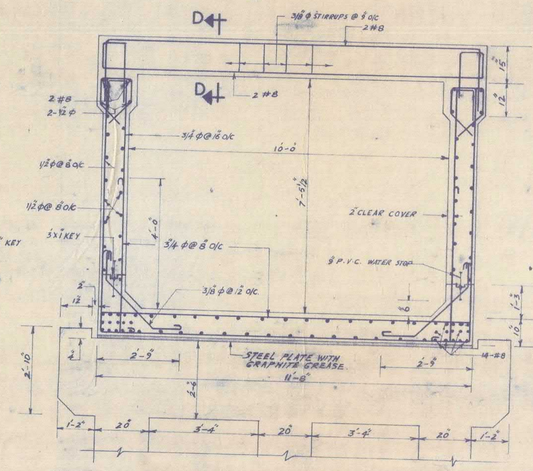
SECTION C-C
SCALE:- 1/2" = 1'-0"



SECTION 1-1
SCALE - 1/2" = 1'-0"



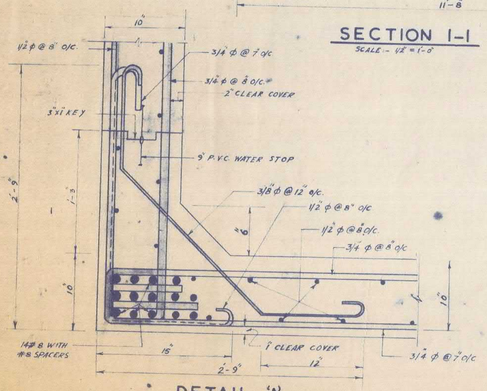
SECTION 2-2
SCALE:- 1/2" = 1'-0"



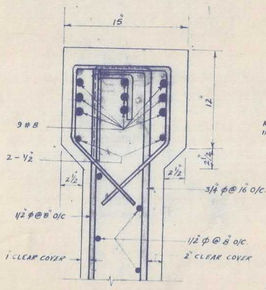
SECTION 3-3
SCALE:- 1/2" = 1'-0"

NOTES.

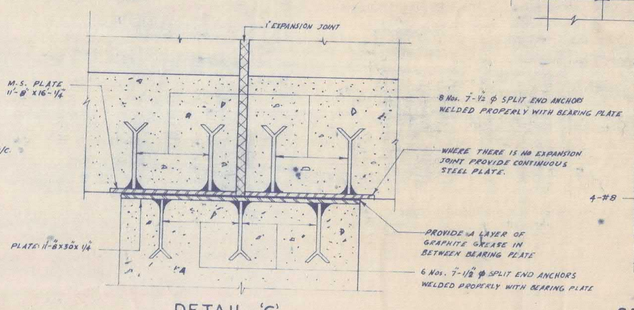
FOR GENERAL STRUCTURAL NOTES SEE DRG. NO. 110-4-43.



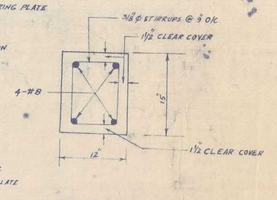
DETAIL 'A'
SCALE:- 1/2" = 1'-0"



DETAIL 'B'
SCALE:- 1/2" = 1'-0"



DETAIL 'C'
SCALE:- 1/2" = 1'-0"



SECTION D-D
SCALE:- 1" = 1'-0"

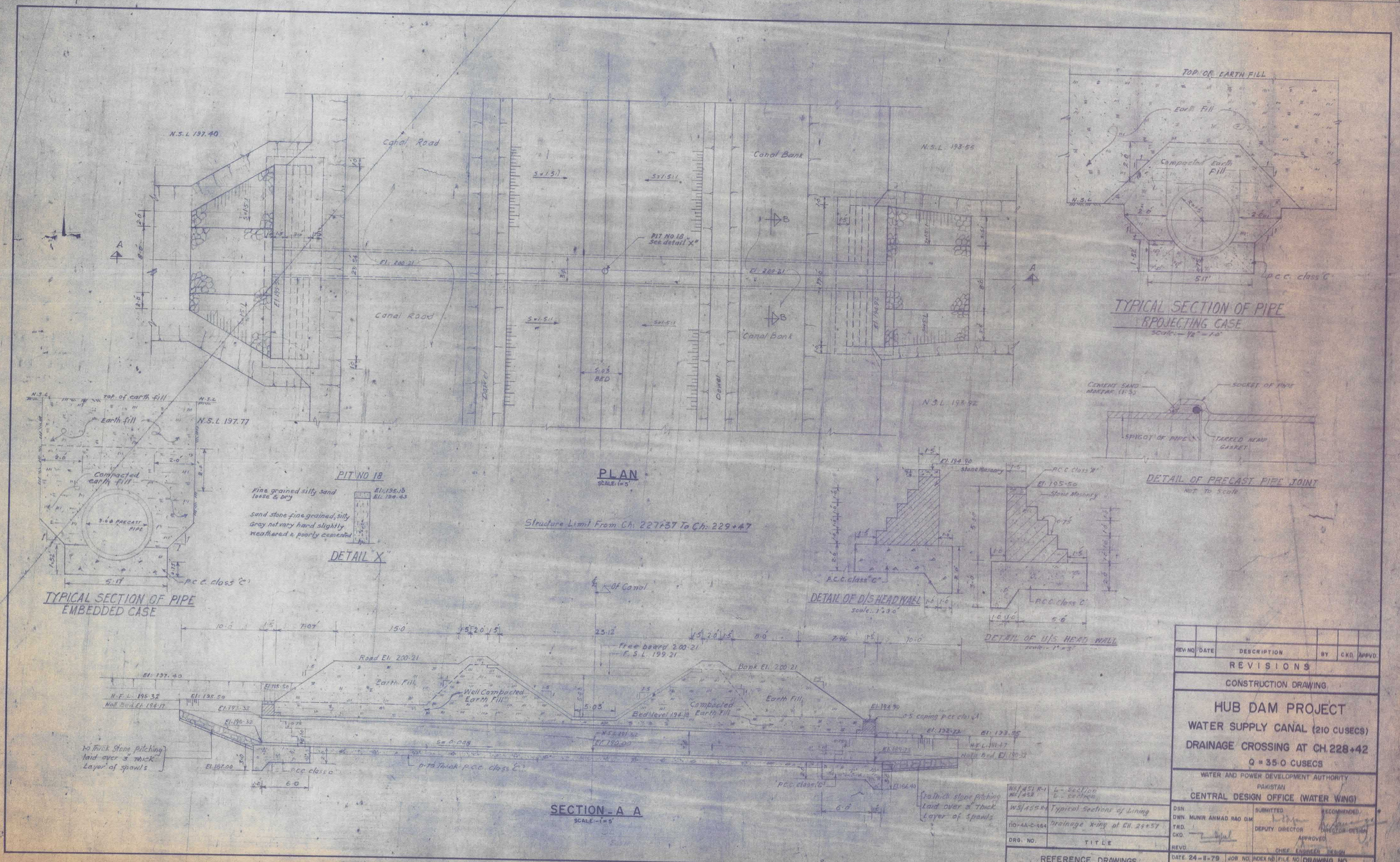
DATE:- 21-12-72	SCALE:- AS SHOWN

WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS

HUB DAM PROJECT
STRUCTURAL DETAILS OF AQUEDUCT FOR DISCHARGE 370 CUSECS
AQUEDUCT SPAN 150 FT.

DRAWN. MUNAWAR ALI	D.H.D	DESIGNED.	A.D.E.
TRACED. MUNIR AHMED	T.R.	SUBMITTED.	A.D.E.
CHECKED. Mohd Sharif Wallah		RECOMMENDED.	
APPROVED w.e.f. JAMIL ASGHAR		ORG No.	110-4-45 (1)

20-4-47	0/3 & 0/5 AQUEDUCT TRANSITION	
DRG No.	TITLE	
REFERENCE DRAWINGS		



REV. NO	DATE	DESCRIPTION	BY	CKD.	APPVD.

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 228+42

Q = 35.0 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

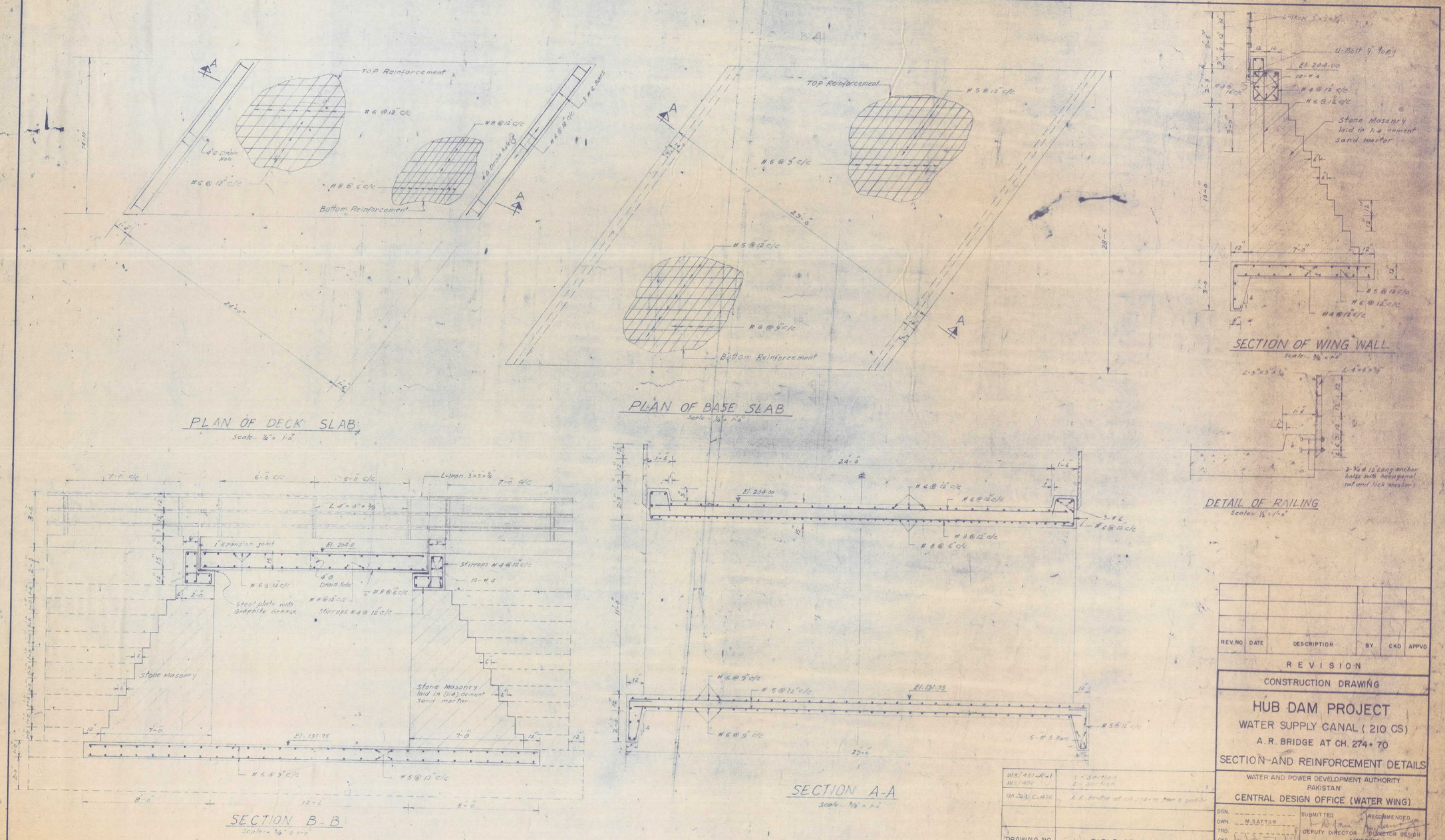
WS/451 R-1	L - Section
WS/452	L - section
WS/455 R-1	Typical Sections of Lining
110-4A-C-464	Drainage X-ing at CH. 29+57
DRG. NO.	TITLE

REFERENCE DRAWINGS

DSN.
DWN. MUNIR AHMAD RAO D.M.
TRD.
CKD.
REVD.

SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE 24-11-79	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES.	C.D.O. (W) 110-4A-C-475



REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CS)

A.R. BRIDGE AT CH. 274+70

SECTION AND REINFORCEMENT DETAILS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

DRAWING NO	TITLE OF DRAWING
W.S./451-R-1	L - Section
W.S./452	L - Section
110-4A-C-476	A.R. Bridge at ch. 274+70 Plan & Section

REFERENCE DRAWING

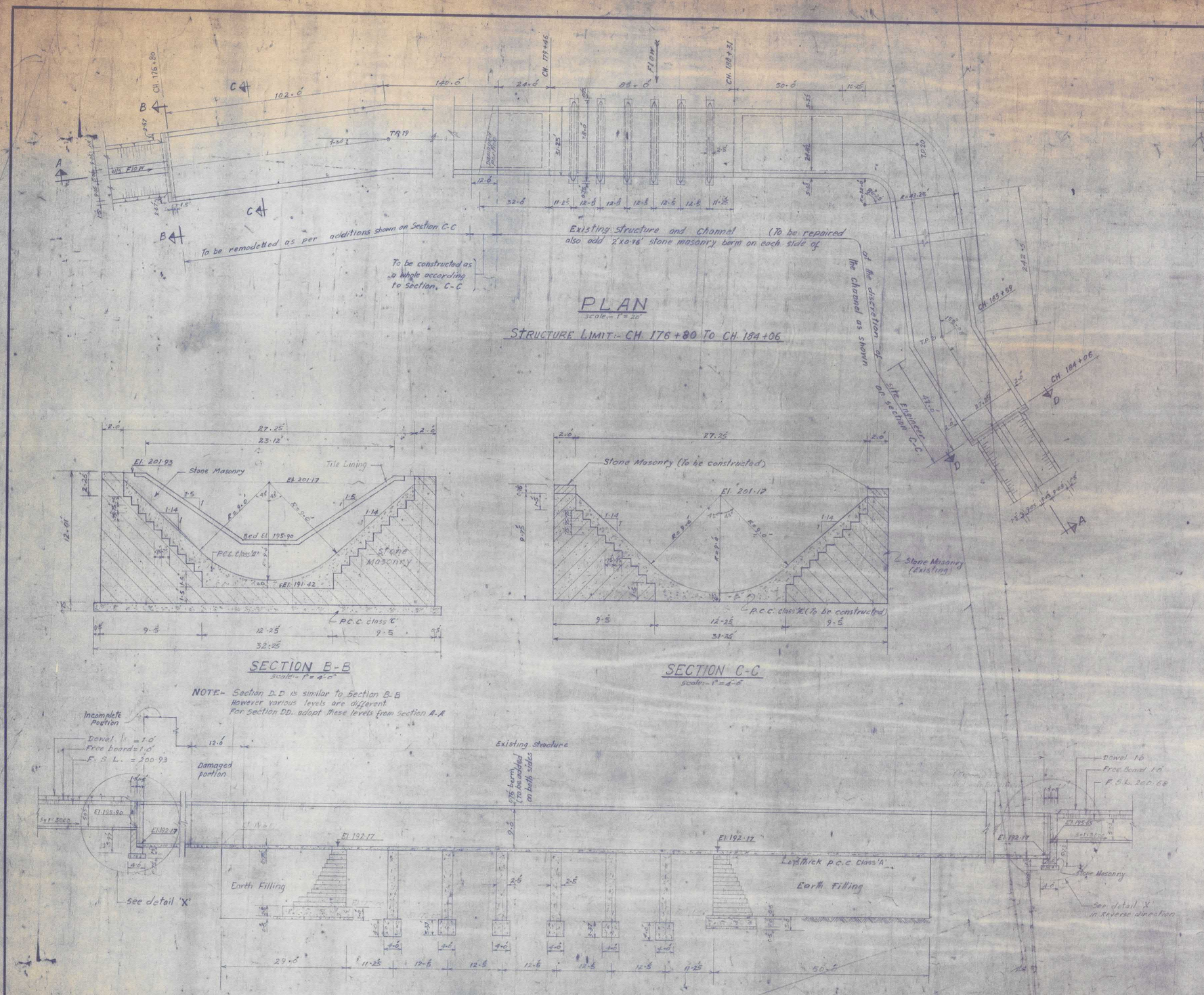
DSN.
DWN. M. SATTAR
TRD.
CKD.
REVD.

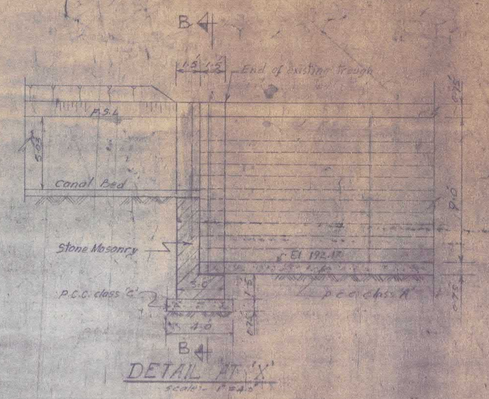
SUBMITTED
DEPUTY DIRECTOR

RECOMMENDED
DIRECTOR DESIGN

APPROVED
CHIEF ENGINEER DESIGN

DATE:-	JOB NO.	INDEX NO	FILE NO.	DRAWING NO
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O. (W) 110-4A-C-477





NOTES:-

1. The P.C.C. Class 'C' will have a minimum cylinder strength of 2000 P.S.I. at 28 days.
2. The P.C.C. Class 'A' will have a minimum cylinder strength of 3000 P.S.I. at 28 days.
3. Stone shall be laid in horizontal courses not less than 5" height. All stone in course shall be of equal height unless otherwise specified. But no course shall be thicker than the course below it. All stones shall be set full in specified mortar in bed & joints.
4. The face stone shall be square on all joints in masonry. The beds shall be hammer or chisel-dressed, true and square for atleast 3 inches, back from the face, and the joints for atleast 1½". The face of the stone shall be hammer-dressed and bushing not to project more than 1½".
5. All sides joints shall be vertical & beds horizontal and no joint shall be more than ⅜" in thickness. No pinning shall be allowed on face.
6. No face stone shall be lesser in breadth than its height nor shall it be laid into the work to a length lesser than its height. Yard of the stone shall be laid into the work atleast twice its height, or in the wall thicker than 3'-0", three times of its height.
7. Through stones shall be inserted 6 & 6 feet apart in every course, and shall run right through the wall, not more than 2' thick. When the wall is more than 2' thick, a line of two or more headers shall be laid from face to back which overlap each other atleast 6". The headers shall have a lenght of atleast 3 times of the height.
8. Stone shall break joint by atleast half the height of the course.
9. Mortar used for stone masonry work shall be (1:4) Cement sand mortar.

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

AQUEDUCT AT CH. 179 + 75

U/S AND D/S TRANSITIONS

PLAN AND SECTIONS

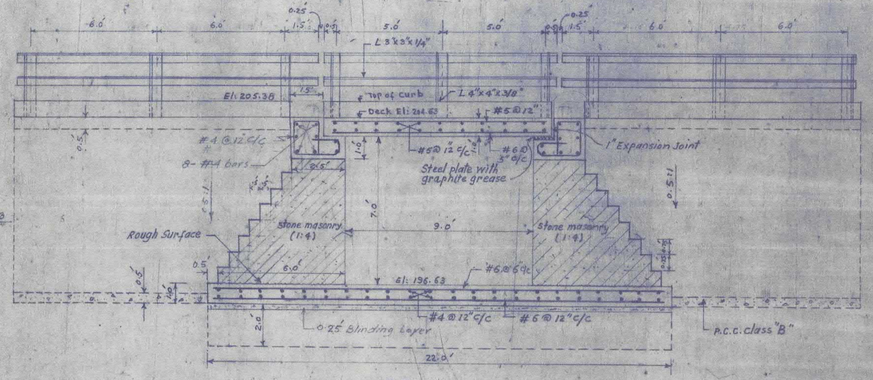
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DRAWING NO.	TITLE
110-4A-C-432R	L-Section at ch. 149+76 to 297+11.5

REFERENCE DRAWING

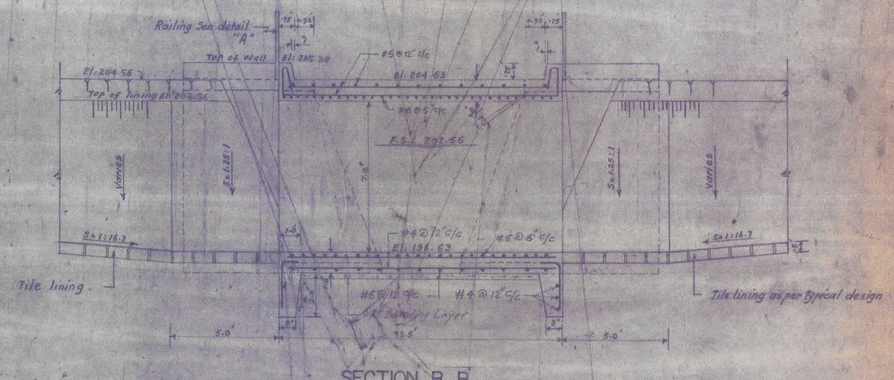
DSN
DWN Munir Ahmad Rao D.M.
TRD
CKD
REVD
SUBMITTED
RECOMMENDED
DEPUTY DIRECTOR
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO.	FILE NO. (W.W. DESIGN)	DRAWING NO.
9-8-80 LAHORE PAKISTAN	110	4-A		C.D.O. (W) 110-4A-C-478



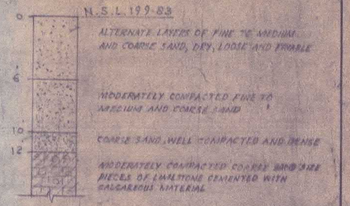
SECTION A-A

SCALE :- 1"= 3'-0"



SECTION B-B

SCALE :- 1"= 3'-0"



BORE HOLE LOG AT CH. 128+00

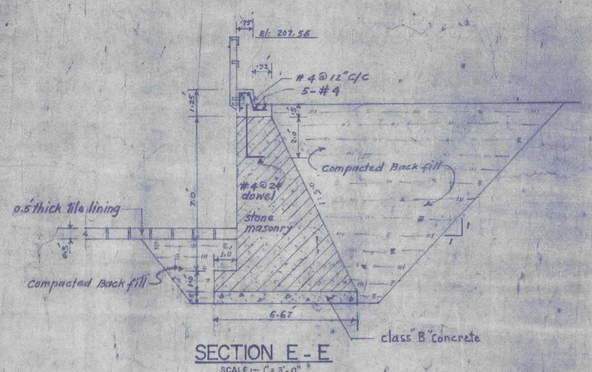
N.S.L. 199.83

ALTERNATE LAYERS OF FINE TO MEDIUM AND COARSE SAND, DRY, LOOSE AND FRIABLE

MODERATELY COMPACTED FINE TO MEDIUM AND COARSE SAND

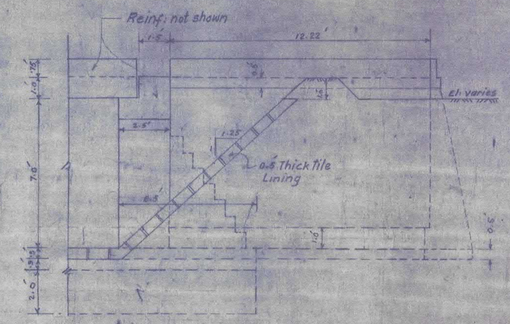
COARSE SAND, WELL COMPACTED AND DENSE

MODERATELY COMPACTED COARSE SAND SIZE PIECES OF LIMESTONE CEMENTED WITH CALCAREOUS MATERIAL



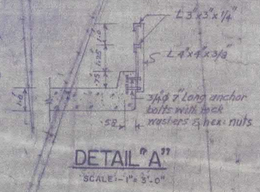
SECTION E-E

SCALE :- 1"= 3'-0"



SECTION C-C

SCALE :- 1"= 3'-0"



DETAIL "A"

SCALE :- 1"= 3'-0"

110-4A-C-145(R2	Longitudinal Section from ch. 0+00 to 149+76
110-4A-C-479	Plan Of Village Road Culvert at ch. 128+00
DRAWING NO	TITLE OF DRAWING

REFERENCE DRAWING

REV NO.	DATE	DESCRIPTION	BY	CKD	APPVD.

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

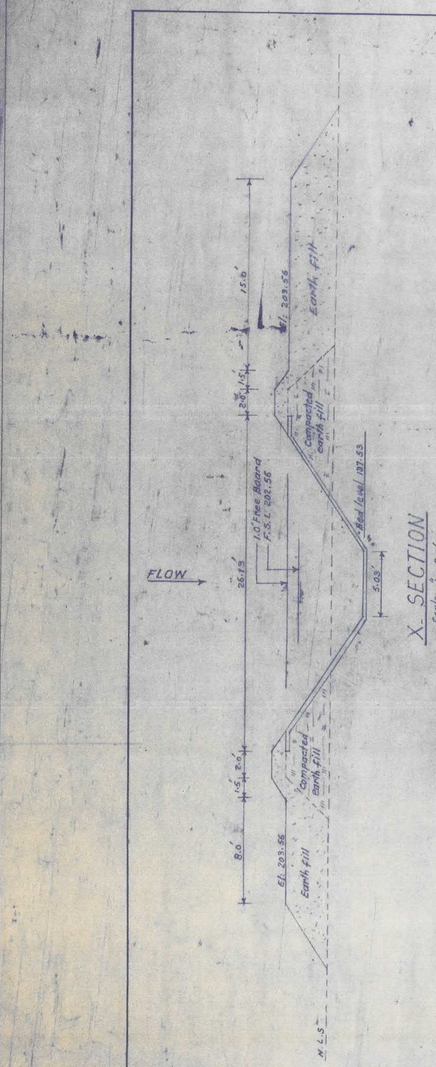
WATER SUPPLY CANAL (210 CUSECS)

VILLAGE ROAD CULVERT AT CH. 128+00

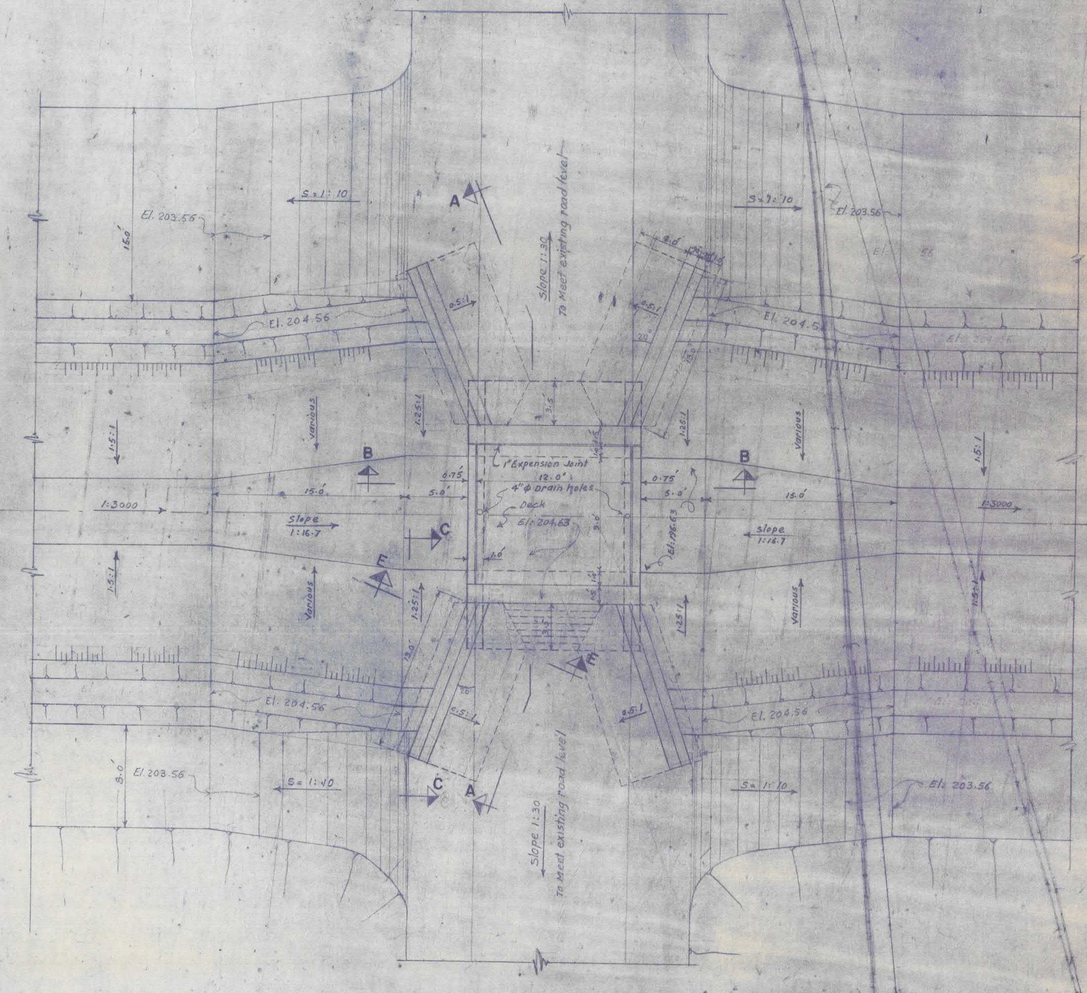
REINFORCEMENT DETAILS & SECTIONS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN		SUBMITTED	RECOMMENDED
DWN BHUKAN MUHTOPO D.H.P.			
TRD		DEPUTY DIRECTOR	DIRECTOR DESIGN
CKD		APPROVED	
REVD		CHIEF ENGINEER DESIGN	
DATE 2.3.0.0	SUB NO	ORDER NO	FILE NO
LAHORE PAKISTAN	110	4A	DRAWING NO. C.D.O(W)110-4A-0480



X-SECTION
Scale:- 1"= 5.0'



PLAN
Scale:- 1"= 5.0'

NOTES:-

1. The bridge has been designed for I.R.C. class A loading.
2. Reinforced Conc. should have min. Compressive strength of 3000 PSI as per A.S.T.M. C-39-61 where necessary ASTM. C42-61
3. All reinforcement bars shall conform to A.S.T.M. A-15-55 intermediate grade and information concerning to A.S.T.M. A-305-45 with a min. yield stress of 60000 psi.
4. Overlaps should be provided where necessary if not detailed out in the drawing. The lap length shall not be less than 24 x bar ϕ
5. All construction joints in R.C.C. shall be air and sand blasted. A neat cement layer be applied before fresh concreting.
6. Safe bearing capacity has been assumed as 1.5 T/ft²
7. Stone shall be laid in horizontal courses not less than 8" height. All stone in course shall be of equal height unless otherwise specified. But no course shall be thicker than course below it. All stones shall be set full in specified mortar in bed and joints.
8. The face stone shall be squared on all joints in stationary. The beds shall be hammer dressed or sawed true and square for atleast 8" back from the face and the joints for atleast 1½". The face of the stone shall be hammer dressed.
9. All side joints shall be vertical and beds horizontal and no joint shall be more than ¾" in thickness. No pinning shall be allowed on face.
10. No face stone shall be less in breadth than its height, nor shall it be laid with the work to a length less than its height. In the stone shall lay into the work atleast twice its height or in walls thicker than 2' three times its height.
11. Through stones shall be inserted 2 to 4 feet apart in every course and shall run right through the wall not more than 2 feet thick. When the wall is more than 2 feet thick, a set of two or more headers shall be laid to break joint and each header running more than atleast 3' the headers shall have a length of atleast 3 times the height.
12. Stone shall break joint by atleast half the length of the stone.
13. Mortar used for stone masonry shall be (1:4) cement sand mortar.

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

CONSTRUCTION DRAWING

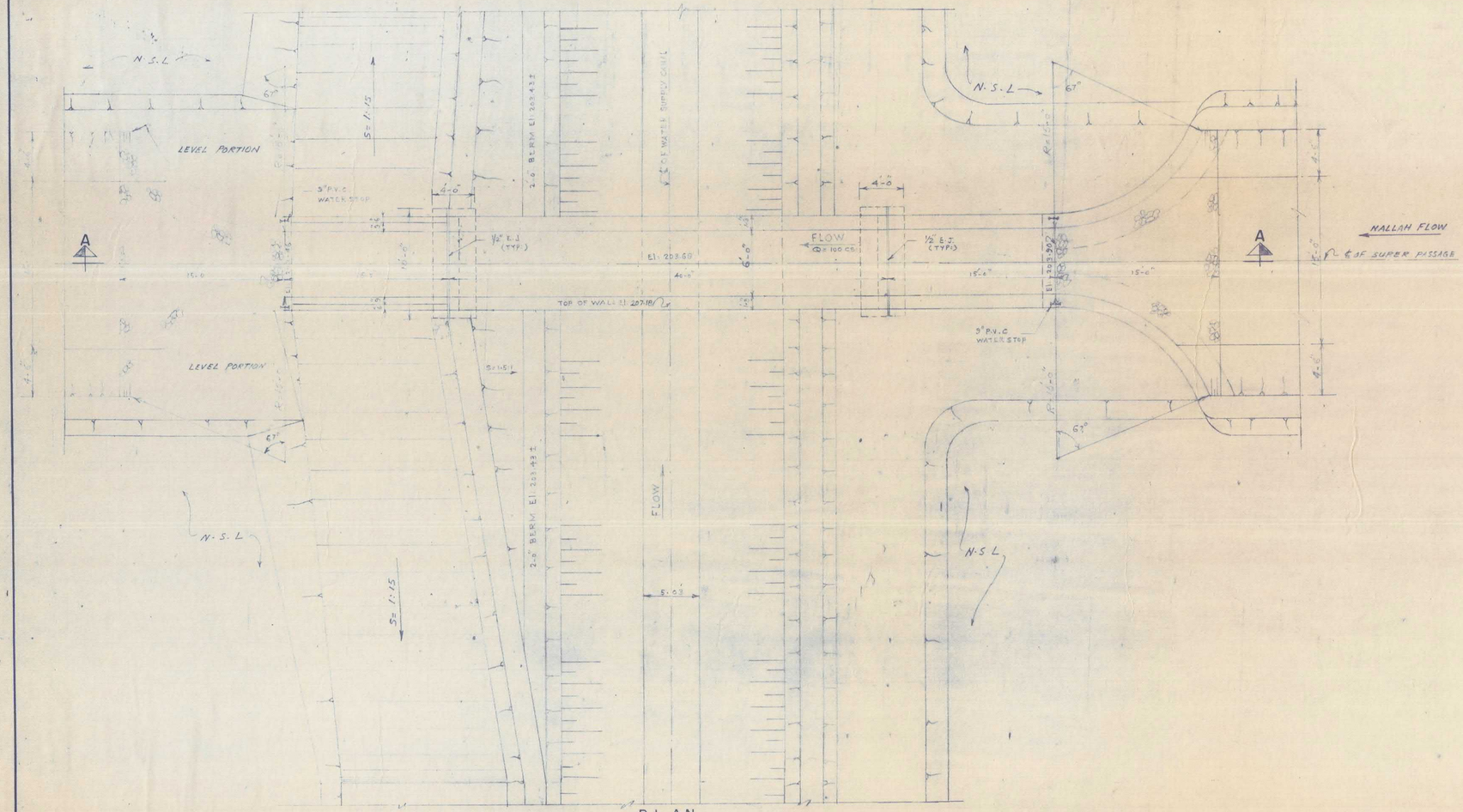
HUB DAM PROJECT
WATER SUPPLY CANAL (210 CUSECS)
PLAN OF VILLAGE ROAD CULVERT AT CH. 128+00

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.		SUBMITTED	RECOMMENDED
DWN. GHULAM MUSTAFA CH.D		DEPUTY DIRECTOR	DIRECTOR DESIGN
TRD.		APPROVED	
CKD.		CHIEF ENGINEER DESIGN	
REVD.			
DATE 23-6-64	JOB NO	INDEX NO	FILE NO DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W DES C.D.O (W) 110-4A-C 479

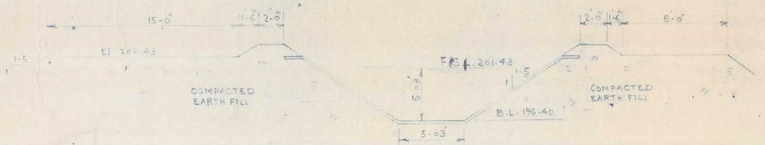
110-4A-C-451 R2	Longitudinal Section from ch 0+00 to 149+76
110-4A-C-480	Village Road Culvert at ch. 128+00 Reinforcement Detail & Sections.
DRAWING NO.	TITLE OF DRAWING

REFERENCE DRAWING



PLAN

SCALE 1"= 5'-0"



TYPICAL SECTION OF WATER SUPPLY CANAL

SCALE 1"= 5'-0"

NOTES.

1. ALL THE WORK SHALL BE CARRIED OUT AS PER SPECIFICATIONS
2. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISIONS OF A.C.I BUILDING CODE (318-71)
3. ALL REINFORCED CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 P.S.I IN 28 DAYS UNLESS OTHERWISE NOTED.
4. ALL REINFORCEMENT SHALL BE INTERMEDIATE GRADE DEFORMED BARS, A.S.T.M DESIGNATION A-615 f_y = 40,000 P.S.I
5. ALL EXPOSED CORNERS SHALL BE CHAMFERED 3/4" UNLESS OTHERWISE SHOWN
6. ALL LEVELS SHOWN IN THE DRAWINGS SHOULD BE VARIFIED BY THE ENGINEER INCHARGE.
7. DRAWINGS HAVE BEEN PREPARED ON THE BASIS OF DATA RECEIVED FROM THE SITE.
8. DECK SLAB FOR ROAD BRIDGE HAS BEEN DESIGED FOR CLASS 'B' LOADINGS
9. ALL BACKFILL AND OVER EXCAVATION SHALL BE LAID IN 9" THICK LAYERS OF LOCALLY AVAILABLE MATERIAL AND EACH LAYER SHALL BE COMPACTED TO 80% RELATIVE DENSITY.
10. LAP LENGTH IN DEFORMED BARS SHALL BE AS FOLLOWS.

BAR DIA	LAP LENGTH (INCHES)
# 4	15
# 6	21
# 8	33

11. EMBEDMENT LENGTH IN DEFORMED BARS SHALL BE AS FOLLOWS.

BAR DIA	EMBEDMENT LENGTH (INCHES)
# 4	12
# 6	14
# 8	21

12. ALL CONSTRUCTION JOINTS SHALL BE PROVIDED WITH ONE 9" P.V.C WATER STOP

REV.NO	DATE	DESCRIPTION	BY	CKD	APPVD.

REVISIONS

TENDER DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL

SUPER PASSAGE AT CH. 162+000

PLAN

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

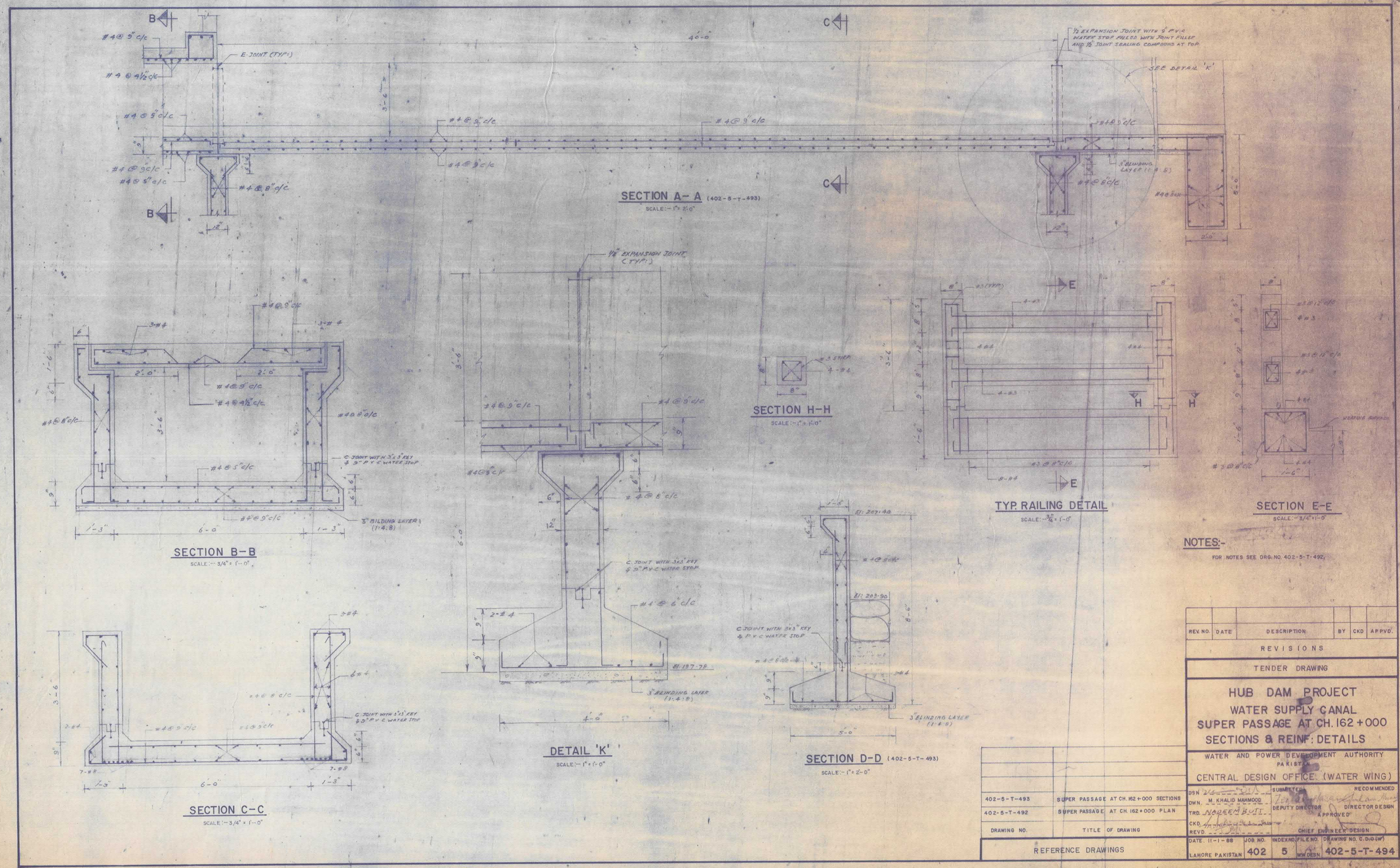
C.D.O(W) WS/454	WATER SUPPLY CANAL X-SECTION FOR THE REACH FROM CH. 64+87 to 297+00
402-5-T-494	SUPER PASSAGE AT CH. 162+000 REINF. DETAIL
402-5-T-493	SUPER PASSAGE AT CH. 162+000 SECTIONS
DRAWING NO.	TITLE OF DRAWING

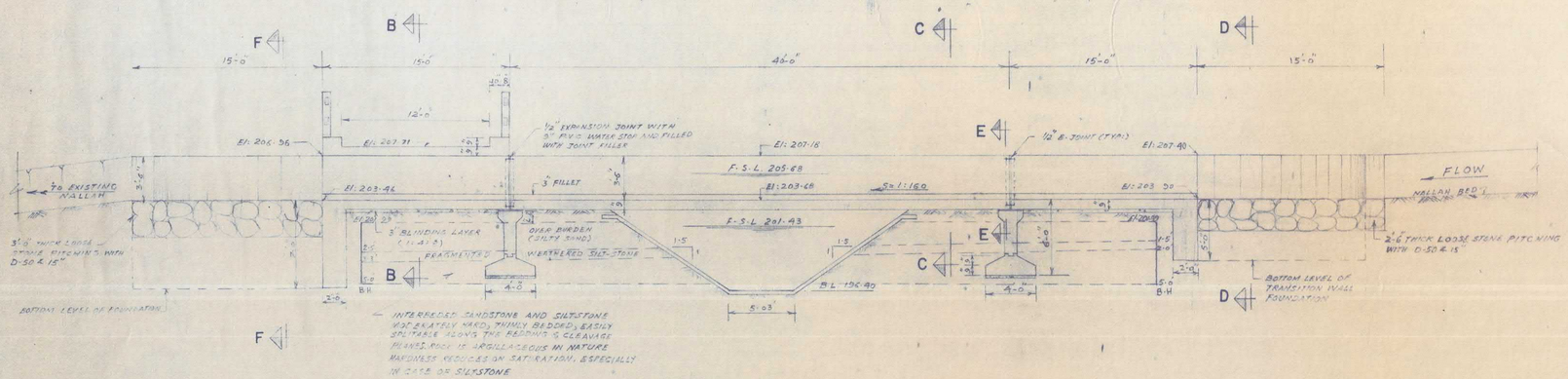
REFERENCE DRAWINGS

DSN. _____ SUBMITTED _____ RECOMMENDED
DWN. S. MUSTAFA D.H.D
TRD. NADEEM BUTT DEPUTY DIRECTOR DIRECTOR DESIGN
CKD. _____ APPROVED
REVD. _____ CHIEF ENGINEER DESIGN

DATE 07-01-1988 | JOB NO. 402 | INDEX NO 5 | FILE NO. | DRAWING NO. C.D.O(W) WW DESN 402-5-T-492

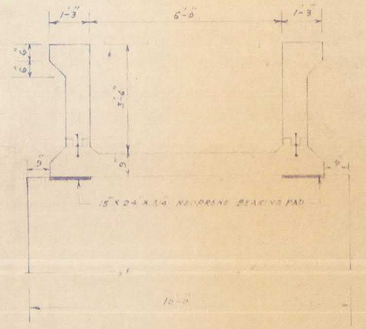
LAHORE PAKISTAN


SECTION A-A (402-5-T-493)
SCALE:- 1" = 2'-0"
SECTION B-B
SCALE:- 3/4" = 1'-0"
SECTION C-C
SCALE:- 3/4" = 1'-0"
DETAIL 'K'
SCALE:- 1" = 1'-0"
SECTION D-D (402-5-T-493)
SCALE:- 1" = 2'-0"
SECTION H-H
SCALE:- 1" = 1'-0"
TYP. RAILING DETAIL
SCALE:- 3/4" = 1'-0"
SECTION E-E
SCALE:- 3/4" = 1'-0"
NOTES:-
FOR NOTES SEE DRG. NO. 402-5-T-492.
REV. NO. | DATE | DESCRIPTION | BY | CKD | APPVD.
REVISIONS
TENDER DRAWING
HUB DAM PROJECT
WATER SUPPLY CANAL
SUPER PASSAGE AT CH. 162+000
SECTIONS & REINF: DETAILS
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)
402-5-T-493 SUPER PASSAGE AT CH. 162+000 SECTIONS
402-5-T-492 SUPER PASSAGE AT CH. 162+000 PLAN
DRAWING NO. TITLE OF DRAWING
REFERENCE DRAWINGS
DSN
DWN. M. KHALID MAHMOOD
TRD. NADEEM BUTT
CKD.
REVD.
SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN
DATE. 11-1-88
LAHORE PAKISTAN
JOB NO. 402
INDEX NO. 5
FILE NO.
W.W. DESN.
DRAWING NO. C.D.O.(W) 402-5-T-494



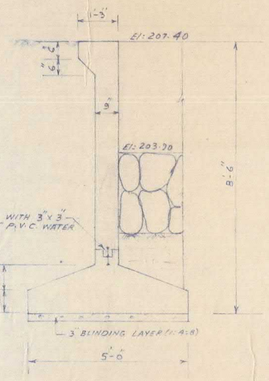
SECTION A-A

SCALE 1" = 5'-0"



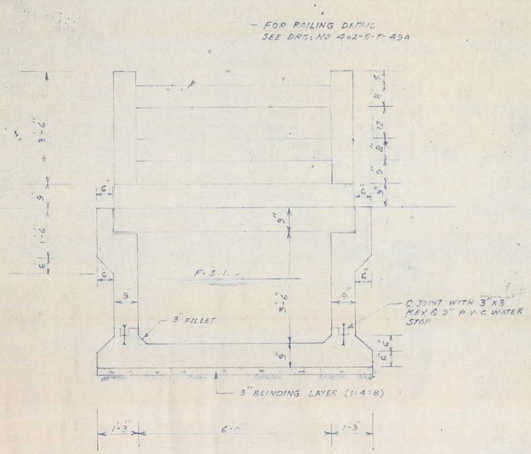
SECTION E-E

SCALE 1" = 5'-0"



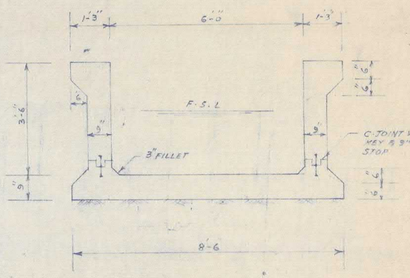
SECTION F-F

SCALE 1" = 2'-0"



SECTION B-B

SCALE 1" = 2'-0"



SECTION C-C

SCALE 1" = 2'-0"

NOTES.

FOR NOTES SEE DRG. NO. 402-5-T-492

REV. NO.	DATE	DESCRIPTION	BY	CKD	APPVD
1	11-1-89	WIDTH OF RCC & C.I. SCRUPT INCREASED FROM 1'-3" AND SECTION A-F ADDED AS E-W/PIX			

REVISIONS

REFERENCE DRAWINGS	
402-5-T-494	SUPER PASSAGE AT CH. 162+000 REINF. DETAIL
402-5-T-492	SUPER PASSAGE AT CH. 162+000 PLAN
DRAWING. NO.	TITLE OF DRAWING

TENDER DRAWING

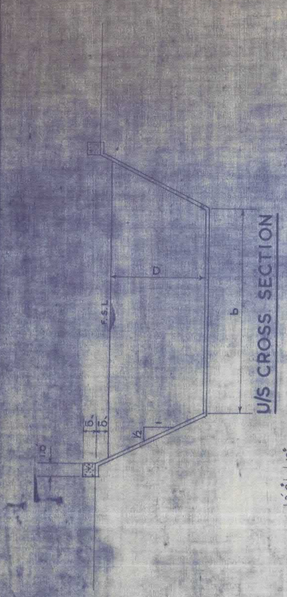
HUB DAM PROJECT
WATER SUPPLY CANAL
SUPER PASSAGE AT CH. 162 + 000
SECTIONS

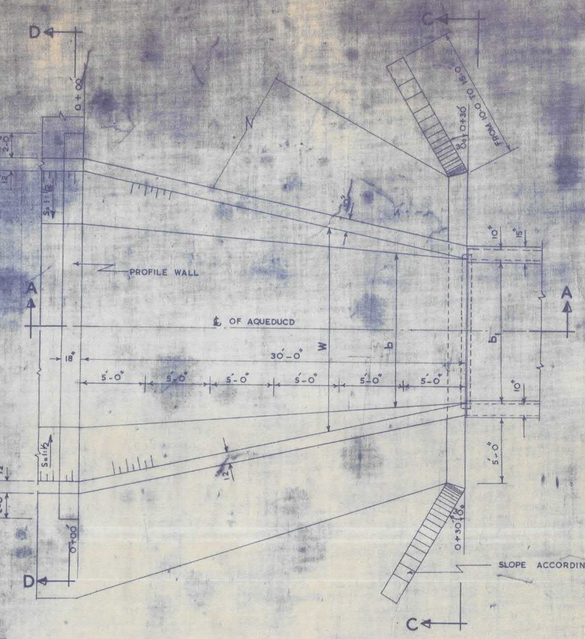
WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN.		SUBMITTED	RECOMMENDED
DWN.	M. SATTAR		
TRD.	NADEEM BUTT	DEPUTY DIRECTOR	DIRECTOR DESIGN APPROVED
CKD.			
REVD.		CHIEF ENGINEER DESIGN	

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO. C.D.O (W)
07-01-1988	402	5	W.W.DESN.	402-5-T-493R1

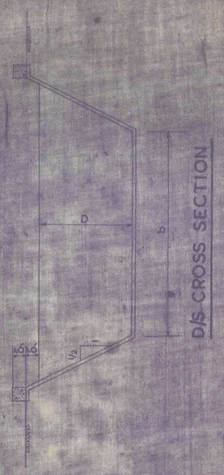
LAHORE. PAKISTAN

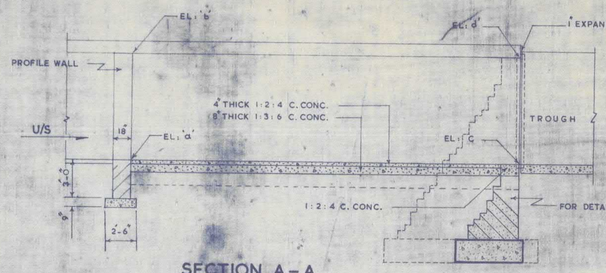




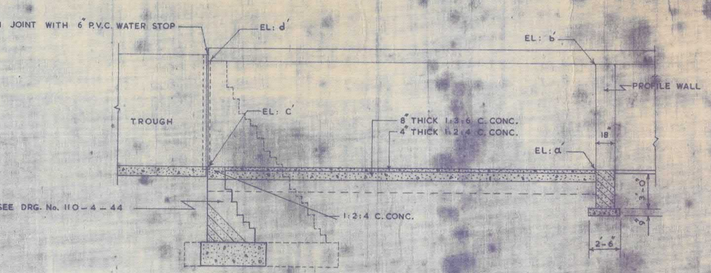
PLAN OF INLET TRANSITION

PLAN OF OUTLET TRANSITION

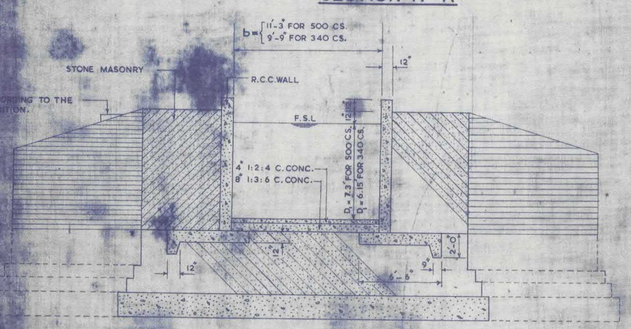




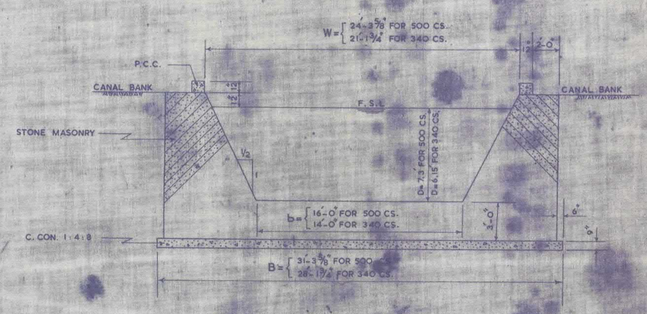
SECTION A-A



SECTION B-B



SECTION C-C



SECTION D-D

R.DS	DISCHARGE Q	U/S TRANSITION				D/S TRANSITION			
		EL: a BED LEVEL AT BEGINING	EL: b BANK LEVEL AT BEGINING	EL: C BED LEVEL AT END	EL: d BANK LEVEL AT END	EL: d BANK LEVEL AT BEGINING	EL: C' BED LEVEL AT BEGINING	EL: b' BANK LEVEL AT ENG	EL: a' BED LEVEL AT END
7850	500 CS.	263.24	271.54	263.24	270.99	SEE DRAWING No. 110-4-33			
35150	340 CS.	SEE DRG. No. 110-4-33				263.65	265.85	253.95	265.80
40150	340 CS.	SEE DRG. No. 110-4-33				262.40	265.60	252.70	258.61

CO-ORDINATES OF TRANSITION
(Q = 500 CS.)

STATION	b		w	
	INLET	OUTLET	INLET	OUTLET
0+00	16'-0"	11'-3"	24'-3 7/8"	11'-3"
0+05	15'-2 1/2"	12'-1/2"	22'-1 7/8"	13'-5"
0+10	14'-5"	12'-10"	19'-8 7/8"	15'-2 1/8"
0+15	13'-7 1/2"	13'-7 1/2"	17'-9 1/4"	17'-9 1/4"
0+20	12'-10"	14'-5"	15'-7 1/8"	19'-11 7/8"
0+25	12'-1/2"	15'-2 1/2"	13'-5"	22'-1 1/2"
0+30	11'-3"	16'-0"	11'-3"	24'-3 7/8"

CO-ORDINATES OF TRANSITION
(Q = 340 CS.)

STATION	b		w	
	INLET	OUTLET	INLET	OUTLET
0+00	14'-10"	9'-9"	21'-1 3/4"	9'-9"
0+05	13'-3 1/2"	10'-5 1/2"	19'-3"	11'-7 3/4"
0+10	12'-7"	11'-3"	17'-4"	13'-6 1/2"
0+15	11'-10 1/2"	11'-10 1/2"	15'-5 1/4"	15'-5 1/2"
0+20	11'-3"	13'-3"	13'-6 1/2"	17'-4"
0+25	10'-5 1/2"	13'-3 1/2"	11'-7 3/4"	19'-3"
0+30	9'-9"	14'-0"	9'-9"	21'-1 3/4"

GENERAL STRUCTURAL NOTES

1. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE (A.C.I. 318-63).
2. ALL REINFORCED CONCRETE SHALL BE OF 1:2:4 MIX AND SHALL HAVE A MIN. COMPRESSIVE STRENGTH OF 3000 LBS/□" IN 28 DAYS UNLESS OTHERWISE SHOWN.
3. ALL REINFORCEMENT LESS THAN ½" DIA SHALL BE PLAIN BARS CONFORMING TO ASTM A-15 AND THAT ½" DIA OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM-305 (fy = 40,000 LBS/□").
4. UNLESS OTHERWISE SHOWN, PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN THE FACE OF CONCRETE AND NEAREST REINFORCEMENT IS 2" EARTH PROVIDE A CLEAR DISTANCE OF 3" FROM THE FACE OF CONCRETE PLACED AGAINST EARTH.
5. ALL SPLICES SHALL BE LAPPED 48 BAR DIA. FOR PLAIN BARS AND 24" DIA FOR DEFORMED BARS.
6. ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2560 Lbs/□".
7. ALL CONCRETE CONSTRUCTION WHERE EVER HAVE CONSTRUCTION JOINTS WILL ALSO BE PROVIDED WITH PVC OR RUBBER WATERSTOPS OR COVER STRIP.
8. A BLINDING LAYER OF 3" THICK CONCRETE IS TO BE LAID UNDER ALL REINFORCED CONCRETE.
9. UNLESS SHOWN OTHERWISE, ALL EXPANSION JOINTS SHALL BE OF 1" SIZE AND SHALL BE PROVIDED WITH P.V.C. WATERSTOP, APPROVED JOINT FILLER AND APPROVED JOINT SEALER.

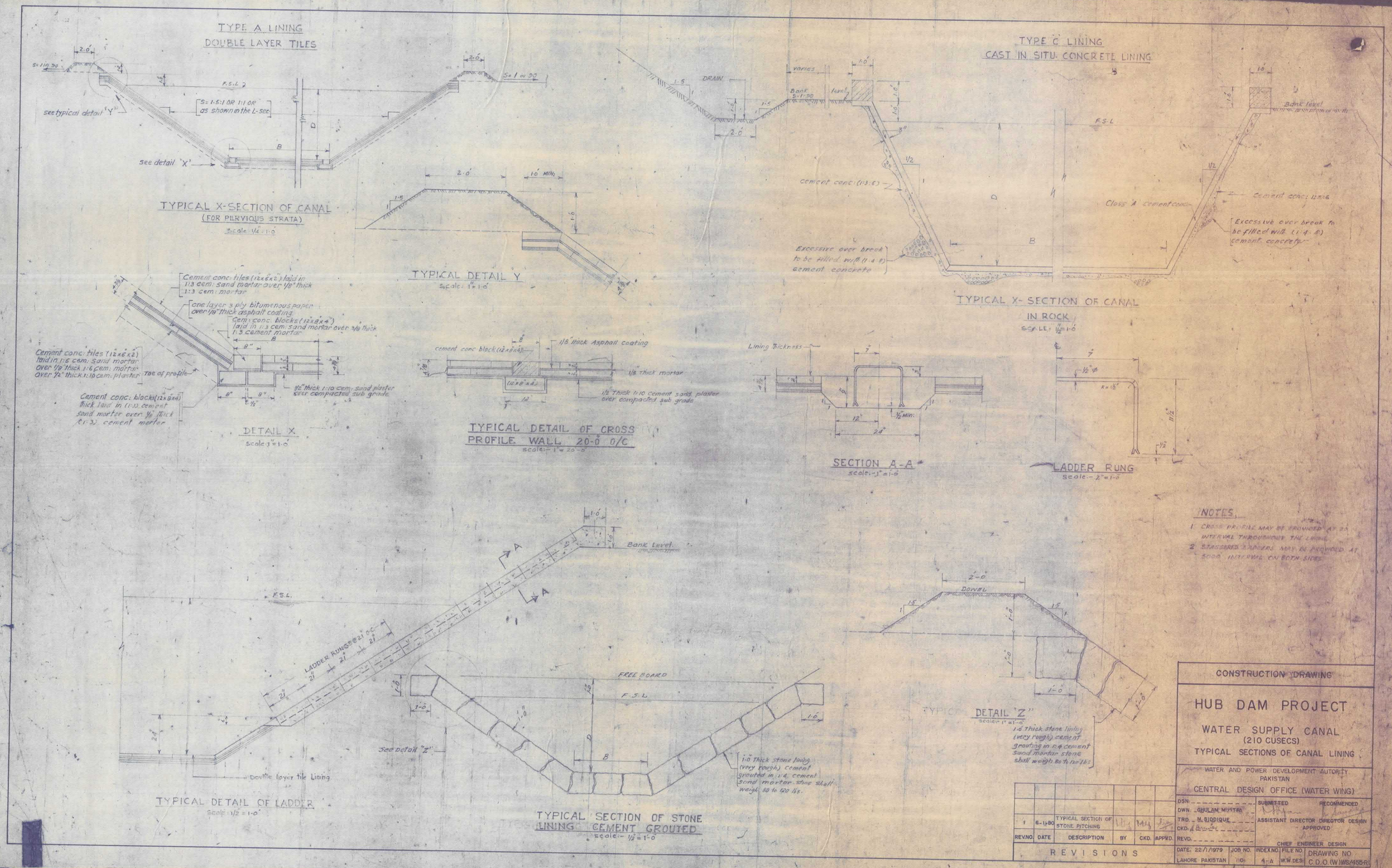
REFERENCE DRAWINGS

REVISION

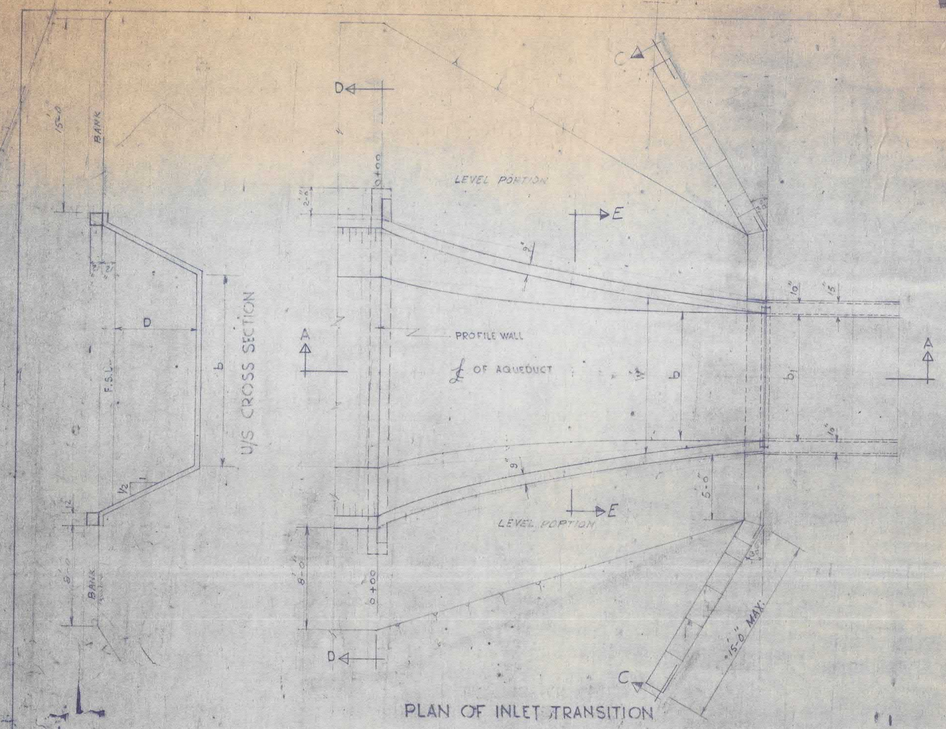
WATER AND POWER DEVELOPMENT AUTHORITY
CENTRAL DESIGN OFFICE (WATER WING)

HUB DAM PROJECT
U/S AND D/S AQUEDUCT TRANSITION (FOR CANAL SECTION IN ROCK)

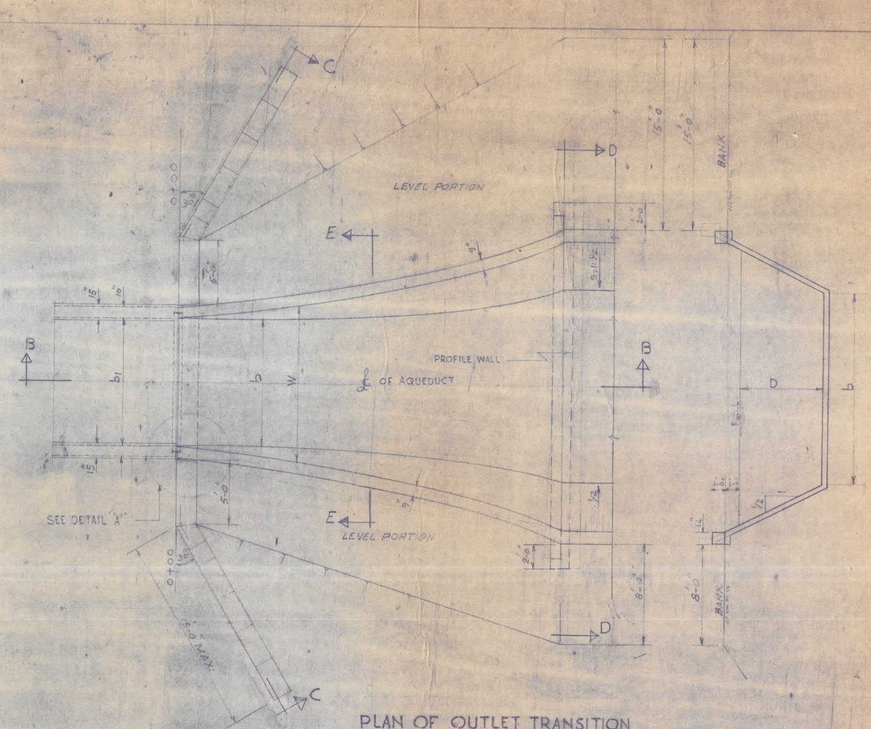
DSN: — SUBMITTED:
DWN: — RECOMMENDED:
TCD: — APPROVED:
CHD: — DESIGNED:
DATE: — JOB No. — DRG. No. 110-4-42
LAHORE, PAKISTAN


TYPE A LINING
DOUBLE LAYER TILES
TYPICAL X-SECTION OF CANAL
(FOR PERVIOUS STRATA)
Scale 1/4" = 1'-0"
TYPICAL DETAIL 'Y'
Scale: 1" = 1'-0"
TYPE 'C' LINING
CAST IN SITU CONCRETE LINING
TYPICAL X-SECTION OF CANAL
IN ROCK
Scale: 1/2" = 1'-0"
DETAIL X
Scale 1" = 1'-0"
TYPICAL DETAIL OF CROSS
PROFILE WALL 20'-0" O/C
Scale: 1" = 20'-0"
SECTION A-A
Scale: 1" = 1'-0"
LADDER RUNG
Scale: 2" = 1'-0"
TYPICAL DETAIL OF LADDER
Scale 1/2" = 1'-0"
TYPICAL SECTION OF STONE
LINING CEMENT GROUTED
Scale: 1/2" = 1'-0"
DETAIL 'Z'
Scale: 1" = 1'-0"
NOTES
1 CROSS PROFILE MAY BE PROVIDED AT 20 INTERVAL THROUGHOUT THE LINING
2 STAGGERED LADDERS MAY BE PROVIDED AT 5000 INTERVAL ON BOTH SIDES
CONSTRUCTION DRAWING
HUB DAM PROJECT
WATER SUPPLY CANAL
(210 CUSECS)
TYPICAL SECTIONS OF CANAL LINING
WATER AND POWER DEVELOPMENT AUTORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)
DSN:
DWN: GHULAM MUSTFA
TRD. M. SIDDIQUE
CKD.
REVD.
SUBMITTED
RECOMMENDED
ASSISTANT DIRECTOR DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN
DATE: 22/1/1979
JOB NO. 110
INDEX NO. 4-A
FILE NO.
W.W. DES.
DRAWING NO. C.D.O.(W)WS/455-R1
REVISIONS
1 6-1-80 TYPICAL SECTION OF STONE PITCHING
REV.NO. DATE DESCRIPTION BY CKD. APPVD.

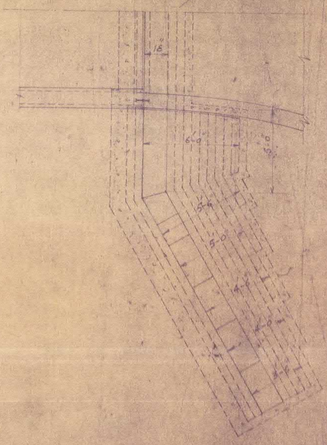
JOB. 110
SER. NO. 56



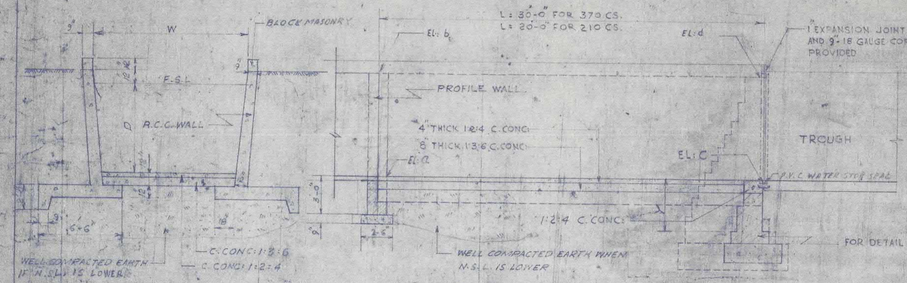
PLAN OF INLET TRANSITION



PLAN OF OUTLET TRANSITION

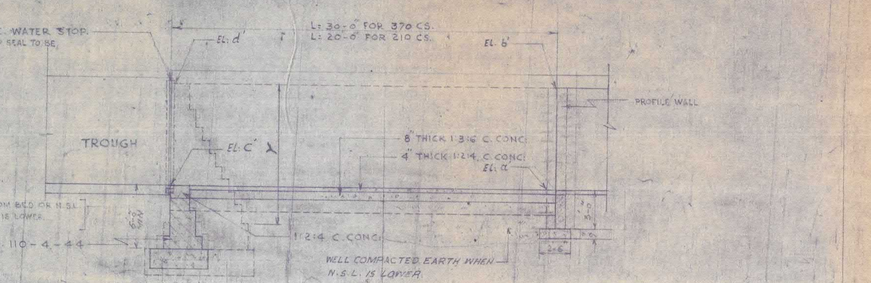


DETAIL 'A'
SCALE 1"=1'-6"



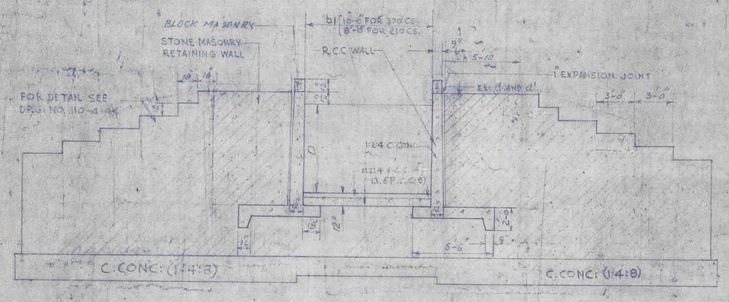
SECTION E-E

SECTION A-A

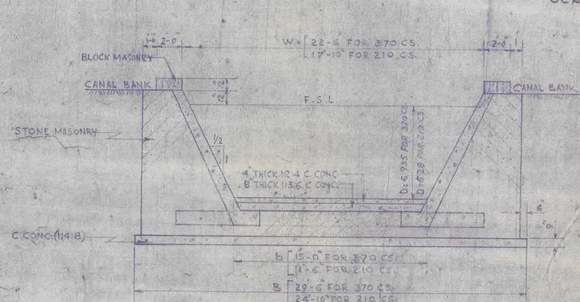


FOR DETAIL SEE DRG. NO. 110-4-44

SECTION B-B



SECTION C-C



SECTION D-D

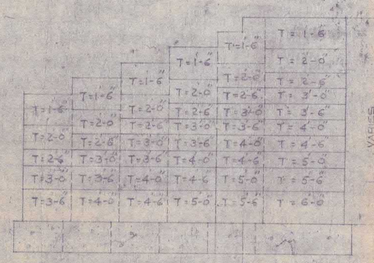
STATION	U/S TRANSITION				D/S TRANSITION			
R.D's	DISCHARGE Q	EL. 'a' BED LEVEL AT BEGINING	EL. 'b' BANK LEVEL AT BEGINING	EL. 'c' BED LEVEL AT END	EL. 'd' BANK LEVEL AT END	EL. 'd' BANK LEVEL AT BEGINING	EL. 'c' BED LEVEL AT BEGINING	EL. 'b' BANK LEVEL AT END	EL. 'a' BED LEVEL AT END
7850	370 CS.	261.85	269.39	261.95	268.90	SEE DRG NO. 110-4-47			
35150	210 CS.	SEE DRG. NO. 110-4-46				261.91	255.98	262.16	255.88
40850	210 CS.	SEE DRG. NO. 110-4-46				260.79	254.85	261.04	254.76

CO-ORDINATES OF TRANSITIONS
(Q = 370 CS)

STATION	b		W	
	INLET	OUTLET	INLET	OUTLET
0+00	15'-0	10'-0	22'-6	16'-0
0+05	12'-7	10+1½	18'-8	11'-4
0+10	11'-4	10'-2	16'-2	12'-7
0+15	10'-7	10'-7	14'-2	14'-2
0+20	10'-2	10'-4	12'-7	16'-2
0+25	10'-1¼	12'-7	11'-4	18'-8
0+30	10'-0	15'-0	10'-0	22'-6

CO-ORDINATES OF TRANSITIONS
(Q = 210 CS)

STATION	b		W	
	INLET	OUTLET	INLET	OUTLET
0+00	11'-6	8'-0	17'-10	8'-0
0+05	9'-½	8'-1	13'-9	9'-6
0+10	8'-7½	8'-7½	11'-8½	11'-8½
0+15	8'-1	9'-½	8'-8	13'-9
0+20	8'-0	11'-6	8'-0	17'-10



ELEVATION OF WING WALL
SCALE: 1"=4'-0"

GENERAL STRUCTURAL NOTES.

1. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE (A.C.E 318-63)
2. ALL REINFORCED CONC. SHALL BE OF 1:2:4 MIX AND SHALL HAVE A MIN. COMPRESSIVE STRENGTH OF 3000 lbs/□" IN 28 DAYS UNLESS OTHERWISE SHOWN.
3. ALL REINFORCEMENT LESS THAN 1" DIA SHALL BE PLAIN BARS CONFORMING TO ASTM A-15 AND THAT 1" DIA OR LARGER BARS BE DEFORMED BARS CONFORMING TO ASTM-305 (f_y = 40,000 lbs/□")
4. UNLESS OTHERWISE SHOWN, PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN THE FACE OF CONCRETE AND NEAREST REINFORCEMENT IS 2" EXCEPT PROVIDE A CLEAR DISTANCE OF 3" FROM THE FACE OF CONC. PLACED AGAINST EARTH.
5. ALL SPLICES SHALL BE LAPPED 48 BAR DIA FOR PLAIN BARS AND 24 DIA FOR DEFORMED BARS.
6. ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2500 lbs/□".
7. ALL CONCRETE CONSTRUCTIONS WHERE EVER HAVE CONSTRUCTION JOINTS WILL ALSO BE PROVIDED WITH P.V.C. OR RUBBER WATER STOPS OR COPPER STRIP.
8. A BLINDING LAYER OF 3" THICK CONCRETE IS TO BE LAID UNDER ALL REINFORCED CONCRETE.
9. UNLESS SHOWN OTHERWISE, ALL EXPANSION JOINTS SHALL BE OF 1" SIZE AND SHALL BE PROVIDED WITH P.V.C. WATER STOPS WITH APPROVED JOINT FILLER AND APPROVED JOINT SEALER.

NO.	DATE	BY	DESCRIPTION	APPROVED
			REVISION	
1	23.9.74	M.N.	SECTION D-D REVISED FOR CUTTING AND FILLING AND COPPER PLATE IN EXPANSION JOINT PROVIDED.	

DATE:- 11-10-72 SCALE:- 1"=6'-0"

WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS

HUB DAM PROJECT

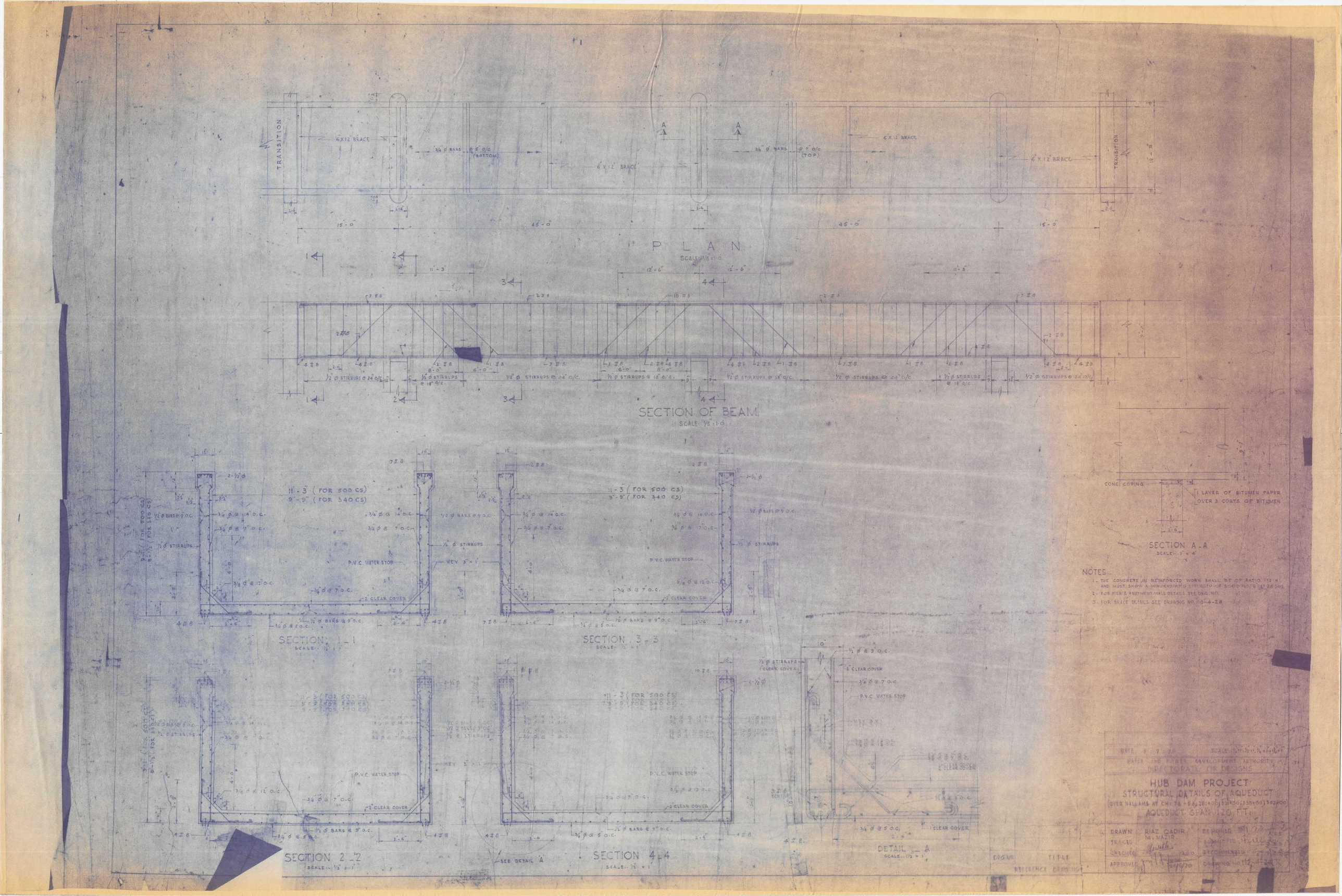
U/S AND D/S AQUEDUCT TRANSITION (FOR CANAL SECTION IN ROCK)

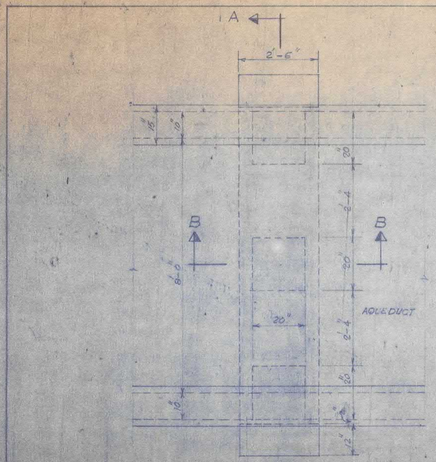
DRAWN M.NAZIR, M.SALEEM
TRACED
CHECKED — C.H.D. — A.D.O.
APPROVED — D.G.P.

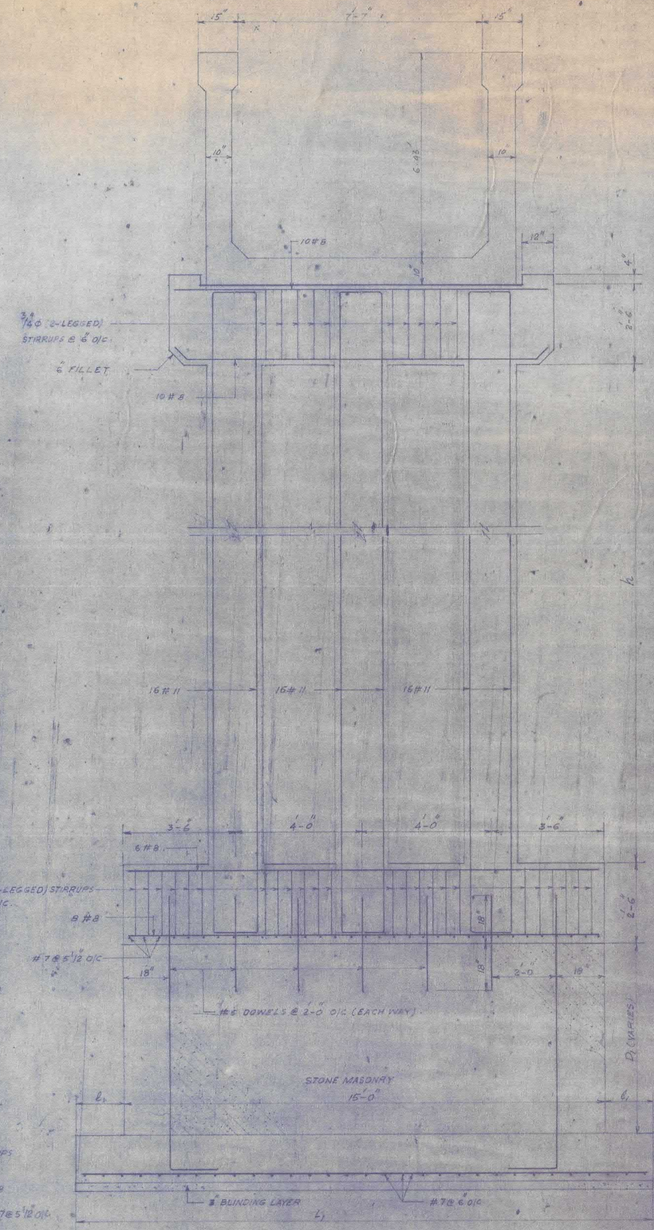
DESIGNED — A.D.O.
SUBMITTED — M.M. — A.D.O.
RECOMMENDED — D.G.P.

DRG. NO. 110-4-48 R

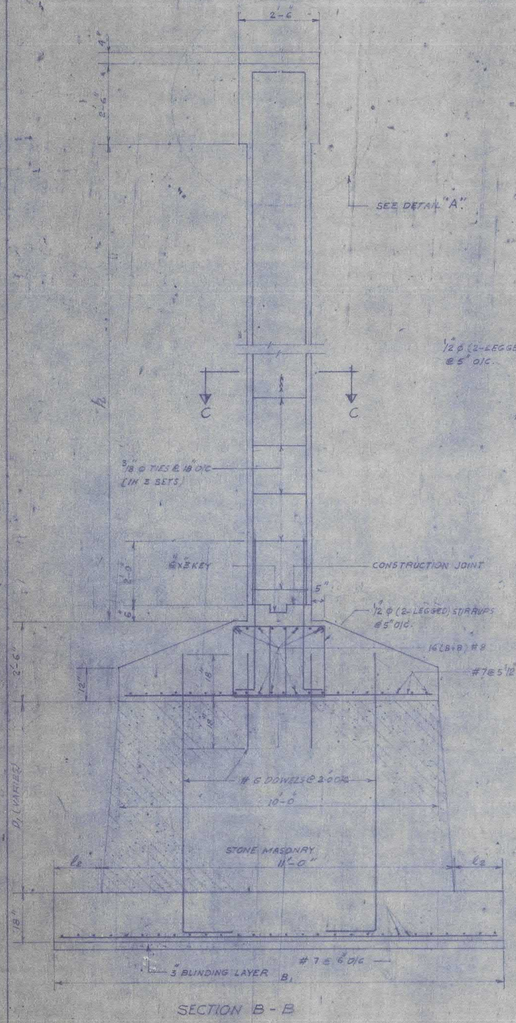
DRG. NO. TITLE
REFERENCE DRAWINGS

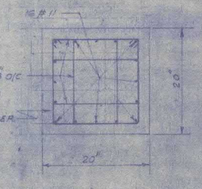

PLAN
SCALE: 1/5" = 1'-0"
TRANSITION
6"X12" BRACE
3/4" ø BARS @ 5" O/C (BOTTOM)
3/4" ø BARS @ 7" O/C (TOP)
15'-0"
45'-0"
SECTION OF BEAM
SCALE: 1/5" = 1'-0"
1/2" ø STIRRUPS @ 24" O/C
1/2" ø STIRRUPS @ 18" O/C
SECTION 1-1
SCALE: 1/2" = 1'
SECTION 3-3
SCALE: 1/2" = 1'
SECTION 2-2
SCALE: 1/2" = 1'
SECTION 4-4
SCALE: 1/2" = 1'
11'-3" (FOR 500 CS)
9'-9" (FOR 340 CS)
P.V.C. WATER STOP
KEY 3" x 1"
2" CLEAR COVER
1/2" ø BARS @ 9" O.C.
SEE DETAIL A
DETAIL A
SCALE: 1 1/2" = 1'
CONC. COPING
1 LAYER OF BITUMEN PAPER OVER 3 COATS OF BITUMEN
SECTION A-A
SCALE: 1" = 4'
NOTES
1. THE CONCRETE IN REINFORCED WORK SHALL BE OF RATIO 1:2:4 AND MUST SHOW A MINI-CRUSHING STRENGTH OF 3000 lbs/□" AT 28 DAYS.
2. FOR PIER & ABUTMENT WALL DETAILS SEE DRG. NO.
3. FOR BRACE DETAILS SEE DRAWING NO. 110-4-28
WATER AND POWER DEVELOPMENT AUTHORITY
DIRECTORATE OF DESIGNS
HUB DAM PROJECT
STRUCTURAL DETAILS OF AQUEDUCT
AQUEDUCT SPAN 120 FT.
DRAWN RIAZ QADIR
TRACED M. NAZIR
CHECKED
APPROVED
DESIGNED
SUBMITTED
RECOMMENDED
DRAWING NO. 110-4-28
DRG. NO.
TITLE
REFERENCE DRAWING

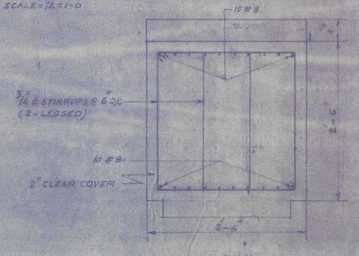


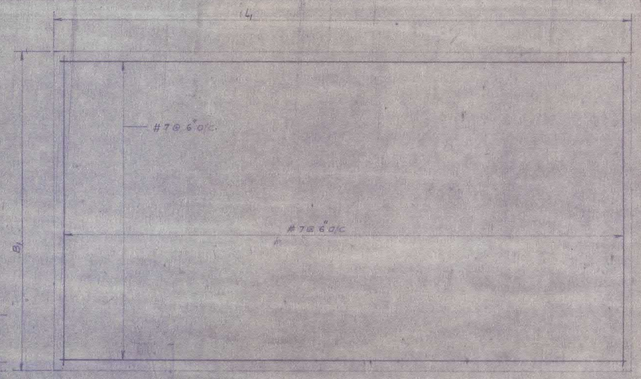


CHAINAGE	FOOTING SIZE ($L_1 \times B_1$)	DIMENSIONS OF PIER AND FOOTING ETC: END PIER U/S h_1	D_1	ℓ_1	ℓ_2	END PIER D/S h_1	D_1	ℓ_1	ℓ_2	PENULTIMATE PIER U/S h_1	D_1	ℓ_1	ℓ_2	PENULTIMATE PIER D/S h_1	D_1	ℓ_1	ℓ_2	CENTRAL PIER h_2	D_1	ℓ_1	ℓ_2	REMARKS
404+00	22'X18'	20'-0"	8'-0"	3'-6"	4'-0"	20'-0"	8'-0"	3'-6"	4'-0"	-	-	-	-	-	-	-	-	20'-0"	8'-0"	3'-6"	4'-0"	DRG NO 110-4-57
607+00	22'X18'	10'-0"	3'-0"	3'-6"	4'-0"	10'-0"	3'-0"	3'-6"	4'-0"	-	-	-	-	-	-	-	-					11 11 110-4-51





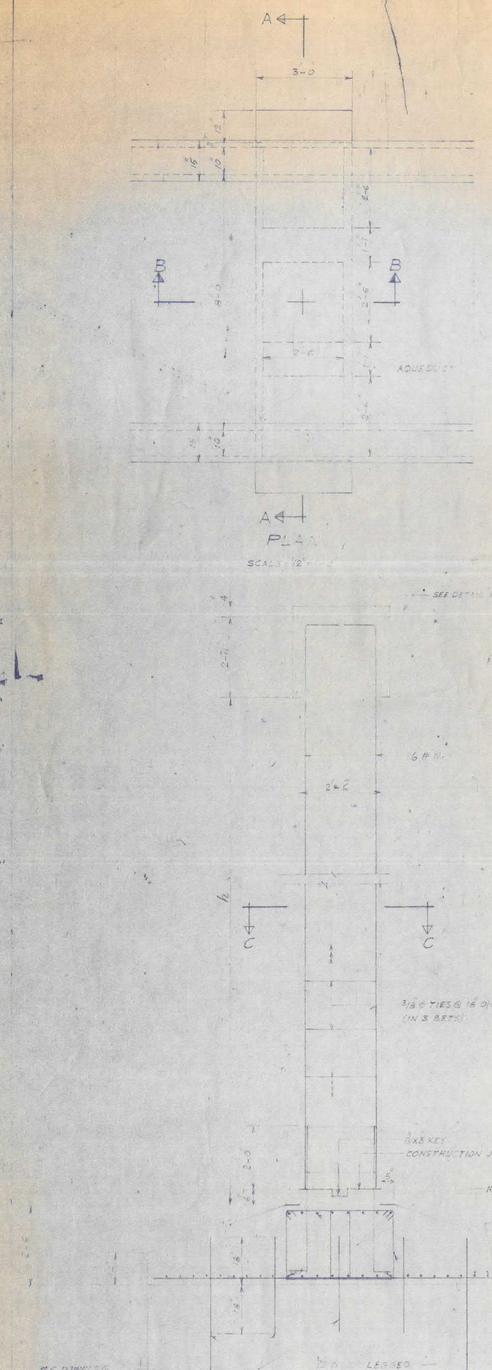




GENERAL STRUCTURAL NOTES:

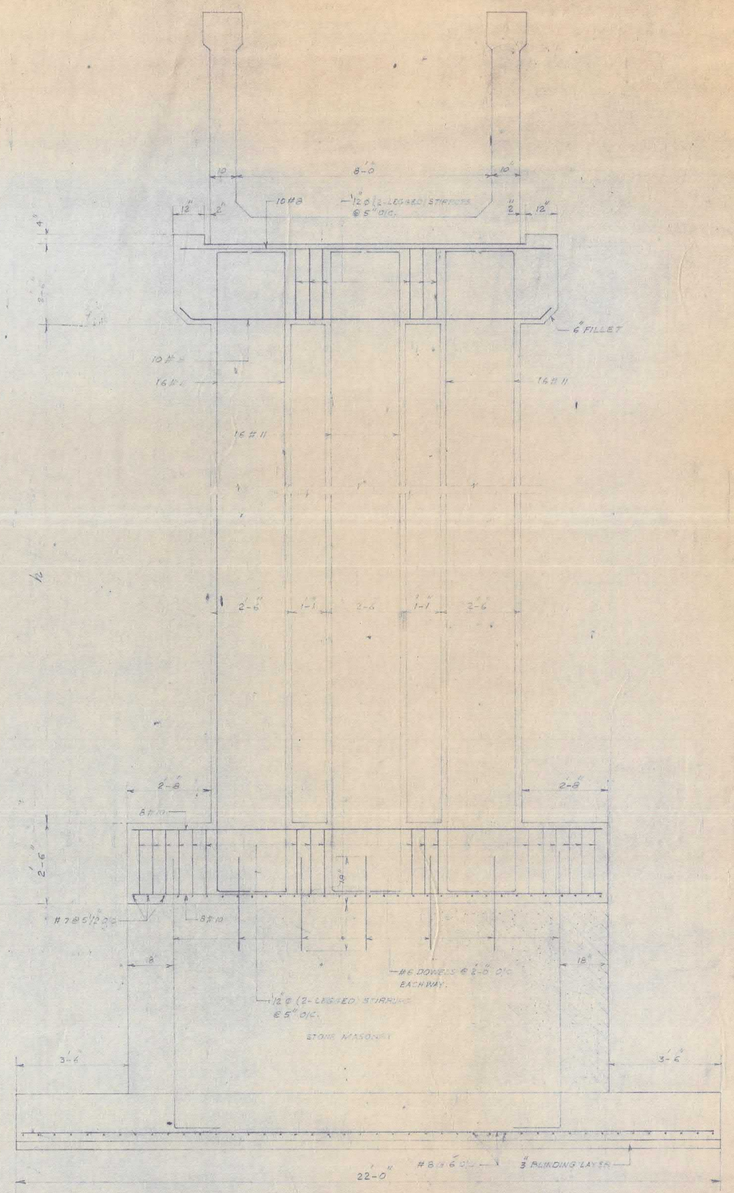
1. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE (A.C.I. 318-63).
2. ALL REINFORCED CONCRETE SHALL BE OF 1:1 1/2:3 MIX AND SHALL HAVE A MINI COMPRESSIVE STRENGTH OF 3000 LBS P.S.I. IN 28 DAYS UNLESS OTHERWISE NOTED.
3. ALL REINFORCEMENT LESS THAN 3/4" DIA. SHALL BE PLAIN BARS CONFORMING TO ASTM A-15 AND THAT 3/4" DIA OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM - 305 (f_y = 40,000 P.S.I.).
4. UNLESS OTHERWISE SHOWN PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN THE FACE OF CONCRETE AND THE NEAREST REINFORCEMENT IS 2" EXCEPT PROVIDE A CLEAR DISTANCE OF 5" FROM FACE OF CONCRETE PLACED AGAINST EARTH.
5. ALL SPLICES SHALL BE LAPPED 48 BAR DIA FOR PLAIN BARS AND 24 BAR DIA FOR DEFORMED BARS.
6. ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2000 LBS P.S.I.
8. A BLINDING LAYER OF 3" THICK CONCRETE IS TO BE LAID UNDER ALL REINFORCED CONCRETE.
9. STONE MASONRY WORK TO BE DONE IN CEMENT MORTAR OF 1:6 AND TO BE POINTED WITH CEMENT MORTAR 1:3.

DATE :- 14-4-1973	SCALE :- AS SHOWN
WATER AND POWER DEVELOPMENT AUTHORITY	
DIRECTORATE OF DESIGNS	
HUB DAM PROJECT	
STRUCTURAL DETAILS OF PIERS OF AQUEDUCT AT CH: 404+00 AND 607+00	
DRAWN: AA SALEEM	DESIGNED:
TRACED:	SUBMITTED:
CHECKED:	RECOMMENDED:
APPROVED: DIRECTOR (PH) DESIGNS	DRG NO. 110-4-61



PLAN

SCALE = 1/2" = 1'-0"

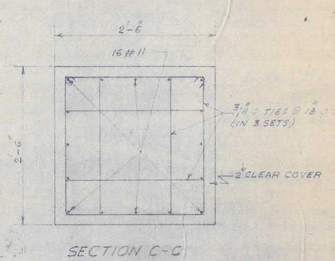


SECTION A-A

SCALE = 1/2" = 1'-0"

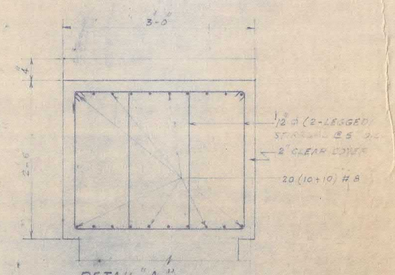
SECTION B-B

SCALE = 1/2" = 1'-0"



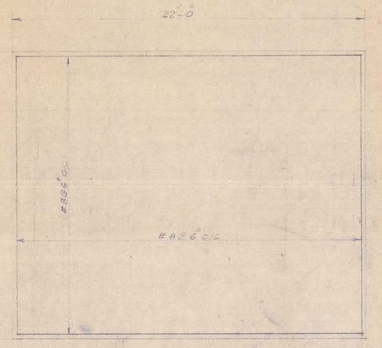
SECTION C-C

SCALE = 1" = 1'-0"



DETAIL "A"

SCALE = 1" = 1'-0"



SECTIONAL PLAN OF FOOTING

SCALE = 1/4" = 1'-0"

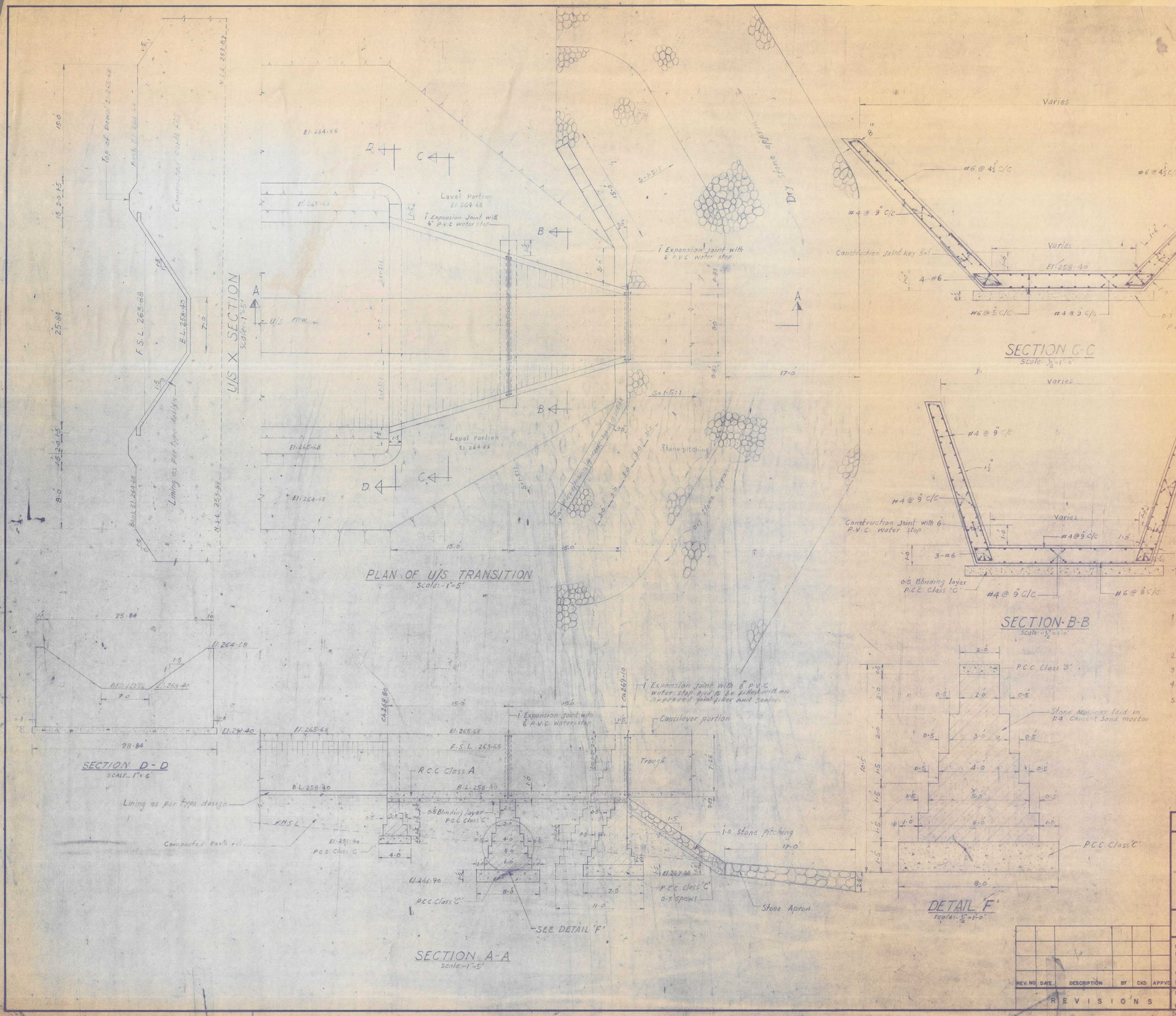
DIMENSIONS OF PIER AND FOOTING ETC.

END PIER				PENNULTIMATE PIER				CENTRAL PIER	
U/S		D/S		U/S		D/S			
h	D	h	D	h	D	h	D	h	D
24'-0"	4'-0"	24'-0"	4'-0"	33'-0"	3'-0"	33'-0"	3'-0"	33'-0"	3'-0"

GENERAL STRUCTURAL NOTES:-

1. CONCRETE DESIGN AND CONSTRUCTION SHALL CONFORM TO THE PROVISION OF THE A.C.I. BUILDING CODE (A.C.I. 318-63).
2. ALL REINFORCED CONCRETE SHALL BE OF 1:2:4 MIX. AND SHALL HAVE A MINI COMPRESSIVE STRENGTH OF 3000 LBS P.S.I. IN 28 DAYS UNLESS OTHERWISE NOTED.
3. ALL REINFORCEMENT LESS THAN 3/4" DIA. SHALL BE PLAIN BARS CONFORMING TO ASTM A-15 AND THAT 3/4" DIA. OR LARGER SHALL BE DEFORMED BARS CONFORMING TO ASTM-305 (fy = 40,000 P.S.I.)
4. UNLESS OTHERWISE SHOWN PLACE ALL REINFORCEMENT SO THAT THE CLEAR DISTANCE BETWEEN THE FACE OF CONCRETE AND THE NEAREST REINFORCEMENT IS 2" EXCEPT PROVIDE A CLEAR DISTANCE OF 3" FROM FACE OF CONCRETE PLACED AGAINST EARTH.
5. ALL SPLICES SHALL BE LAPPED 48 BAR DIA. FOR PLAIN BARS AND 24 BAR DIA. FOR DEFORMED BARS.
6. ALL BLOCK MASONRY IN STRUCTURES SHALL HAVE AN ULTIMATE CRUSHING STRENGTH OF NOT LESS THAN 2500 LBS P.S.I.
8. A BLINDING LAYER OF 3" THICK CONCRETE IS TO BE LAID UNDER ALL REINFORCED CONCRETE.
9. A 1/2" THICK EXPANDED POLYSTYRENE PAD IS TO BE PLACED ON TOP OF PIER CAPS.
10. STONE MASONRY WORK TO BE DONE IN CEMENT MORTAR OF 1:3 AND TO BE POINTED WITH CEMENT MORTAR 1:3.

DATE - 11-4-1973	SCALE - AS SHOWN
WATER AND POWER DEVELOPMENT AUTHORITY DIRECTORATE OF DESIGNS	
HUB DAM PROJECT STRUCTURAL DETAILS OF PIERS OF AQUEDUCT AT CH. 508+00	
DRAWN M. SALEEM TRACED CHECKED Mcwalla 11-4-73 APPROVED DIRECTOR GEN. DESIGNS	DESIGNED SUBMITTED A.D.C. RECOMMENDED A.D.D. D.D.
	DRG. NO. 110-4-62 R



NOTES:-

1. Cement conc. of various classes shall have minimum cylinder strength after 28 days.
   Class 'A' = 3000 lbs/□".
   Class 'B' = 2000 lbs/□".
   Class 'C' = 1000 lbs/□".
2. Use plain bars of billet steel structural grade for reinforcement conforming to A.S.T.M. A-15.
3. Earth shall be compacted upto 95% of the maximum standard proctor density of the material.
4. Mortar used for stone masonry work shall be (1:6) cement sand mortar until and unless specified.
5. The stone masonry work will be in coarse rubble masonry (its class) inside face dressed or in block masonry and shall conform to the specifications as laid down in west pakistan standing rates committees schedule of rates volume I part II specification for execution of works.

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

HUB DAM PROJECT

MAIN CANAL

U/S TRANSITION OF BURKI NALA AQUEDUCT

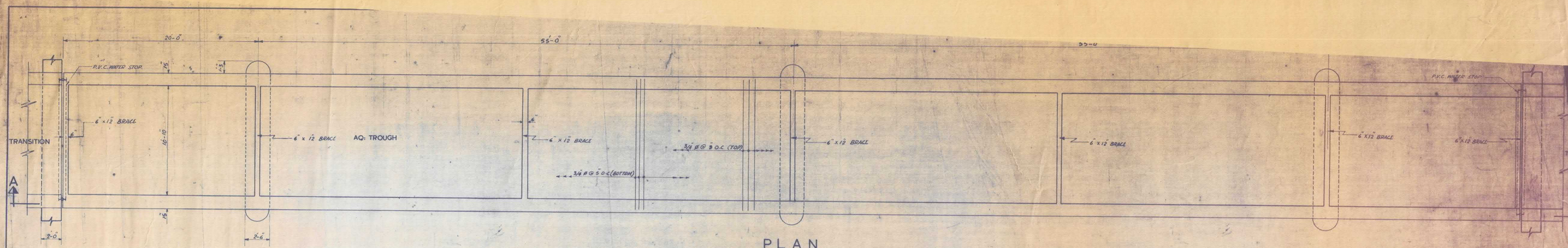
CH. 268·80 TO 271·05

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN. [illegible]
DWN. C.R.K.
TRD.
CKD. [illegible]
REVD.

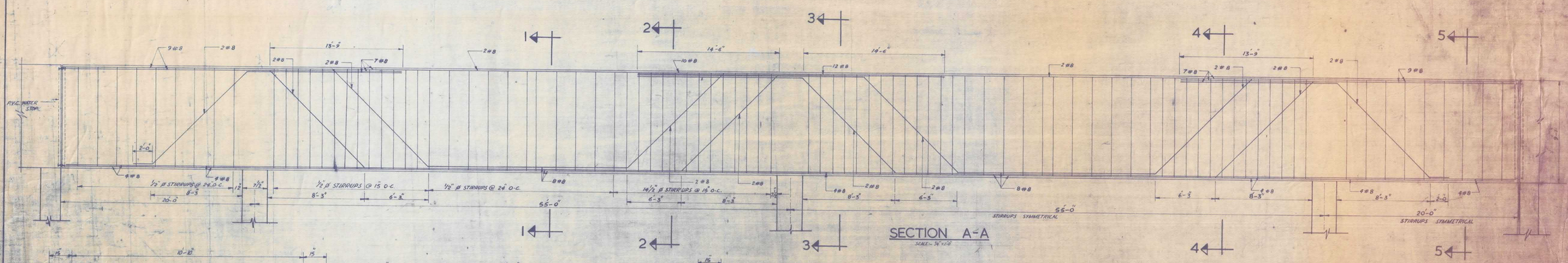
SUBMITTED — ASSISTANT DIRECTOR
RECOMMENDED — DIRECTOR DESIGN
APPROVED — CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	410	4	W.K.DESIGN	C.D.O. (W) 110-4-60



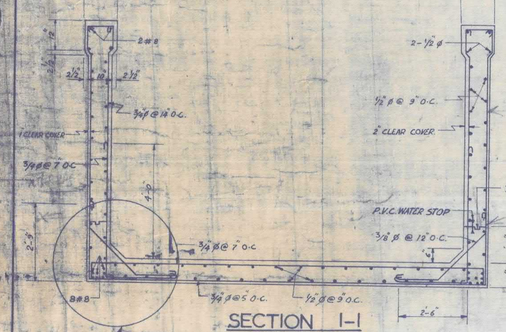
PLAN

SCALE:- 3/4"=1'-0"



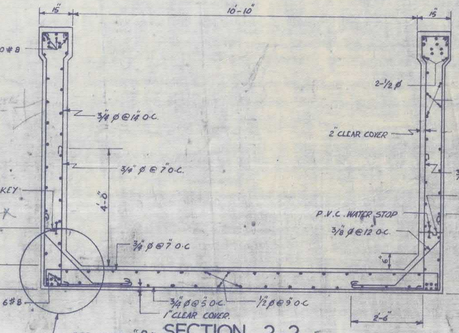
SECTION A-A

SCALE:- 3/4"=1'-0"



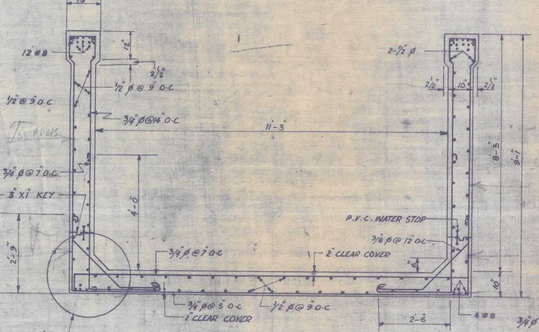
SECTION 1-1

SCALE:- 1/2"=1'-0"



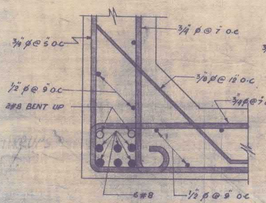
SECTION 2-2

SCALE:- 1/2"=1'-0"



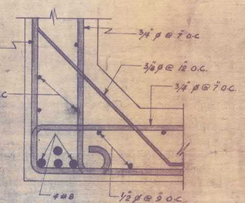
SECTION 3-3

SCALE:- 1/2"=1'-0"



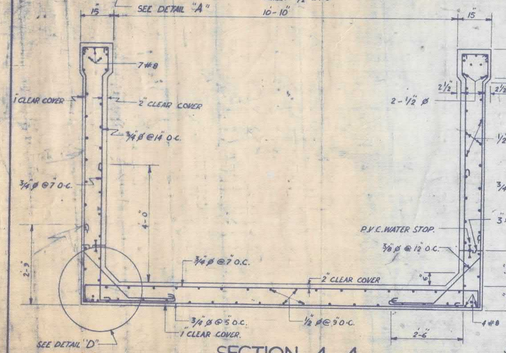
DETAIL "D"

SCALE:- 1/2"=1'-0"



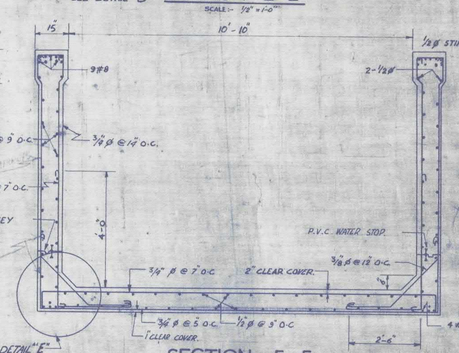
DETAIL "E"

SCALE:- 1/2"=1'-0"



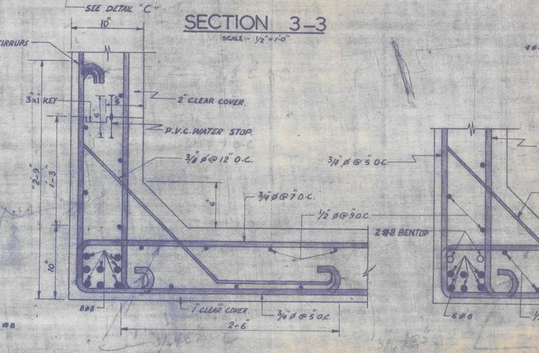
SECTION 4-4

SCALE:- 1/2"=1'-0"



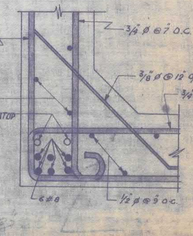
SECTION 5-5

SCALE:- 1/2"=1'-0"



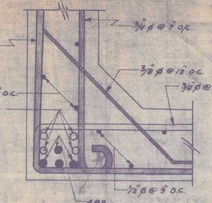
DETAIL "A"

SCALE:- 1/2"=1'-0"



DETAIL "B"

SCALE:- 1/2"=1'-0"



DETAIL "C"

SCALE:- 1/2"=1'-0"

NOTES:

1. THE CONCRETE IN REINFORCED WORK SHALL BE OF RATIO 1:2:4 AND MUST SHOW A MIN. STRENGTH OF 3000 LBS/SQ. IN. AT 28 DAYS.
2.
3.
4.

REVISION	
DATE:-	SCALE:-

WATER AND POWER DEVELOPMENT AUTHORITY

DIRECTORATE OF DESIGNS

HUB DAM PROJECT

STRUCTURAL DETAILS OF AQUEDUCT

(OVER NALLAH AT CH 183+00)

AQUEDUCT SPAN 150 FT.

DRAWN:- MOHD SALEEM	DESIGNED:-
TRACED:- MOHD SHAFI SOOMRO	SUBMITTED:-
CHECKED:-	RECOMMENDED:-
APPROVED:-	DRG. No. HD-4-25

COMPLETION DRAWING

Sub. Engineer Asst. Engineer Executive Engineer

APPROVED

Superintending Engineer

PIT NO 21

FINE SILTY SAND, LOOSE, DRY LIGHT BROWNISH

SAND WITH GRAVELS SAND IS MEDIUM TO COARSE GRAINED AND GRAVELS ARE MOSTLY FINE THESE ARE MOSTLY WELL COMPACTED BY CALCAREOUS CEMENT VERY DIFFICULT TO EXCAVATE WITH NORMAL TOOLS. IN PLACE CONDITION IN THE BOTTOM BEARING LIKE ROCK FOUNDATION.

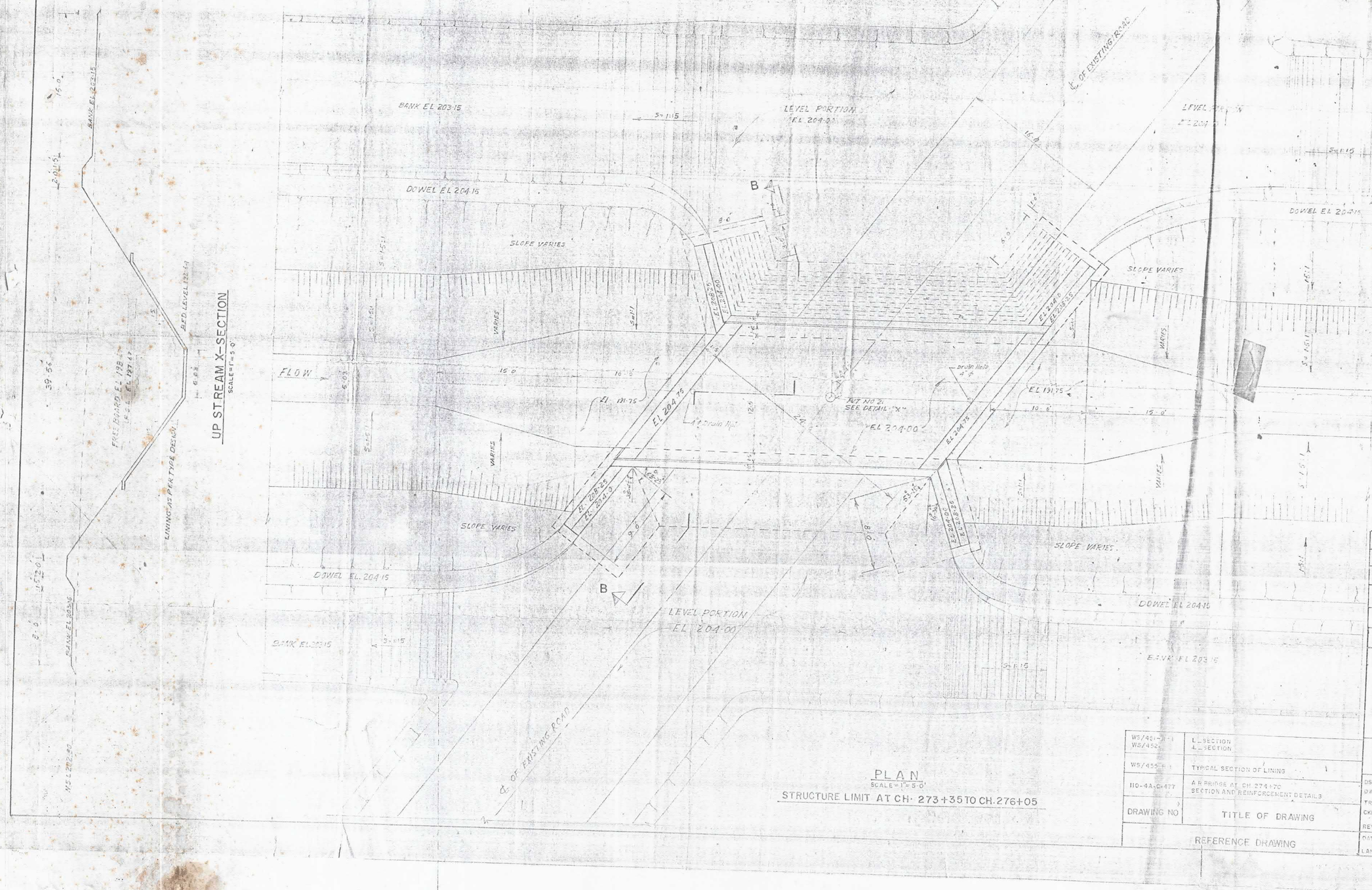
PIT COULD NOT BE EXCAVATED FURTHER DUE TO HARDNESS AND COMPACTNESS OF SAND - GRAVELS.

EL 208.80

EL 197.5

EL 190.50

DETAIL X



PLAN

SCALE = 1" = 5'-0"

STRUCTURE LIMIT AT CH. 273+35 TO CH. 276+05

UP STREAM X-SECTION

SCALE = 1" = 5'-0"

NOTES

1. CEMENT CONCRETE OF VARIOUS CLASSES SHALL HAVE MINIMUM CYLINDER STRENGTH AT 28 DAYS AS:
   CLASS A = 3000 P.S.I.
   " " B = 2500 P.S.I.
   " " C = 1500 P.S.I.
2. THE BRIDGE HAS BEEN DESIGNED FOR MS CLASS A LOADING.
3. REINFORCED CONCRETE SHALL HAVE MINIMUM COMPRESSIVE STRENGTH OF 3000 P.S.I. AS PER ASTM C-39-61 WHEN NECESSARY A.S.T.M. C 42-61
4. ALL REINFORCEMENT BARS SHALL CONFORM TO ASTM A 15-65 INTERMEDIATE GRADE WITH DEFORMATION CONFORMING TO A.S.T.M. A-305-65 WITH A MINIMUM YIELD STRESS OF 40000 LBS/□"
5. OVERLAPS SHALL BE PROVIDED WHERE NECESSARY IF NOT DETAILED OUT IN THE DRAWING THE LAP LENGTH SHALL NOT BE LESS THAN 24 X BAR DIA.
6. ALL CONSTRUCTION JOINTS IN R.C. SHALL BE WIRE AND SAND BLASTED & NEAT CEMENT LAITANCE APPLIED BEFORE FRESH CONCRETING.
7. SAFE BEARING CAPACITY HAS BEEN ASSUMED AS 15 T/S.F.
8. STONE SHALL BE LAID IN HORIZONTAL COURSE NOT LESS THAN 6" HEIGHT. ALL STONE IN COURSE SHALL BE OF EQUAL HEIGHT, UNLESS OTHERWISE SPECIFIED BUT NO COURSE SHALL BE THICKER THAN ADJACENT COURSE BELOW IT. ALL STONES SHALL BE SET FULL IN SPECIFIED MORTAR IN BED AND JOINTS.
9. THE FACE STONE SHALL BE SQUARE ON ALL JOINTS IN MASONRY. THE BEDS SHALL BE HAMMER DRESSED, TRUE AND SQUARE FOR AT LEAST 6 INCHES BACK FROM THE FACE AND THE JOINTS FOR AT LEAST 1½". THE FACE OF THE STONE SHALL BE HAMMER-DRESSED.
10. ALL SIDE JOINTS SHALL BE VERTICAL AND BEDS HORIZONTAL AND NO JOINTS SHALL BE MORE THAN ⅜" IN THICKNESS. NO PINNING SHALL BE ALLOWED ON FACE.
11. NO FACE STONE SHALL BE LESS IN BREADTH THAN ITS HEIGHT, NOR SHALL IT BE LAID IN THE WORK TO A LENGTH LESS THAN ITS HEIGHT OVER THE BED OF THE STONE SHALL BE LAID INTO THE WORK AT LEAST TWICE ITS HEIGHT OR IN WALLS THICKER THAN 2.0 THREE TIMES OF ITS HEIGHT.
12. THROUGH STONE SHALL BE INSERTED 5 TO 6 FEET APART IN EVERY COURSE AND SHALL RUN RIGHT THROUGH THE WALL NOT MORE THAN 2 FEET THICK AND THE WALL IS MORE THAN 2' THICK A TIER OF TWO OR MORE HEADERS SHALL BE LAID FROM FACE TO BACK WHICH SHALL OVERLAP EACH OTHER AT LEAST 6" THE HEADER SHALL HAVE A LENGTH OF AT LEAST 1½ TIMES THE THICKNESS OF THE COURSE.
13. STONE SHALL BREAK JOINT BY AT LEAST HALF THE HEIGHT OF THE COURSE.
14. MORTAR USED FOR STONE MASONRY SHALL BE 1:4 CEMENT SAND MORTAR.

WS/481-A-1	L-SECTION
WS/452	L-SECTION
WS/455-A-1	TYPICAL SECTION OF LINING
110-4A-C-477	A.R. BRIDGE AT CH. 274+70 SECTION AND REINFORCEMENT DETAILS
DRAWING NO	TITLE OF DRAWING
REFERENCE DRAWING	

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

A.R. BRIDGE AT CH 274+70

PLAN AND SECTION

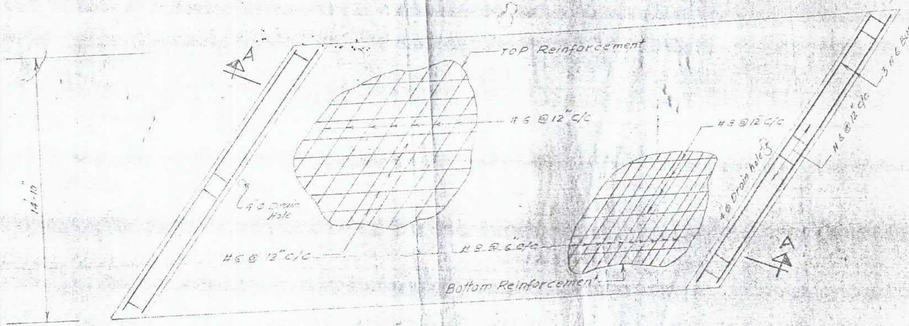
WATER AND POWER DEVELOPMENT AUTHORITY

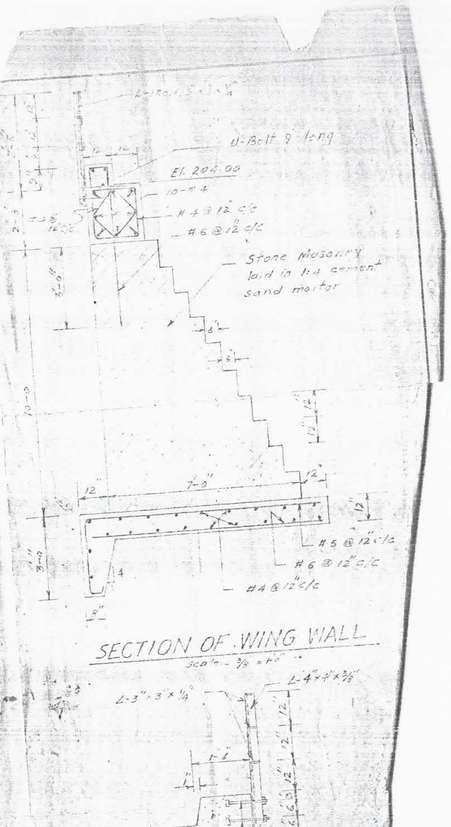
PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

DSN.		SUBMITTED	RECOMMENDED
DWN. M. SIDDIQUE			
TRD.		DEPUTY DIRECTOR	DIRECTOR DESIGN
CKD.		APPROVED	
REVD.		CHIEF ENGINEER DESIGN	

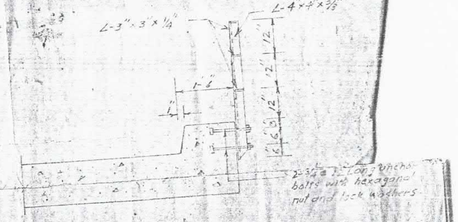
DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O. (W) 110-4A-C-476





SECTION OF WING WALL

Scale:- 3/8 = 1'-0"

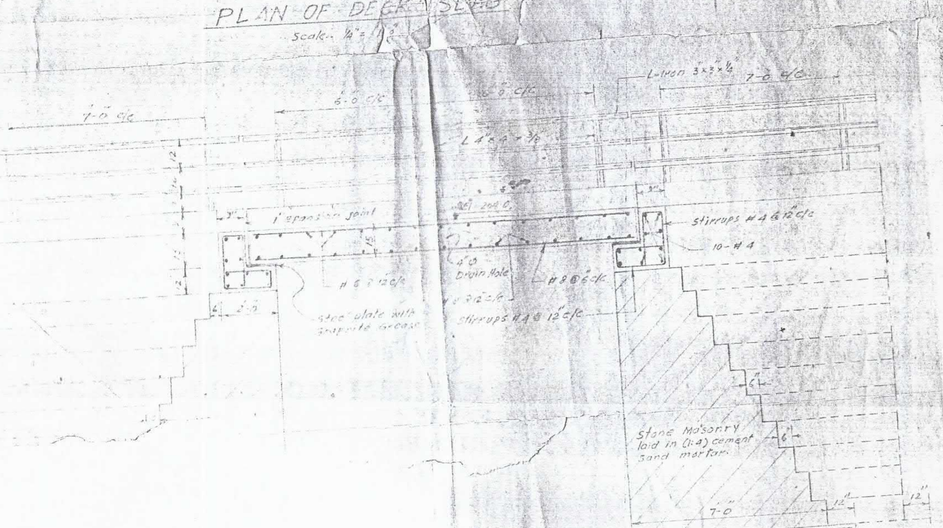


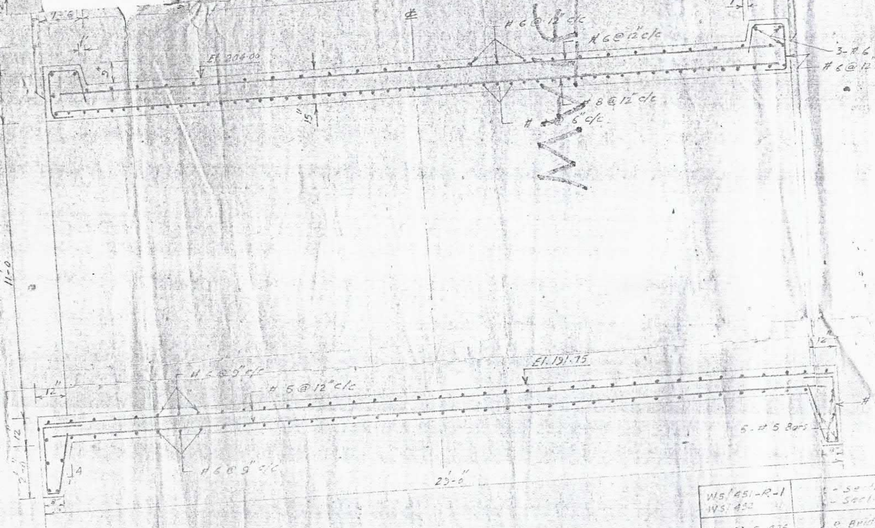
DETAIL OF RAILING

Scale:- 1/2"=1'-0"

PLAN OF DECK SLAB

Scale:- 1/4" = 1'-0"





SECTION A-A

Scale:- 3/8" = 1'-0"

COMPLETION DRAWING

Sub. Engineer | Asstt. Engineer | Executive Engineer

APPROVED

Superintending Engineer

REV. NO	DATE	DESCRIPTION	BY	CKD	APPD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CS)

A.R. BRIDGE AT CH. 274+70

SECTION AND REINFORCEMENT DETAI

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN	
DWN	M.SATTAR
TRD	
CKD	
REVD	

SUBMITTED — DEPUTY DIRECTOR
RECOMMENDED — DIRECTOR DE
APPROVED — CHIEF ENGINEER DESIGN

DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W.DES	C.D.O.(W)110-4

DRAWING NO	TITLE OF DRAWING
WS-451-R-1 WS-452 110-4A-C-476	L-Section C-Section A.R. Bridge at ch. 274+70 Plan & Section

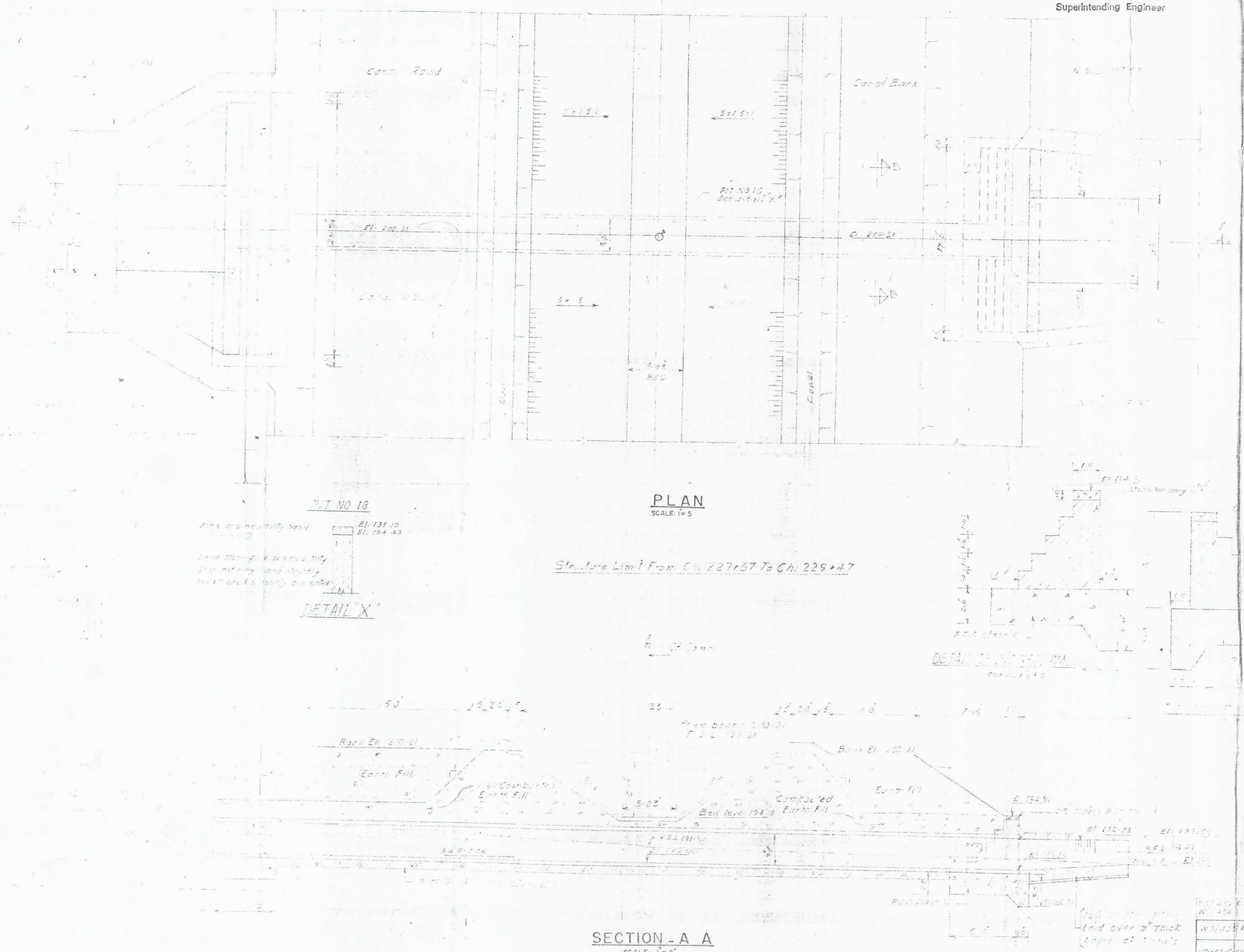
REFERENCE DRAWING

COMPLETION DRAWING

Sub. Engineer Asstt. Engineer Executive Engineer

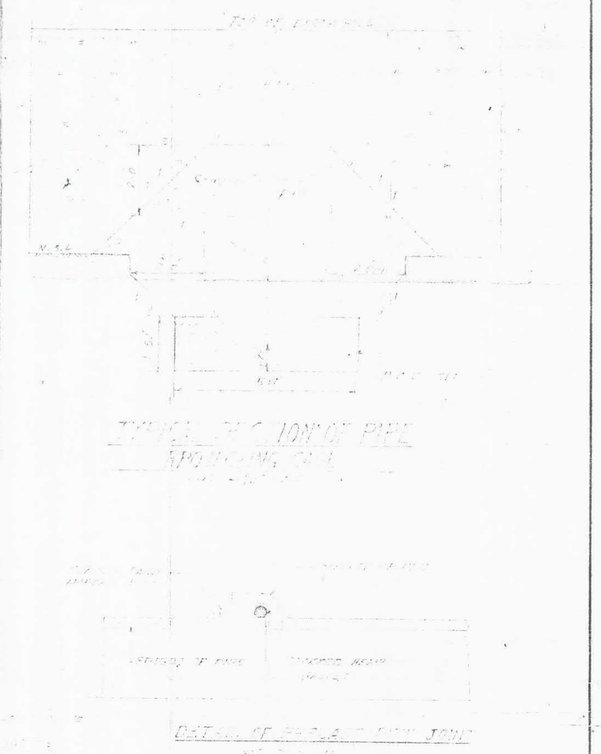
APPROVED

Superintending Engineer



PLAN
SCALE: 1"=5'

SECTION - A A
SCALE: 1"=5'



REV. NO.	DATE	DESCRIPTION	BY	CKD.	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 228+42

Q = 35.0 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

W.S/45 R.1	Typical Sections of Lining
110-4A-C-464	Drainage X-ing at Ch. 29+57
DRG. NO.	TITLE

REFERENCE DRAWINGS

DSN.
DWN. MUNIR AHMAD RAO D.M.
TRD.
CKD.
REVD.

SUBMITTED
DEPUTY DIRECTOR

RECOMMENDED
DIRECTOR DESIGN

APPROVED
CHIEF ENGINEER DESIGN

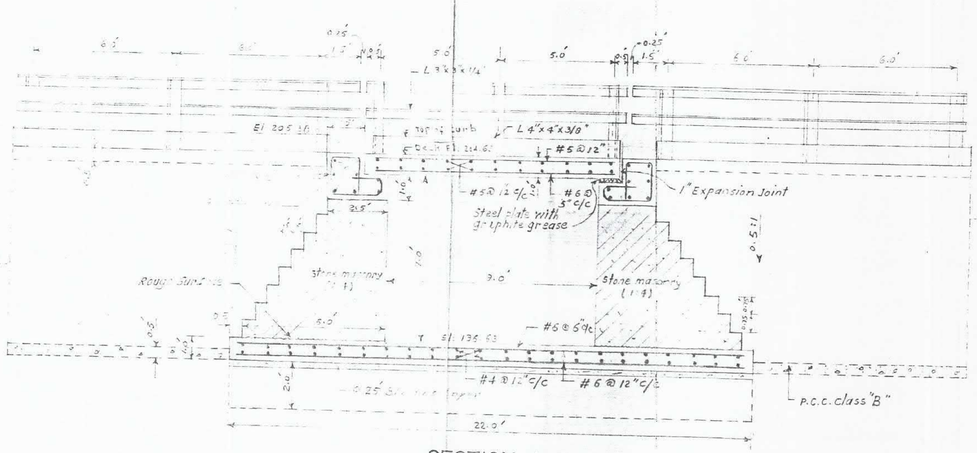
DATE 24-11-79	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES.	C.D.O. (W) 110-4A-C-475

COMPLETION DRAWING

Sub. Engineer Ass't. Engineer Executive Engineer

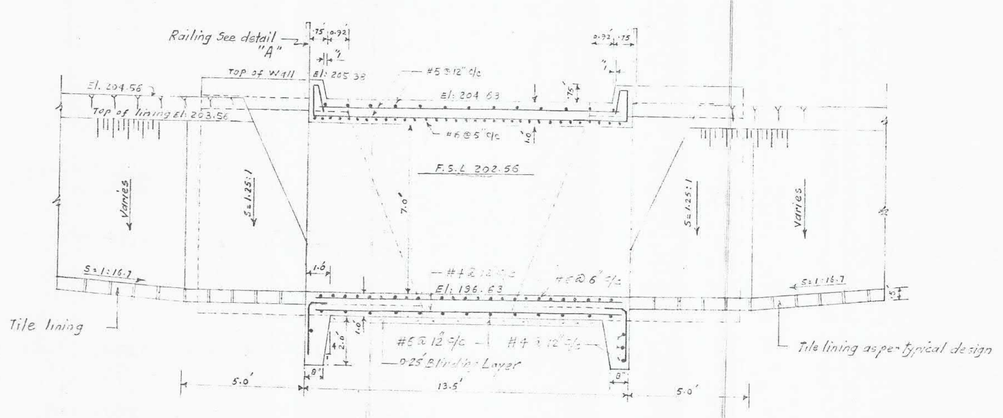
APPROVED

Superintending Engineer



SECTION A-A

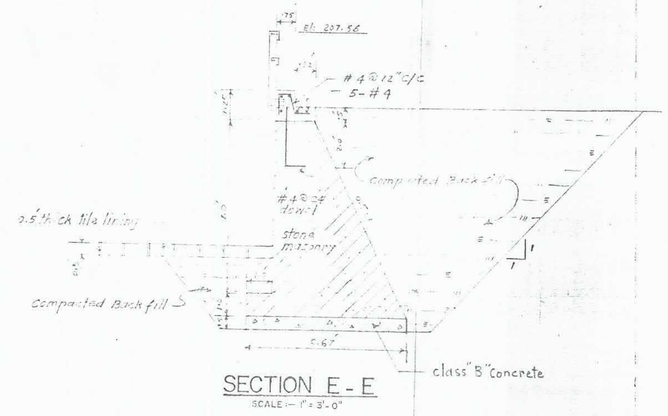
SCALE :- 1" = 3'-0"



SECTION B-B

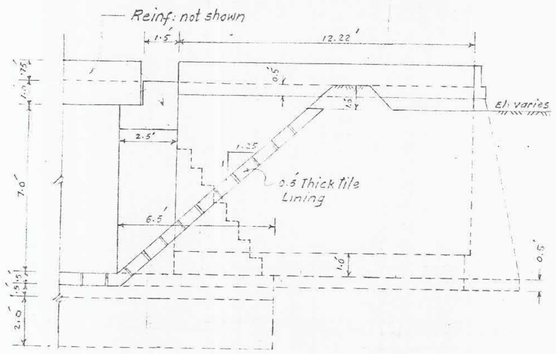
SCALE :- 1" = 3'-0"

BORE HOLE LOG AT CH 128+00



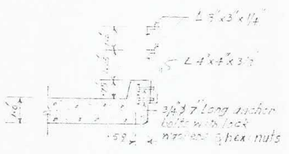
SECTION E-E

SCALE :- 1" = 3'-0"



SECTION C-C

SCALE: 1" = 3'-0"



DETAIL "A"

SCALE :- 1" = 3'-0"

REV NO.	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

VILLAGE ROAD CULVERT AT CH. 128+00

REINFORCEMENT DETAILS & SECTIONS

110-4A-C-451R2	Longitudinal Section from ch. 0+00 to 149+76
110-4A-C-479	Plan Of Village Road Culvert at ch: 128+00
DRAWING NO	TITLE OF DRAWING

REFERENCE DRAWING

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN. ---
DWN. GHULAM MUSTAFA D.H.D
TRD ---
CKD ---
REVD ---
DATE 23-5-80
LAHORE PAKISTAN
JOB NO 110
INDEX NO 4-A
FILE NO W.W DES
DRAWING NO. C.D.O(W)110-4 A-G480

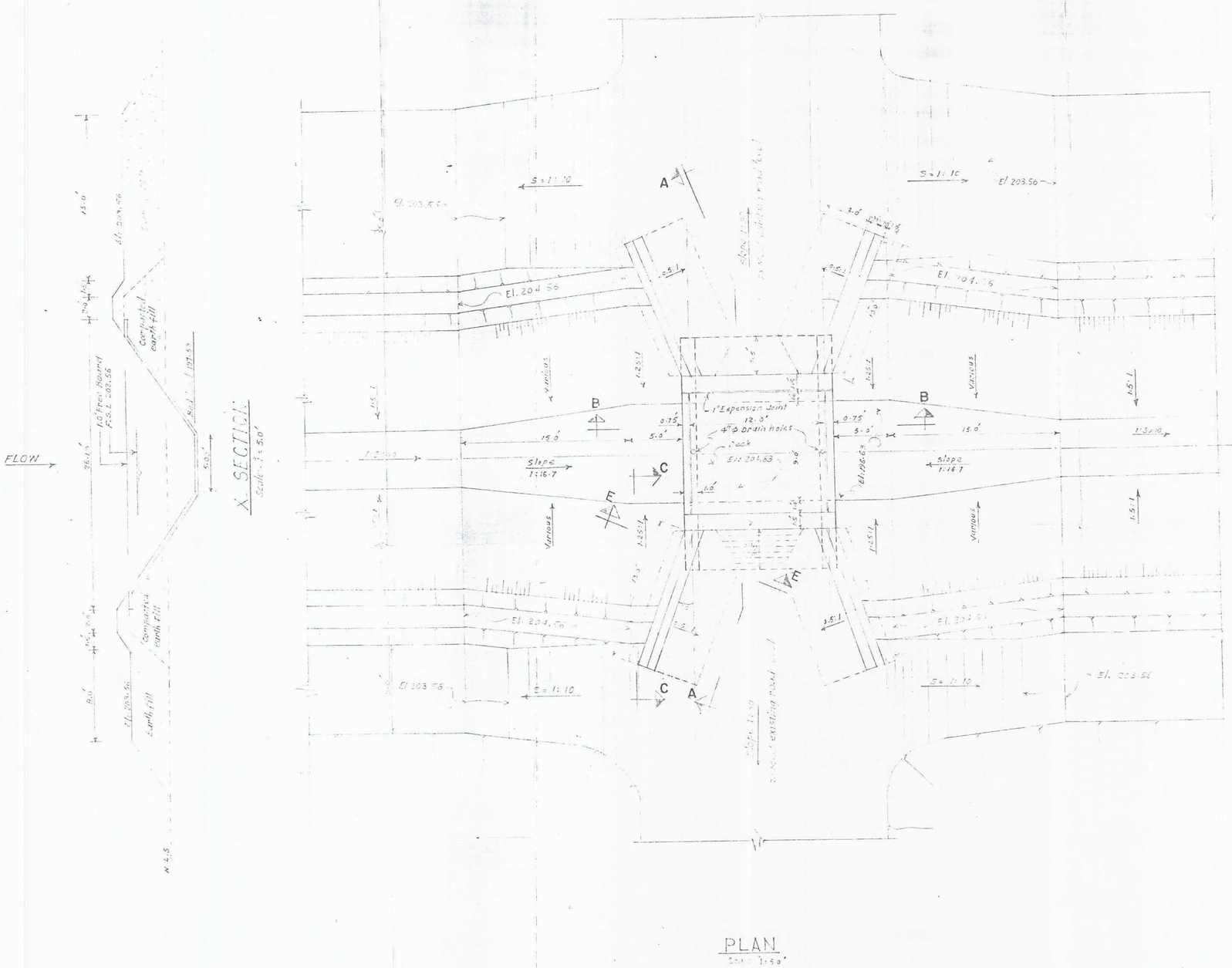
SUBMITTED ---
RECOMMENDED ---
DEPUTY DIRECTOR
DIRECTOR DESIGN
APPROVED ---
CHIEF ENGINEER DESIGN

COMPLETION DRAWING

Sub. Engineer Asst. Engineer Executive Engineer

APPROVED

Superintending Engineer



NOTES -

110-4A-C-451 R2	Longitudinal Section from ch 0+00 to 149+76
110-4A-C-480	Village Road Culvert at ch 128+00 Reinforcement Detail & Sections.
DRAWING NO.	TITLE OF DRAWING
	REFERENCE DRAWING

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

PLAN OF VILLAGE ROAD CULVERT AT CH. 128+00

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

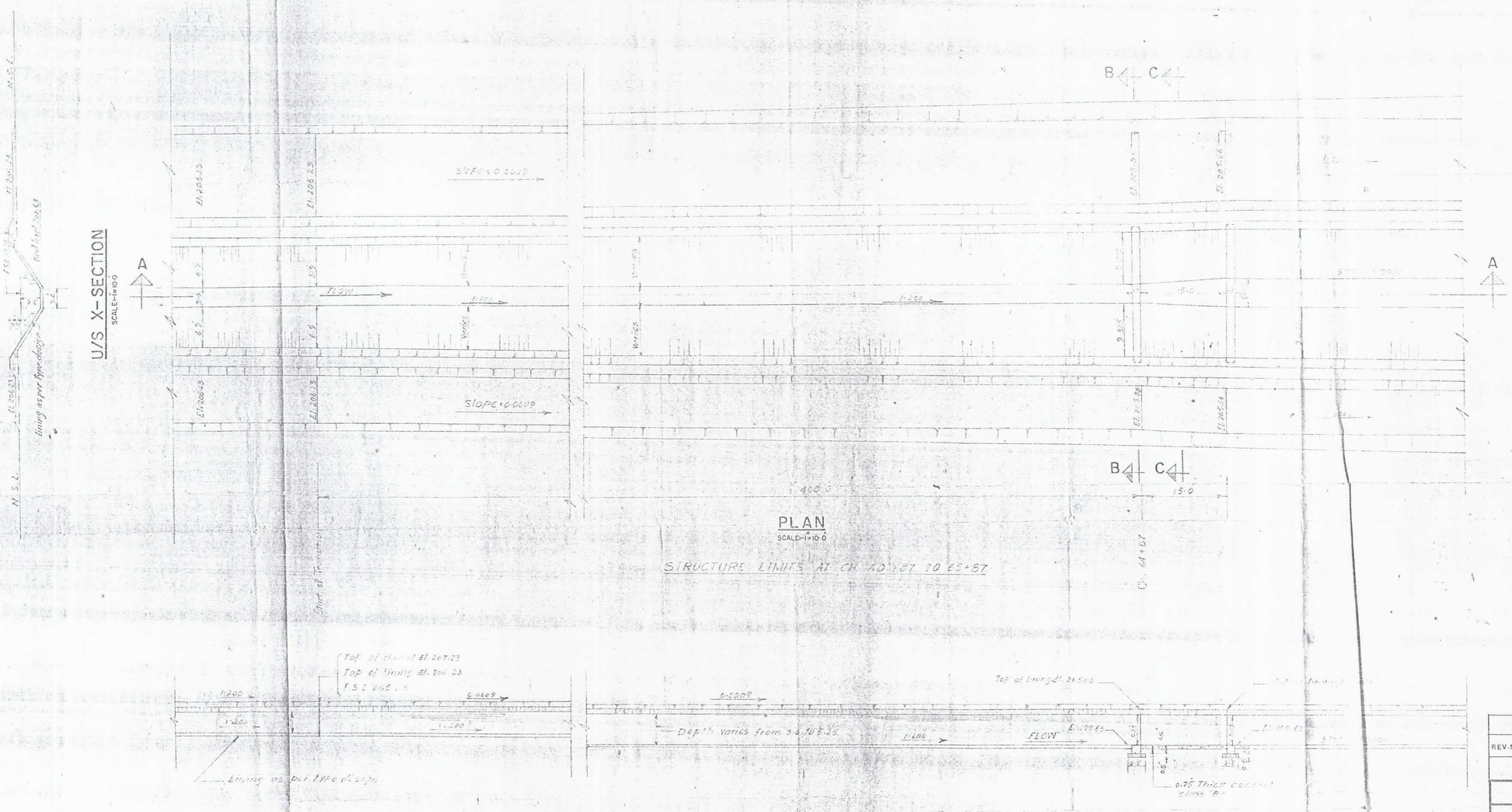
DSN.		SUBMITTED	RECOMMENDED
DWN. GHULAM MUSTAFA D.H.D		DEPUTY DIRECTOR	DIRECTOR DESIGN
TRD.		APPROVED	
CKD.		CHIEF ENGINEER DESIGN	
REVD.			
DATE 23-5-[illegible]	JOB NO 110	INDEXING 4-A	FILE NO DRAWING NO.
LAHORE PAKISTAN		ARCHIVES	C.D.O (W) 110-4A-C 479

COMPLETION DRAWING

Sub. Engineer | Asstt. Engineer | Executive Engineer

APPROVED

Superintending Engineer



REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD
		REVISION			

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

TRANSITION AT CH. 64 + 87

PLAN AND SECTIONS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

110-44-C-458	PLAN OF DRAINAGE X-ING AT CH. 5+30
W.S.451 R-I W.S.452	L-SECTION OF WATER SUPPLY CANAL
WS/455 R-I	TYPICAL SECTION OF LINING
DRG. NO.	TITLE

REFERENCE DRAWING

DSN. _____
DWN. REHMAT BARI TRACER
TRD. _____
CKD. _____
REVD. _____

SUBMITTED _____ RECOMMENDED _____
DEPUTY DIRECTOR DIRECTOR-DESIGN
APPROVED _____
CHIEF ENGINEER DESIGN

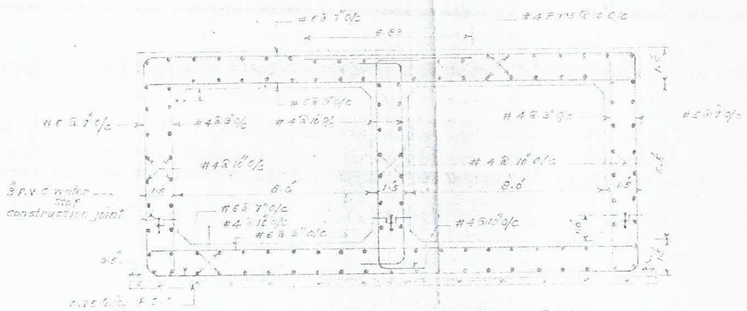
DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
2-12-1979 LAHORE PAKISTAN	110	4-A	W.W.DES.	C.D.O. (W)110-44-C-474

COMPLETION DRAWING

Sub. Engineer Asst. Engineer Executive Engineer

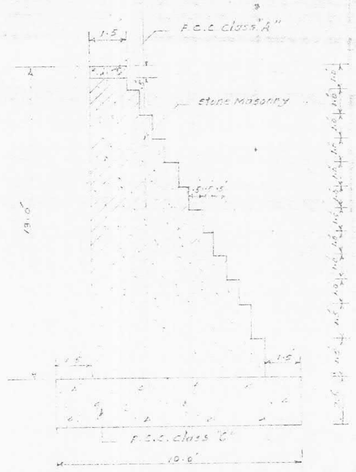
APPROVED

Superintending Engineer



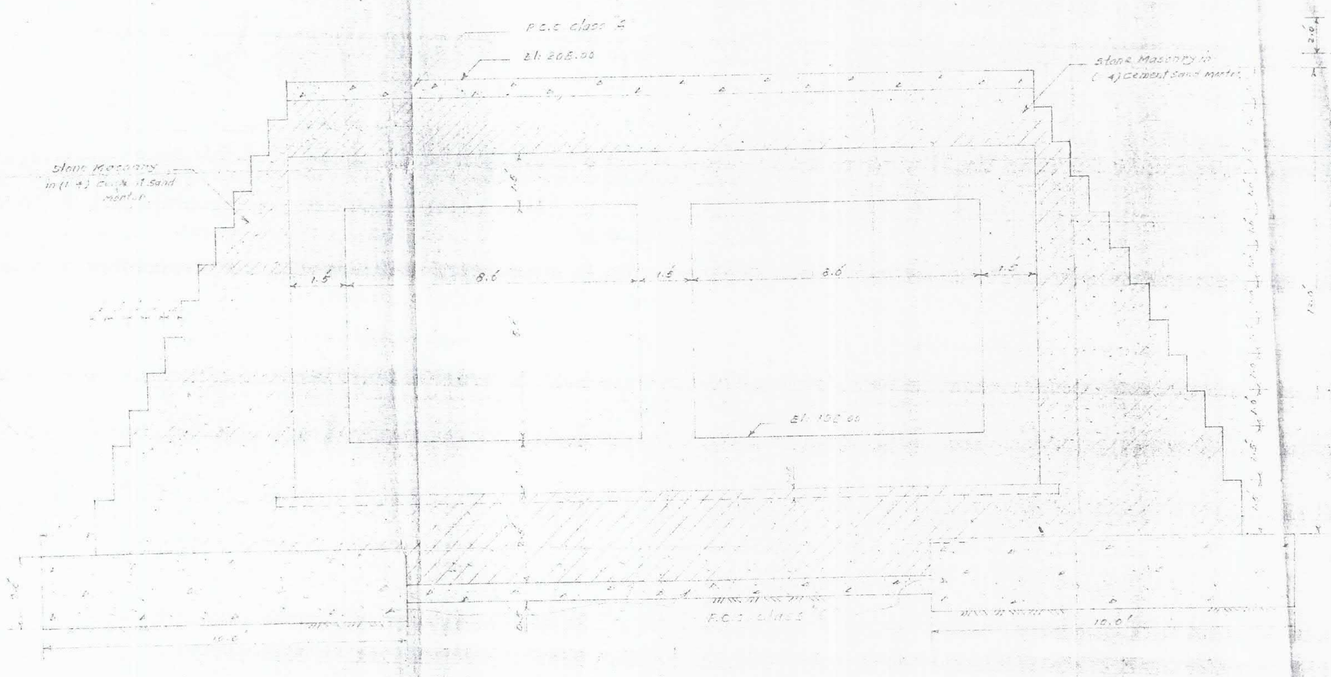
REINF. DETAILS OF DOUBLE BARREL

Scale: 1" = 3.0'



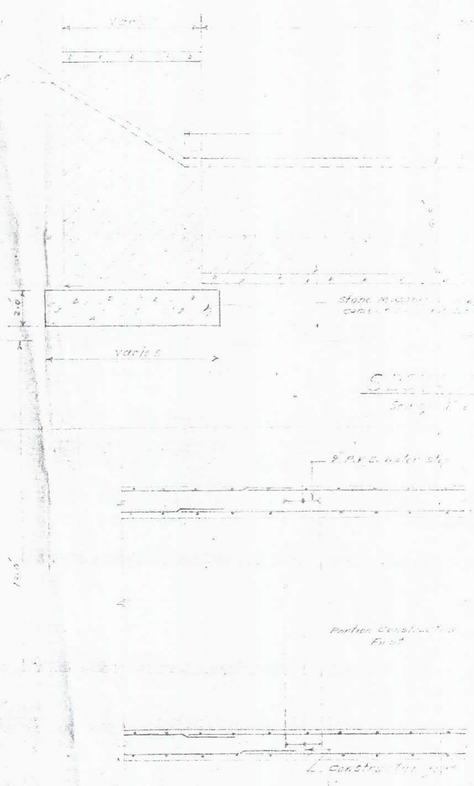
TYPICAL SECTION OF U/S & D/S WING WALL

Scale: 1" = 3.0'



SECTION B-B

Scale: 1/2" = 1.0'

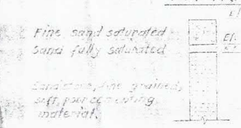


DETAIL OF CONSTRUCTION JOINT

TO BE PROVIDED BY CONTRACTOR AT HIS DISCRETION

DETAIL OF EXPANSION JOINT

PIT No 16



REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)
DRAINAGE CROSSING AT CH 50+06
DETAIL OF CONDUIT AND WING WALLS
Q = 1400 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DRAWING NO	TITLE OF DRAWING
W.S. 451	
W.S. 452	
W.S. 453	
W.S. 454	

REFERENCE DRAWING

DSN. GHULAM MUSTAFA D.H.D
DWN.
TRD.
CKD.
REVD.

SUBMITTED. DEPUTY DIRECTOR
RECOMMENDED DIRECTOR DESIGN
APPROVED CHIEF ENGINEER DESIGN

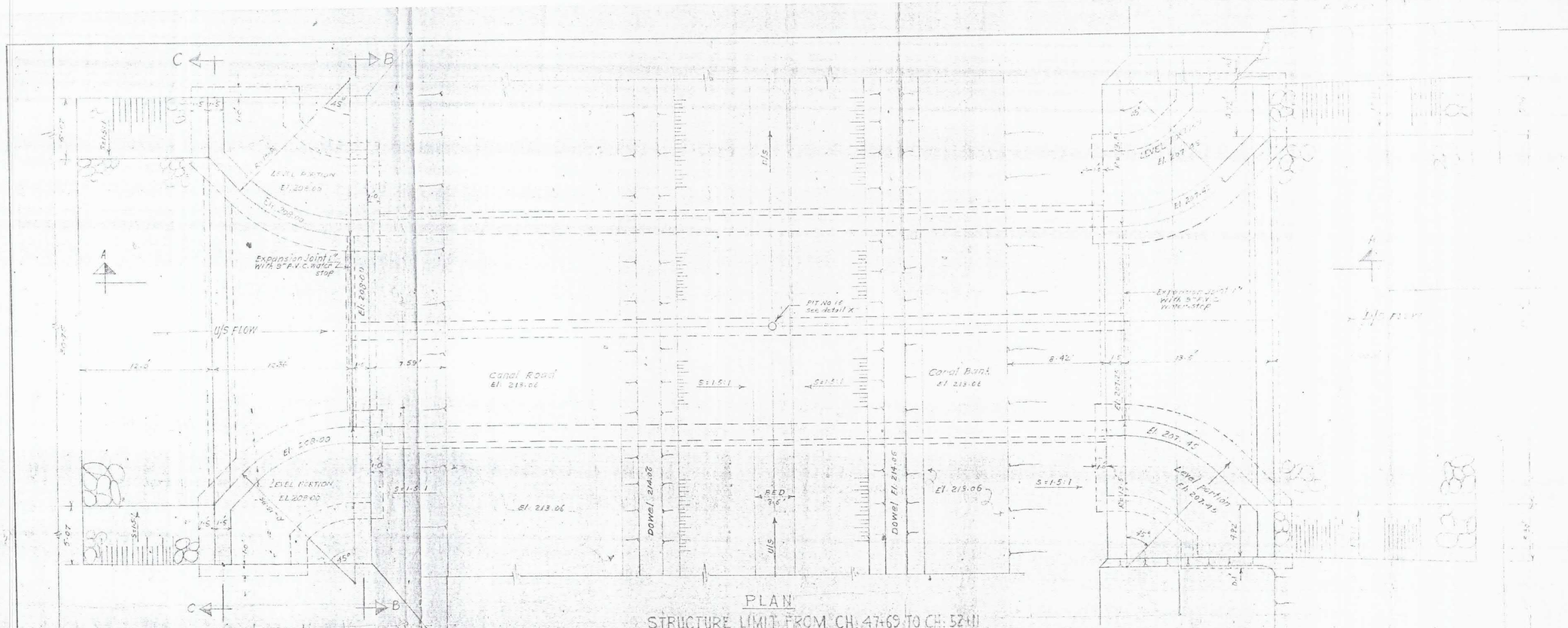
DATE	JOB NO.	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O. (W) 110-4A-C-473

COMPLETION DRAWING

Sub. Engineer Asstt. Engineer Executive Engineer

APPROVED

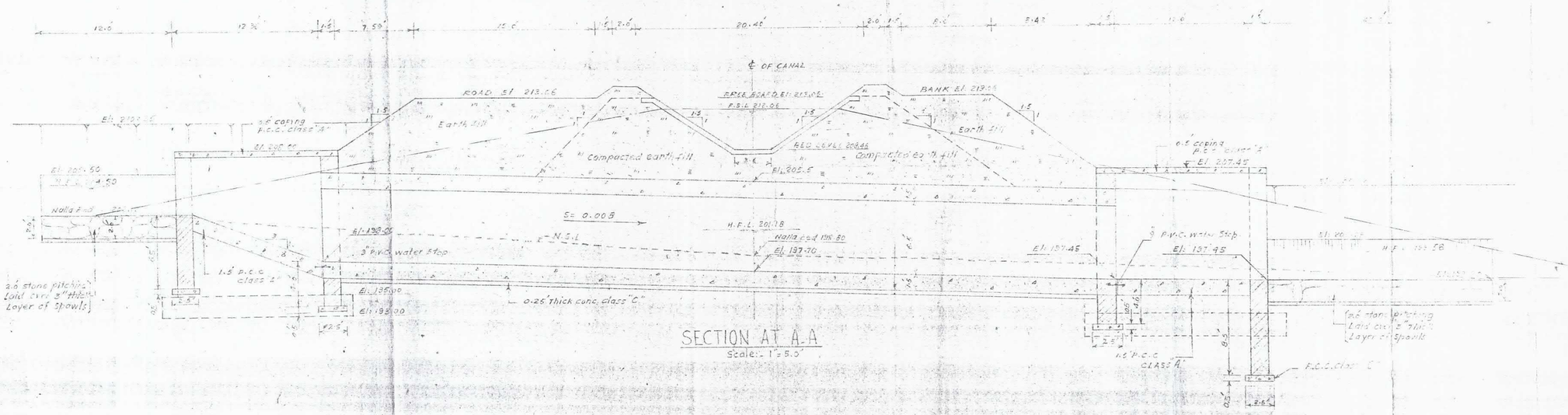
Superintending Engineer



PLAN

STRUCTURE LIMIT FROM CH: 47+69 TO CH: 52+11

(REFER DRGS. NO. C.D.O. (W) WS/451, 452 & 455)



SECTION AT A-A

Scale:- 1"=5.0'

NOTE

See note 4 on drawing no. C.D.O.(W)110-4A-C-471

W.S. 451 R-1 W.S. 452	L-SECTION OF CANAL
W.S. 455 R-1	TYPICAL SECTION OF CANAL LINING
110-4A-C-473	DRAINAGE X-ING AT CH: 50+06 DETAIL OF CONDUIT AND WING WALLS

REFERANCE DRAWING

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL

(210 CUSECS)

PLAN AND SECTION OF DRAINAGE X-ING AT CH: 50+06

Q = 1400 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY

PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

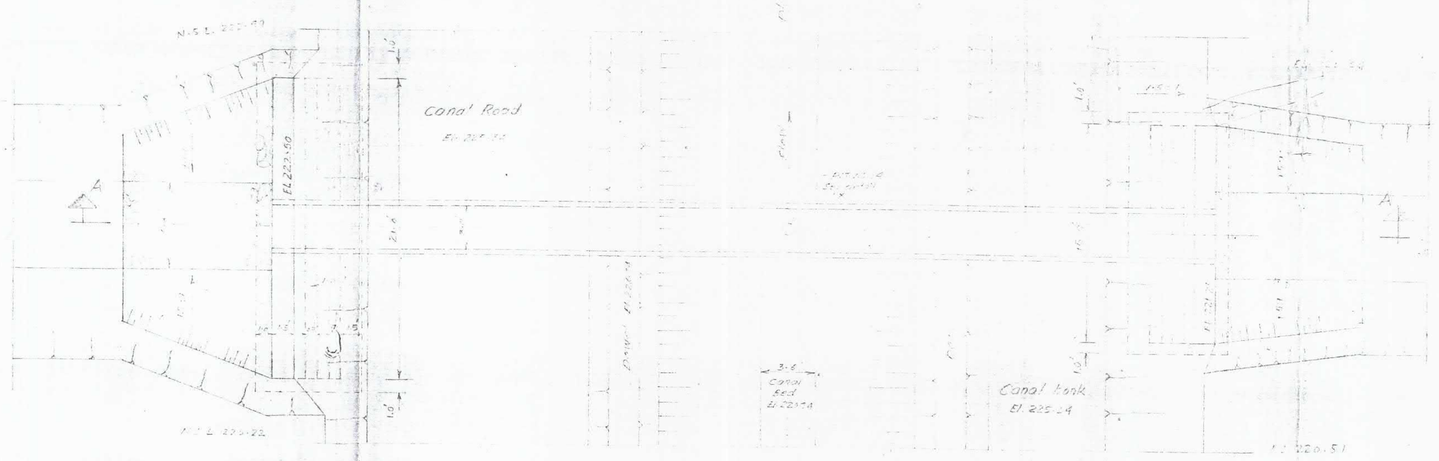
DSN.		SUBMITTED.		RECOMMENDED.	
DWN. GHULAM MUSTAFA D.H.D					
TRD.		DEPUTY DIRECTOR		DIRECTOR DESIGN	
CKD.		APPROVED			
REVD.		CHIEF ENGINEER DESIGN			
DATE 20-11-79 LAHORE PAKISTAN	JOB NO 110	INDEX NO 4-A	FILE NO W.W.DES	DRAWING NO. C.D.O.(W)110-4A-C-472	

COMPLETION DRAWING

Sub. Engineer Asst. Engineer Executive Engineer

APPROVED

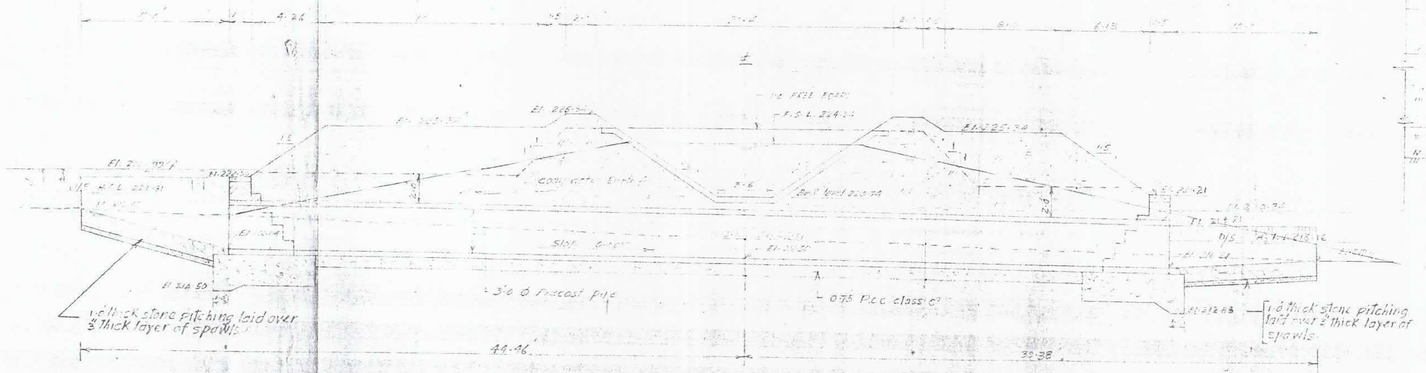
Superintending Engineer



PLAN

Scale 1"=20'

STRUCTURE LIMIT FROM CH. 42-48 TO CH. 43-41

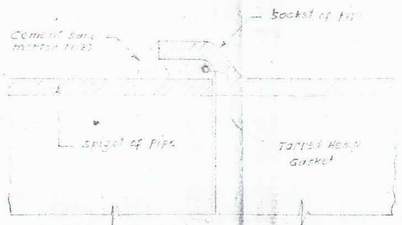

Cement mortar 1:3
Concrete 1:2:4
Earth
Concrete

COMPLETION DRAWING

Sub. Engineer Asstt. Engineer Executive Engineer

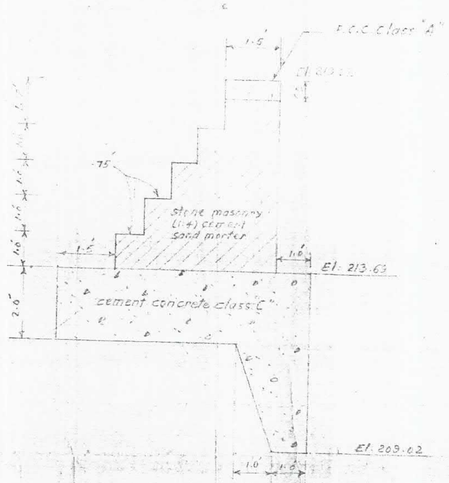
APPROVED

Superintending Engineer



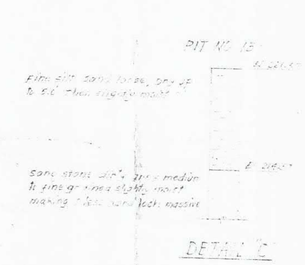
DETAIL OF PRECAST PIPE JOINT

NOT TO SCALE

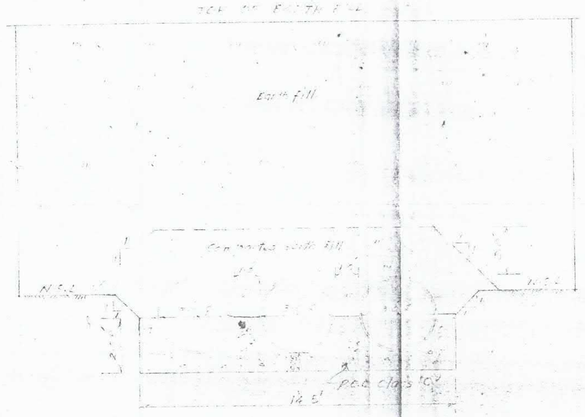


DETAIL OF D/S HEAD WALL

SCALE: 1/2" = 1.0'

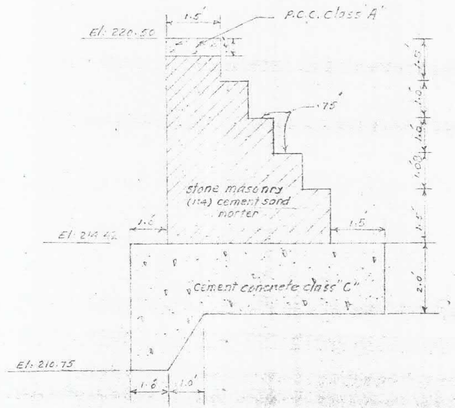


DETAIL 'C'



TYPICAL SECTION OF PIPE PROJECTION CASE

SCALE 1" = 5'-0"



DETAIL OF U/S HEAD WALL

SCALE: 1/2" = 1.0'

Sheet 2 of 2

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 38+92

DETAIL OF JOINT AND HEAD WALLS

Q=150 CS.

WATER AND POWER DEVELOPMENT AUTHORITY

PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

W-5.495 R.I W-5.495	L SECTION OF CANAL
W-5.495 R.I	TYPICAL SECTIONS OF LINING
110-4A-C-464	DRAINAGE CROSSINGS AT CH. 23+97
110-4A-C-468	DRAINAGE X-ING PLAN & SECTION CH. 38+92
DRAWING NO	TITLE OF DRAWING

REFERENCE DRAWING

DSN

DWN. GHULAM MUSTAFA

TRD. D.H.D

CKD

REVD.

SUBMITTED

DEPUTY DIRECTOR

RECOMMENDED

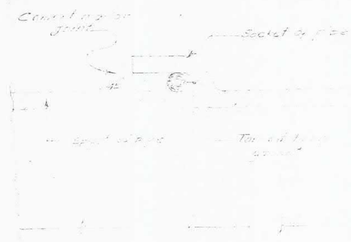
DIRECTOR DESIGN

APPROVED

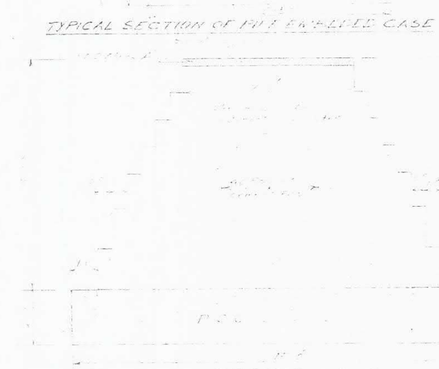
CHIEF ENGINEER DESIGN

DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	1140	4-A	W.W.DES	C.D.O.(W)110-4A-C-469

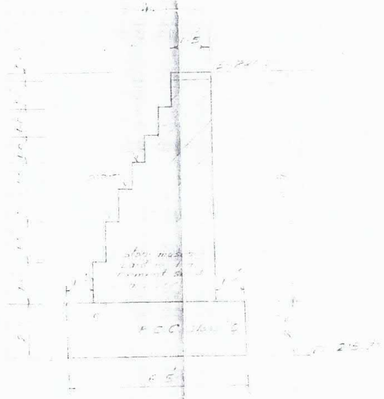
TYPICAL SECTION OF PIPE
PROJECTING CASE
Scale: 1/2" = 1'



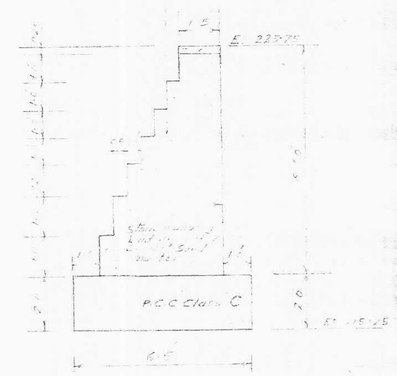
JOINT OF PRECAST PIPE



TYPICAL SECTION OF PIPE ENTRENCHED CASE



TYPICAL SECTION OF WING WALL E.L.



DETAIL SECTION OF WING WALL D/S

PIT NO. 9

DETAIL "X"

SECTION C-C

COMPLETION DRAWING

Sub. Engineer Asstt. Engineer Executive Engineer
APPROVED
Superintending Engineer

W.S. 451R-1 W.S. 452	L- SECTION OF CANAL
W.S. 455 R-1	TYPICAL SECTION OF LINING
110-4A-C-464	DRAINAGE X-ING AT CH. 29+57
110-4A-C-466	DRAINAGE X-ING AT CH. 33+72
DRAWING NO	TITLE OF DRAWING
REFERENCE DRAWING	

REV. NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 33+72
DETAIL OF JOINT AND WING WALLS
DISCHARGE OF NALA 87 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN
DWN MUHAMMAD RIAZ D/M
TRD
CKD
REVD

SUBMITTED RECOMMENDED
DEPUTY DIRECTOR DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

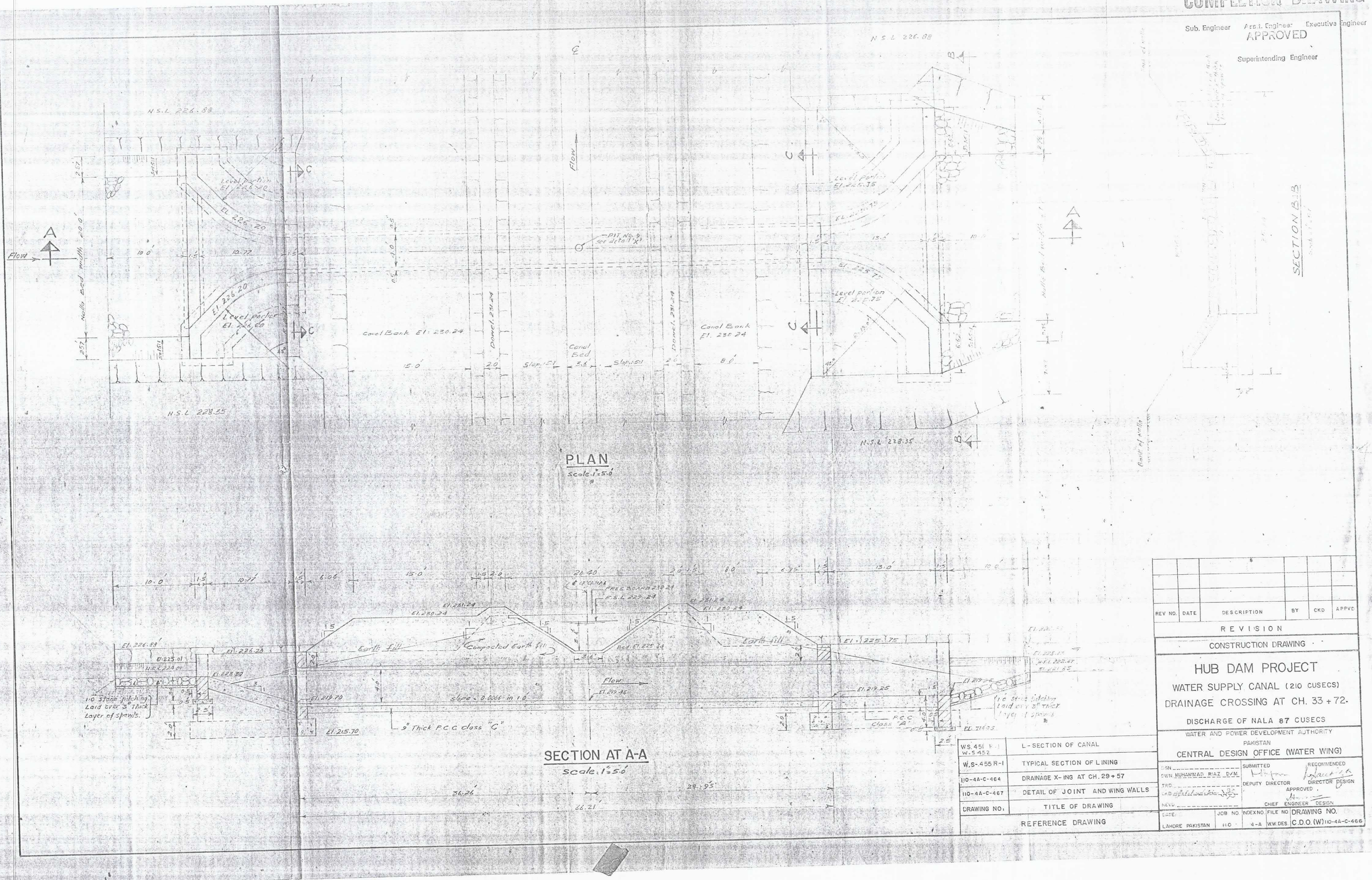
DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W.DES	C.D.O.(W)110-4A-C-467

COMPLETION DRAWING

Sub. Engineer | Asst. Engineer | Executive Engineer

APPROVED

Superintending Engineer



PLAN

Scale 1"=5.0'

SECTION AT A-A

scale 1"=5.0'

W.S. 451 R-I W.S 452	L-SECTION OF CANAL
W.S-455 R-I	TYPICAL SECTION OF LINING
110-4A-C-464	DRAINAGE X-ING AT CH. 29+57
110-4A-C-467	DETAIL OF JOINT AND WING WALLS
DRAWING NO.	TITLE OF DRAWING

REFERENCE DRAWING

REV NO.	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 33+72.

DISCHARGE OF NALA 87 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY

PAKISTAN

CENTRAL DESIGN OFFICE (WATER WING)

DSN

DWN MUHAMMAD RIAZ D/M

TRD

LAD

REVD

SUBMITTED

DEPUTY DIRECTOR

RECOMMENDED

DIRECTOR DESIGN

APPROVED

CHIEF ENGINEER DESIGN

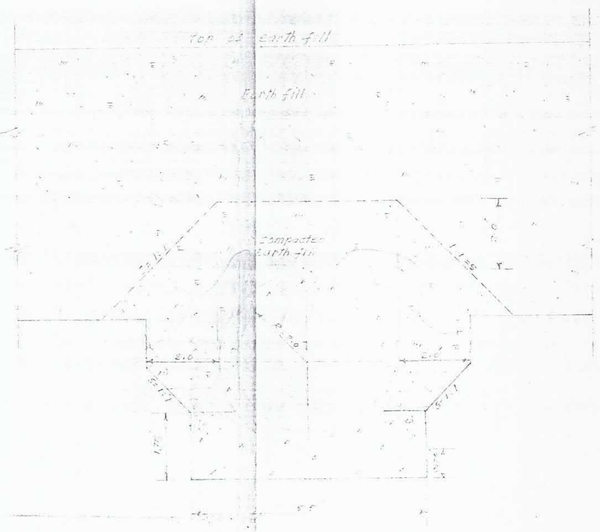
DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	WW.DES	C.D.O.(W) 110-4A-C-466

COMPLETION DRAWING

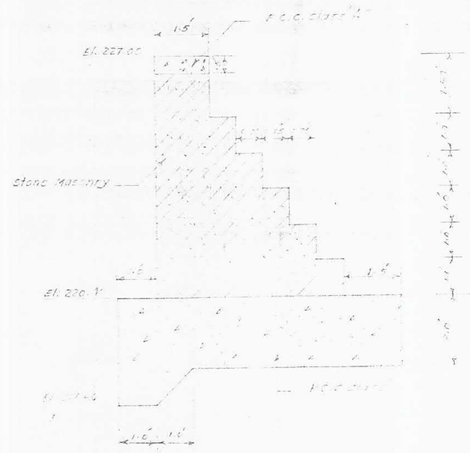
Sub. Engineer Asst. Engineer Executive Engineer

APPROVED

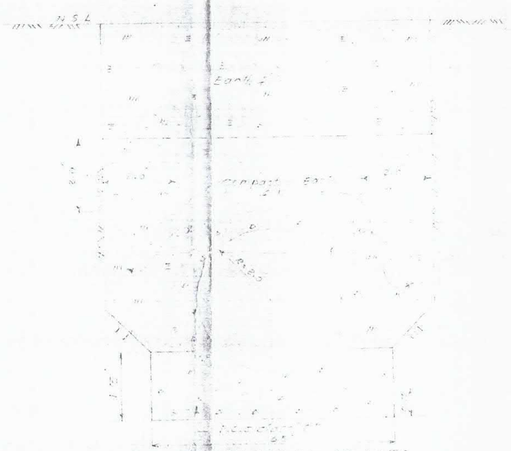
Superintending Engineer



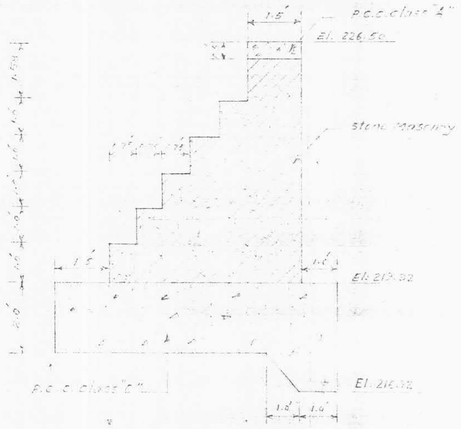
TYPICAL SECTION OF PIPE
PROJECTING CASE
Scale:- 1" = 2'



U/S HEAD WALL
Scale:- 1" = 2'



TYPICAL SECTION OF PIPE
EMBEDDED CASE
Scale:- 1" = 2'



D/S HEAD WALL
Scale:- 1" = 2'

REV. NO.	DATE	BY	DESCRIPTION	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT
WATER SUPPLY CANAL (210 CUSECS)
DRAINAGE CROSSING AT CH.29+57
SECTION & JOINTS OF PRECAST PIPE
Q = 110 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DRG. NO.	TITLE

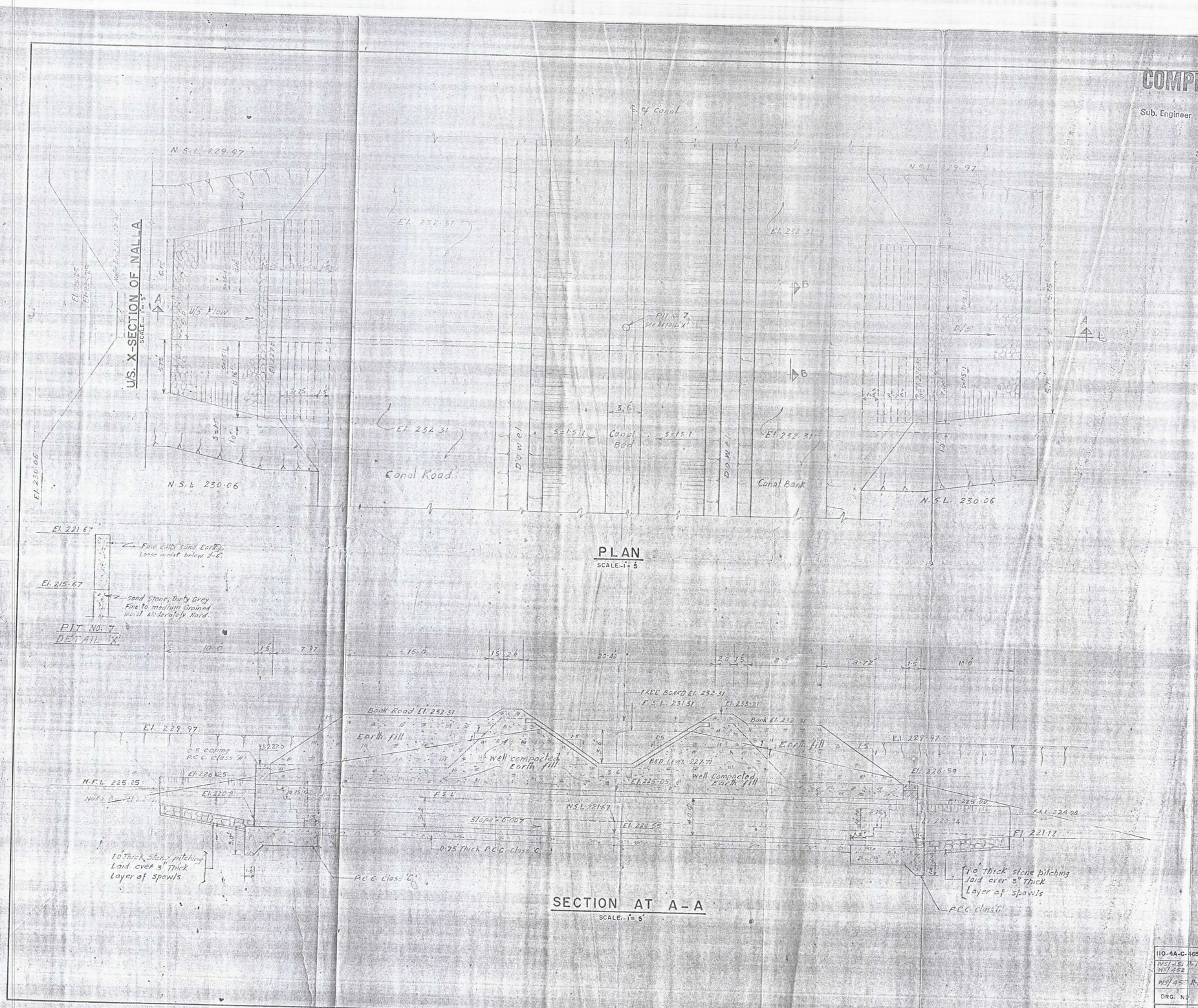
REFERENCE DRAWINGS

DSN. GHULAM MUSTAFA
DWN.
TRD.
CKD.
REVD.

SUBMITTED
DEPUTY DIRECTOR
RECOMMENDED
DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
5-12-1979	110	4A	W.W. DES.	C.D.O. (W) 110-4A-C-465

LAHORE PAKISTAN



COMPLETION DRAWING

Sub. Engineer | Ass't. Engineer | Executive Engineer

APPROVED

Superintending Engineer

NOTES:-

1. Strength of various classes of concrete at 28 days in Class - 'A' 3000 lbs. P.S.I. cylinder strength (ii) Class 'C' 1500 lbs. " " "
2. The depth of cut-off walls should be as shown, unless encountered by sound rock before that depth is achieved, in which case, the cut-off walls should be carried to the depth at which the rock is encountered, and proper bond should be established between rock surface and wall footing.
3. Precast R.C.C. pipes will conform to A.S.T.M. specification C 76-61 T class 'D' Wall B. These will be designed for a working head of 100 ft of water and a test pressure of 200 ft. of water.
4. Pipe joints will be bell and spigot type as shown on the drawing.
5. The invert of the concrete cradle shall be left about ½ lower than the finished level throughout and after the R.C.C. pipe has been laid and levelled thereon, the space between the underside of the pipes and invert of the cradle shall be carefully grouted solid with a thin grout consisting of 1 1½ cement mortar, in such a manner that no void shall be left, and the pipe shall rest throughout their length and breadth on the cradle. The cradle will be shaped appropriately at the joints.
6. The concrete cradle shall be allowed to set for at least 5 days before any pipe is placed on it.
7. Backfilling around the pipe will be done in 6" layers to a depth of 2 ft above the pipe. Each layer will be watered and tamped carefully.
8. Concrete Design and Construction shall conform to the Provision of A.C.I. Building Code (A.C.I. - 318-63)
9. Safe bearing capacity has been assumed as 1.5 T/□'.
10. Stone shall be laid in horizontal courses not less than 6" height. All stones in course shall be equal height unless otherwise specified, but no course shall be thicker than the course below it. All stone shall be set full in specified mortar in bed and joint.
11. The stone shall be square on all joints in masonry. The beds shall be hammer or chisel dressed true and square for at least 3" back from face, and the joints for at least 1½". The face of the stone shall be hammer dressed and bushing not to project more than 1½".
12. All sides joints shall be vertical and beds horizontal and no joint shall be more than 3/8" in thickness. No pinning shall be allowed.
13. No face stone shall be less in breadth than its height nor shall it be laid into the work to a length lesser than its height. 1/3rd of the stone stone shall be laid into the work, atleast twice its height or in wall thicker than three times of its height.
14. Through stones shall be inserted 5 ft to 6 ft apart in every course and shall run right through the wall 2 ft thick. When the wall is more than 2 ft thick a line of two or more headers shall be laid from face to back which overlap each other atleast 6", the headers shall have a length of atleast 3 times of its height.
15. Stone shall break joint by atleast half the height of the course.
16. Mortar used for stone masonary work shall be 1:4 cement sand mortar.
17. The contractor for structure will also complete the excavation and lining of canal portion within structure limits.

NO.	DATE	BY	DESCRIPTION	APPVD.

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

DRAINAGE CROSSING AT CH. 29+57

Q = 110 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

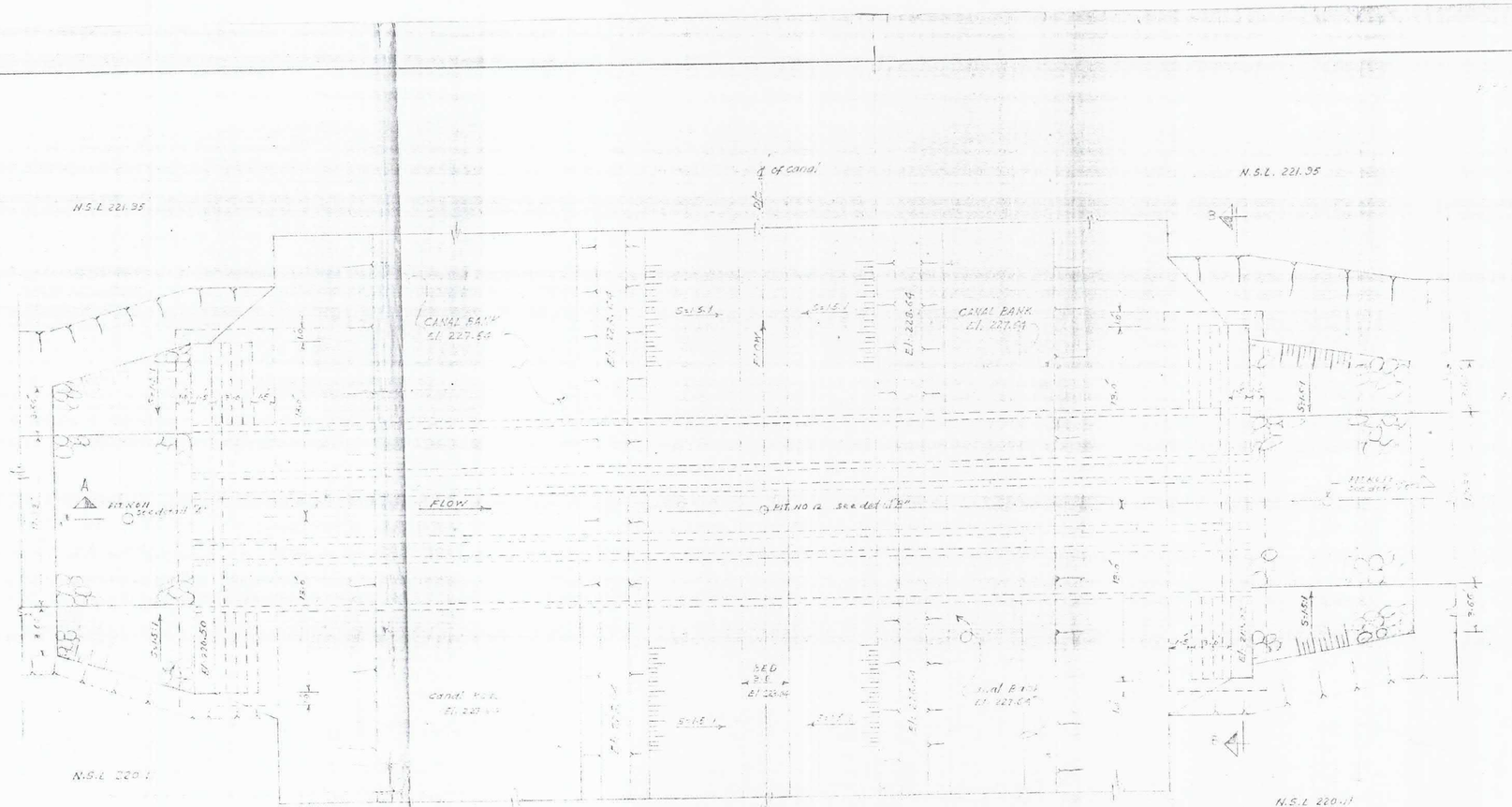
110-4A-C-465	SECTION & JOINTS OF PRECAST PIPE
WS/45 R-1 WS/452	L-SECTION OF CANAL
WS/45 R-1	TYPICAL SECTIONS OF LINING
DRG. NO	TITLE

REFERENCE DRAWINGS

DSN
DWN Munir Ahmad Rao D.M.
TRD
CKD
REVD 20-X-79

SUBMITTED — DEPUTY DIRECTOR
RECOMMENDED — DIRECTOR DESIGN
APPROVED — CHIEF ENGINEER DESIGN

DATE 18-11-79	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES	C.D.O (W) 110-4A-C-464

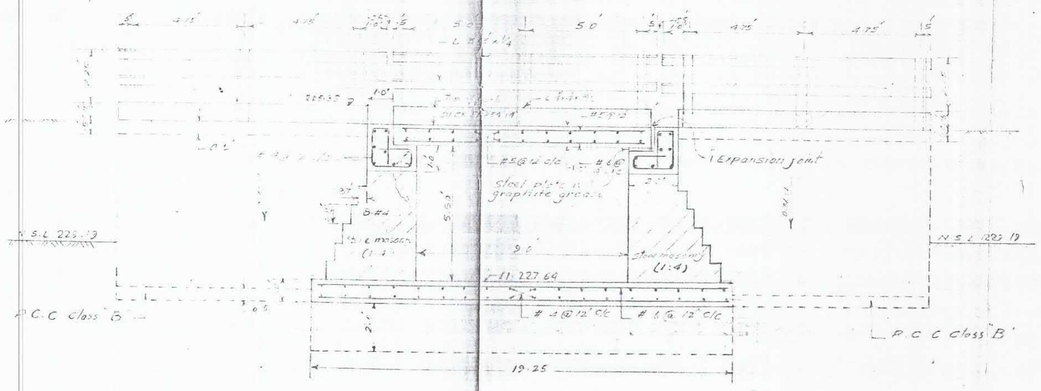

N.S.L. 221.35
℄ of canal
CANAL BANK EL. 227.64
CANAL BANK EL. 227.64
FLOW
EL. 228.64
EL. 230.50
EL. 230.50
EL. 227.64
EL. 227.64
EL. 220.64
EL. 220.64
EL. 220

COMPLETION DRAWING

Sub. Engineer Asst. Engineer Executive Engineer

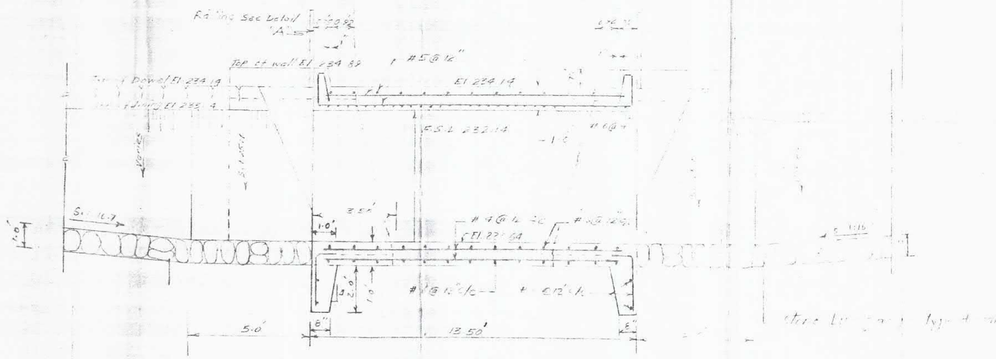
APPROVED

Superintending Engineer



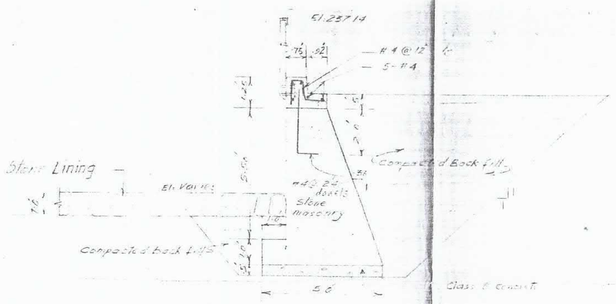
SECTION A-A

Scale 1" = 3'-0"



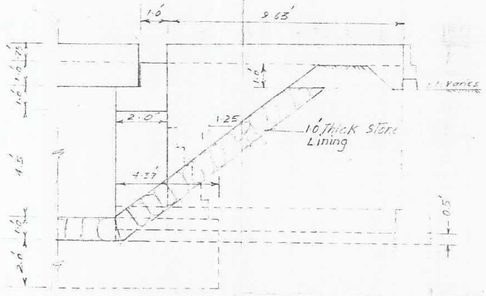
SECTION B-B

Scale 1" = 3'-0"



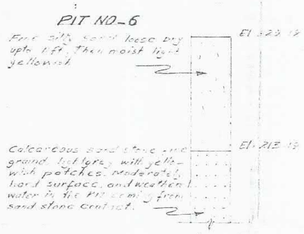
SECTION E-E

Scale 1" = 3'-0"



SECTION C-C

Scale 1" = 3'-0"



DETAIL "X"

DETAIL "A"

WS/451-R-1 WS/452-	L. SECTION OF CANAL
W.S. 455-R-1	TYPICAL SECTIONS OF LINING
110-4A-C-462	PLAN OF VILLAGE ROAD CULVERT
DRAWING NO.	TITLE OF DRAWING
REFERENCE DRAWING	

REV NO.	DATE	DESCRIPTION	BY	CKD.	APPVD
1	25.9.80	Abutment Caps Revised on Sections A-A & C-C	[illegible]	[illegible]	[illegible]

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

VILLAGE ROAD CULVERT AT CH. 28+17

REINFORCEMENT DETAILS & SECTIONS

WATER AND POWER DEVELOPMENT AUTHORITY.
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

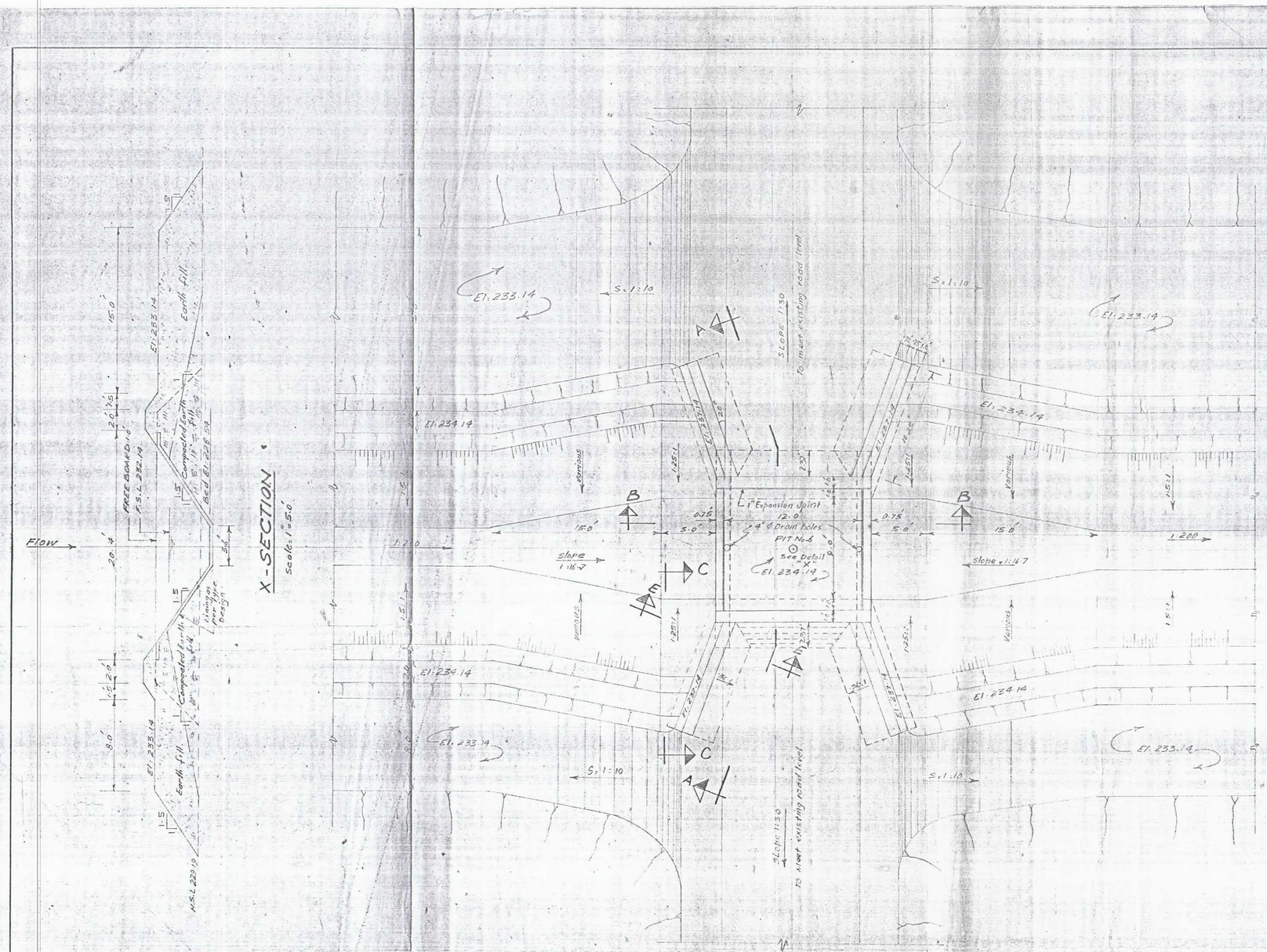
DSN
DWN. MOHAMMAD RIAZ
TRD.
CKD.
REVD.

SUBMITTED
DEPUTY DIRECTOR

RECOMMENDED
DIRECTOR DESIGN

APPROVED
CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W. DES.	C.D.O (W) 110-4A-C-463 R-1



COMPLETION DRAWING

Sub. Engineer Asstt. Engineer Executive Engineer

APPROVED

Superintending Engineer

NOTES:

1. The under mentioned design for [illegible] drawing
2. [illegible] compressive strength [illegible]
3. [illegible] ASTM A 615 Grade 60 [illegible]
4. [illegible] shall be provided with [illegible]
5. [illegible] shall be [illegible]
6. Superimposed [illegible]
7. Stone shall be laid in horizontal courses not less than 6 [illegible]
8. [illegible] square on all joints in masonry. The [illegible]
9. [illegible] of the stone shall be hammer-dressed [illegible]
10. [illegible] shall be [illegible]
11. [illegible] shall be [illegible]

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISIONS

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)

PLAN OF VILLAGE ROAD CULVERT AT CH. 28 + 17

W.S. 451 R-1 W.S. 452	L - SECTION OF CANAL
W.S. 455-R-1	TYPICAL SECTION OF LINING
110-4A-C-463	VILLAGE ROAD CULVERT AT CH. 28+17 REINFORCEMENT DETAILS & SECTIONS
DRAWING NO.	TITLE OF DRAWING
REFERENCE DRAWING	

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN		SUBMITTED	RECOMMENDED
DWN	MOHAMMAD RIAZ		
TRD		DEPUTY DIRECTOR	DIRECTOR DESIGN
CKD		APPROVED	
REVD		CHIEF ENGINEER DESIGN	

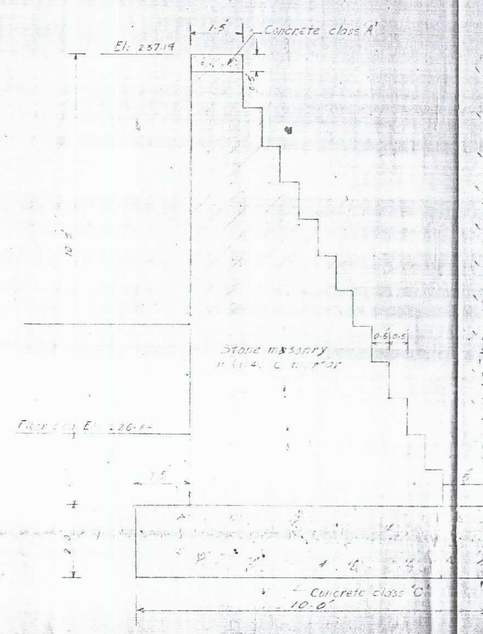
DATE	JOB NO	INDEX NO	FILE NO	DRAWING NO.
LAHORE PAKISTAN	110	4-A	W.W.DES	C.D.O (W) 110-4A-C-462

COMPLETION DRAWING

Sub. Engineer Asst. Engineer Executive Engineer

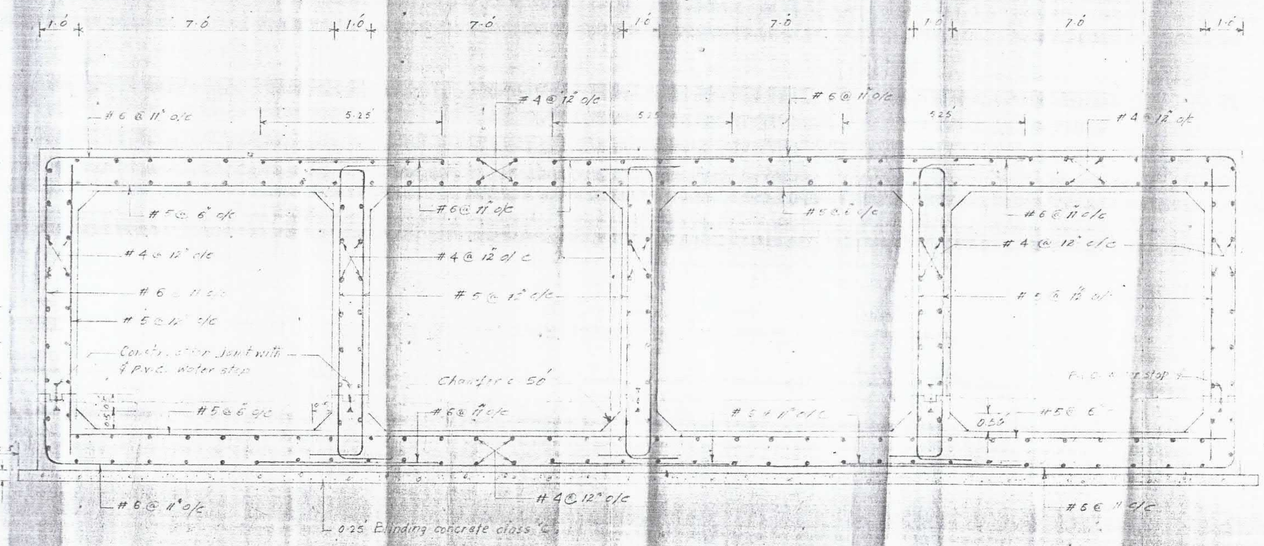
APPROVED

Superintending Engineer

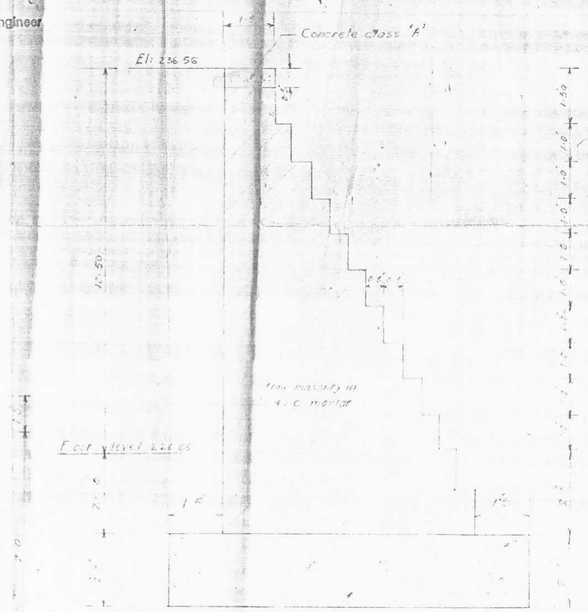


DETAIL OF U/S WING WALL

SCALE: 1/2" = 1'-0"

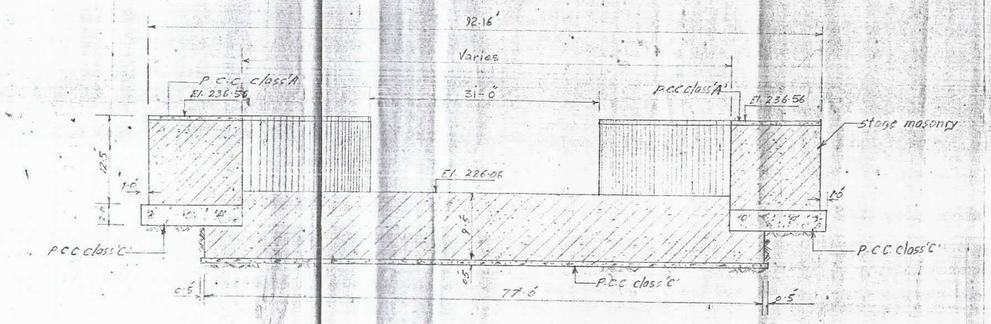


DETAILS OF R.C.C. CONDUIT (4 BARELS)



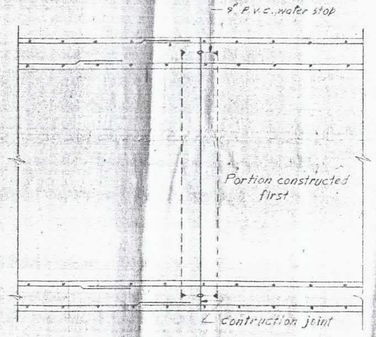
DETAIL OF D/S WING WALL

SCALE: 1/2" = 1'-0"



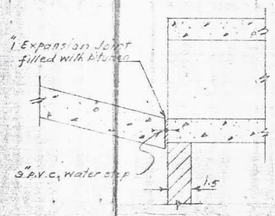
SECTION D-D

Scale: 1" = 10'-0"



DETAIL OF CONSTRUCTION JOINT

TO BE PROVIDED BY CONTRACTOR AT HIS DISCRETION



DETAIL OF EXPANSION JOINT

(Not to scale)

REV. NO.	DATE	DESCRIPTION	BY	CKD.	APPVD.

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL (210 CUSECS)
DRAINAGE CROSSING, SECTIONS,
DETAIL OF CONDUIT AND WING WALL
AT CH: 15+00 Q = 2750 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

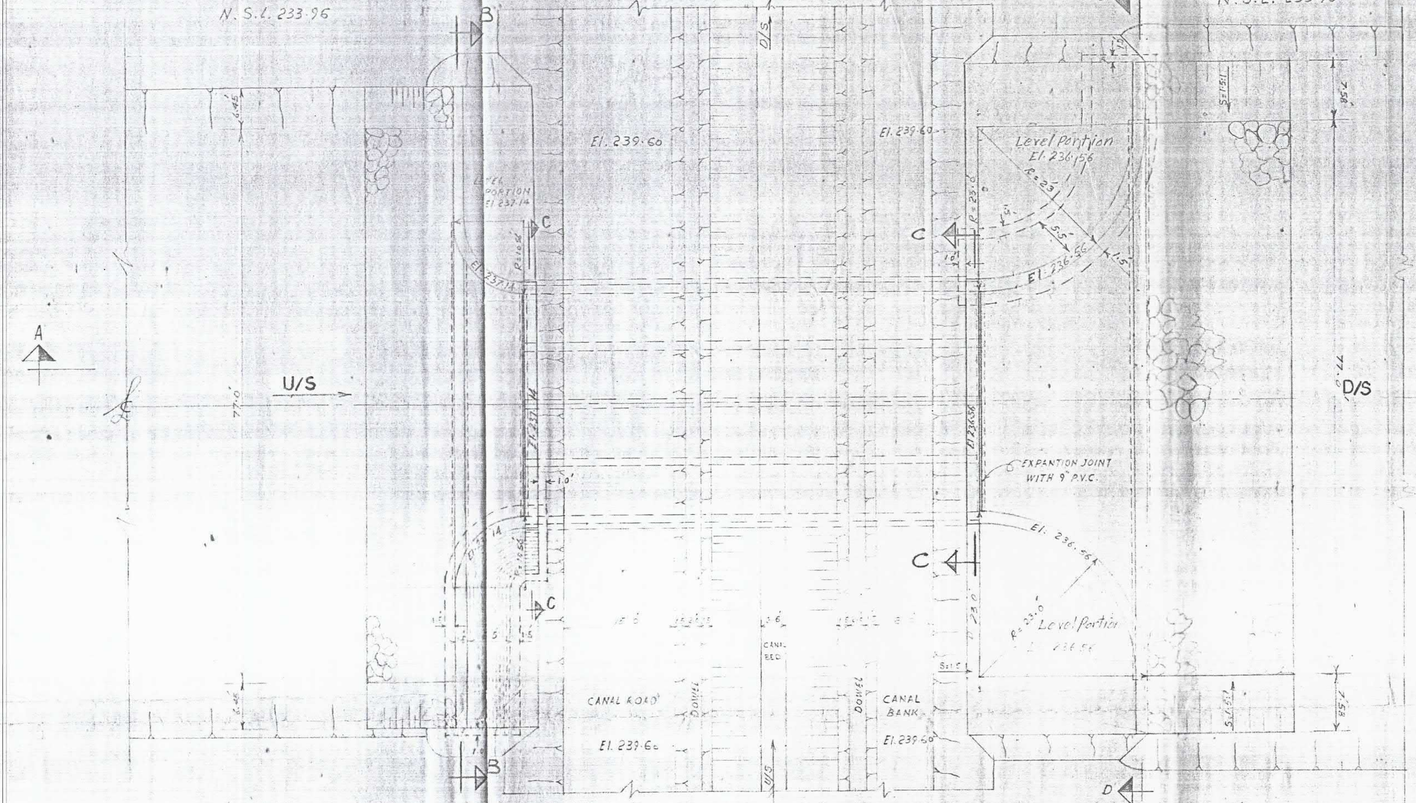
W.S./451 & 452	L-SECTION OF CANAL
W.S./455	TYPICAL SECTION OF LINING
110-4A-C-458	PLAN OF DRAINAGE X-ING AT CH: 5+30
110-4A-C-460	DETAIL OF CONDUIT AND WING WALLS
DRAWING NO.	TITLE OF DRAWING

REFERENCE DRAWING

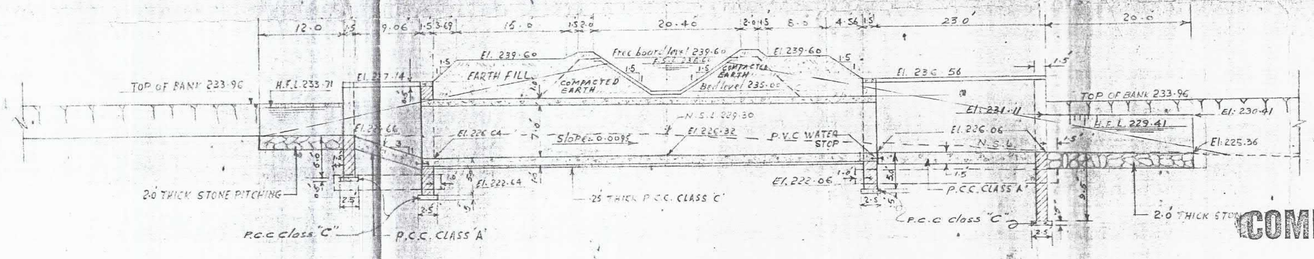
DSN. ----------
DWN. S.I.H. Munir Kar
TRD. ----------
CKD. ----------
REVD. ----------

SUBMITTED: DEPUTY DIRECTOR
RECOMMENDED: DIRECTOR DESIGN
APPROVED: CHIEF ENGINEER DESIGN

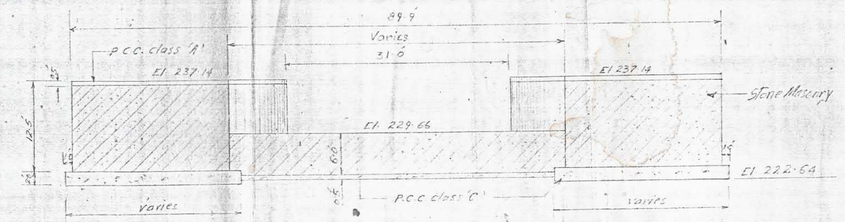
DATE	JOB NO.	INDEX NO.	FILE NO.	DRAWING NO.
LAHORE PAKISTAN	110	4-A	WW. DES.	C.D.O. (W) 110-4A-C-461



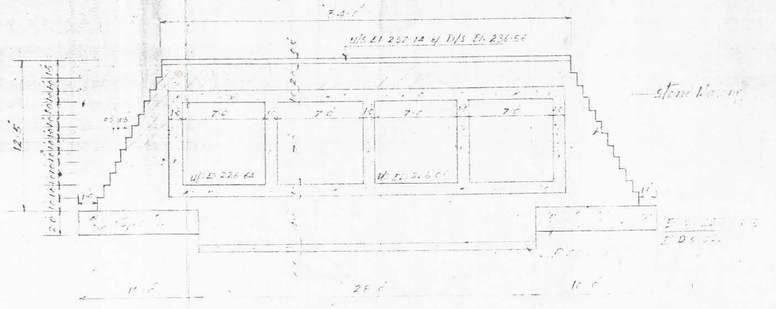
PLAN
SCALE= 1"=10.0'



SECTION AT A-A
SCALE = 1"=10.0'



SECTION B-B
Scale - 1"=10.0'



SECTION C-C
Scale - 1"=10.0'

NOTES

See drawing No. C.D.O.(W) 110-4A-C-458

WS/451 & 452	L-SECTION OF CANAL
WS/455	TYPICAL SECTION OF LINING
110-4A-C-458	PLAN OF DRAINAGE X-ING AT CH. 5+30
110-4A-C-461	DETAIL OF CONDUIT & WING WALLS.
DRAWING NO	TITLE OF DRAWING

REFERENCE DRAWING

COMPLETION DRAWING

Sub. Engineer Asst. Engineer Executive Engineer

APPROVED

Superintending Engineer

REV NO	DATE	DESCRIPTION	BY	CKD	APPVD

REVISION

CONSTRUCTION DRAWING

HUB DAM PROJECT

WATER SUPPLY CANAL 210 CUSECS

DRAINAGE CROSSING AT CH 15+00

DISCHARGE OF NALA 2750 CUSECS

WATER AND POWER DEVELOPMENT AUTHORITY
PAKISTAN
CENTRAL DESIGN OFFICE (WATER WING)

DSN
DWN MUHAMMAD NAZIR
TRD
CKD
REVD

SUBMITTED / RECOMMENDED
JUNIOR REP. C.N.I.
DEPUTY DIRECTOR / DIRECTOR DESIGN
APPROVED
CHIEF ENGINEER DESIGN

DATE	JOB NO.	INDEX NO	FILE NO.	DRAWING NO.
24-11-79	110	4-A	W.W. DES.	C.D.O. (W) 110-4A-C-460

LAHORE PAKISTAN

Annex 2. STUDIES AND FIELD CAMPAIGNS

CONSULTING SERVICES KARACHI WATER CANAL PPP

Annex 2. STUDIES AND FIELD CAMPAIGNS

- FIELD VISIT REPORTS
- FLOW MEASUREMENT REPORT
- HYDROLOGICAL REPORT
- HYDRAULIC CALCULATIONS
- WATER QUALITY ANALYSIS TEST
- GEOTECHNICAL SURVEY
- GEOPHYSICAL SURVEY
- GEOTAG MAPS
- SOLAR PV PLANT FEASIBILITY STUDY

SITE VISIT REPORT
(E&S VISIT & TECHNICAL VISIT)

CONSULTING SERVICES KARACHI WATER CANAL PPP

TYPSA

Karachi Water Canal

MEP System Assessment Report

13 10 2020

Halcrow Pakistan (Pvt) Limited
3rd Floor, Nawa-e-Waqt House, Mauve Area
Sector G-7/1, Zero Point, Islamabad, Pakistan
Tel: + 92 51 220 3451 Fax: + 92 51 220 3462
Email: hpkmail.halcrowpk.com
www.halcrowpk.com

HPK

Document history

Karachi Water Canal

Site Visit Report

This document has been issued and amended as follows:

Version	Date	Description	Prepared by	Reviewed by	Approved by
1	13/10/2020	Draft	US/MA	KA	KA

US Usama Ali

KA Khursheed Ali

MA Mesum Ali

Contents

1 Site Visit Dates & Locations 1

2 Pumping Station 1

2.1 Building's Inventory 1

2.2 Old Water Pump House 2

2.2.1 Equipment Status Detail (Old Pump Station) 3

2.3 New Water Pumping Station 6

2.3.1 Detail of Water Intake Pumps 6

2.3.2 Equipment Status Detail (New Pump Station) 8

2.4 Ancillary Buildings / Systems 15

2.4.1 Intake Structure for water 15

2.4.2 Water Screening System 15

2.4.2.1 Chain Racked Screen 15

2.4.2.2 Band Screen 16

2.4.3 Main Rising Line 16

2.4.4 Low Capacity Pump Yard & Surge Vessels 17

2.4.5 Surge Vessels 17

2.4.6 Old Pump Station Transformer Room 18

2.4.7 New Pump Station Transformer Yard 18

2.4.8 K-Electric Room (Substation) 18

3 Filtration Plant 19

3.1 Building's Inventory 19

3.2 Water Filtration Plant 19

3.2.1 Equipment Status Detail (Filtration Plant) 21

4 MEP Equipment Checklists 29

4.1 Site Observations Checklist for Old Pumping Station 29

4.2 Site Observations Checklist for New Pumping Station 33

4.3 Site Observations Checklist for Filtration Plant 37

5 Major Observations, Suggestions & Recommendations 40

5.1 List of Major Issues 40

5.2 Other Related Observations 41

Appendices

Appendix A (Old & New Pump Station Equipment Layout)
Appendix B (11 kV SLD of Old Pump Station)
Appendix C (11 kV SLD of New Pump Station)
Appendix D (Flow Diagram of Filtration Plant)
Appendix E (Flow Diagram of Pump Station)
Appendix F (Main SLD of Filtration Plant)
Appendix G (Site Photos)

List of Tables

Table 2-1 Equipment Status Details of Old Pump Station 3
Table 2-2 Equipment Status Detail of New Pump Station 8
Table 3-1 Equipment Status Details of Filtration Plant 21
Table 4-1 Typsa's Checklist and HPK's Comments (Old Pumping Station) 29
Table 4-2 Typsa's Checklist and HPK's Comments (New Pumping Station) 33
Table 4-3 Typsa's Checklist and HPK's Comments (Filtration Plant) 37
Table 5-1 Major Issues and their Suggestions 40
Table 5-2 Some Related Issues and their Suggestions 41

1 Site Visit Dates & Locations

Team visited on following dates and places:

1. 14 September, Water Pumping Stations
2. 18 September, Water Filtration Plant

2 Pumping Station

There are 2 water pumping houses available and are placed in the same vicinity. These pump houses are used to pump water from "Pump Station" to the Filtration Plant which is about 2-3 km away.

On the basis of observations and site condition, HPK team has made sketches of equipment layout and single line diagrams of power distribution system. Refer Appendix-A for old and new pump house equipment layout.

There are 2 water sources for the pump station as under:

1. Hub Canal, which contributes 70 MGD throughout the seven days of week.
2. K3 branch line (Alternate bulk water source scheme which serves the other part of Karachi) is second source adding 50 MGD for 3 days in a week. This source may be used during the rehabilitation period of Karachi water canal

Hence, the total capacity of water pumping stations is around 120 MGD.

2.1 Building's Inventory

The following ancillary building/rooms are present at pump station's vicinity, which are:

1. K-Electric Substation (Utility Company)
2. Old Pumping House
3. Transformer room (Old pumping House)
4. New Pumping House
5. Transformer yard (New pumping House)
6. LCP (Low Capacity Pump) Room
7. Division/Sub-division office
8. Staff room
9. Electrical workshop
10. Mechanical workshop
11. Main Store
12. Surge vessels platform

13. Water Screen System platform.

2.2 Old Water Pump House

1. Old pump house has basement and ground floor. All pumps and motors are installed at basement level, while 11 kV OCB panels and 3600 kW Standby DG set is placed at ground floor.
2. There are total six pumps installed in the old pump room, comprising of 2 Nos. 12 MGD and 4 Nos. 24 MGD.
3. Capacity of old pump room is 120 MGD. Arrangement of pumps can be seen in the sketch. Refer Appendix-A.
3. Common head of old pump house is of 72 inches diameter.
4. There is a standby 11kV DG set of 3,600 kW capacity for old pump motors only. This is MAN made DG set at 1000 rpm.
5. Old pump house has a 20 ton gantry crane for the O&M of pumps and motors.
6. 17 Nos. 11 kV OCB (Oil Circuit Breaker) panels are installed at the ground floor of old pump house. Detail of each panel can be seen in the single line diagram. Refer Appendix-B
7. There is a 110 volt DC system and 400/230 volt AC supply system also available in the old pump house to supply power to the auxiliaries of water pumps and OCBs (11 kV Panels).
8. Old pump has a DC battery charger for charging the battery bank placed in the room.
9. All motors and pumps are installed in the basement area, while electrical panels and DG set etc. are installed at the ground floor.
10. All pumps are horizontal type in the old pump house.
11. Motors make is 'AEG' and pumps are of 'MAN' make.
12. As per design, motor rating of 12 MGD pump is 600 kW and of 24 MGD is 1150 kW.
13. Flow diagram of pump station is referred as Appendix-E
14. Pumps and motors status;
    a. 24 MGD pump No. 1, (motor is out of order)
    b. 24 MGD pump No. 2, (Condition is Ok and in running condition)
    c. 24 MGD pump No. 3, (motor is out of order)
    d. 24 MGD Pump No. 4, (pump is out of order)
    e. 12 MGD Pump No. 5, (motor is out of order)

f. 12 MGD Pump No. 6, (Condition is Ok and in running condition)

2.2.1 Equipment Status Detail (Old Pump Station)

Table 2-1 Equipment Status Details of Old Pump Station

S.No.	Equipment Detail	*Current Status	Observations	Suggestions
Mechanical				
	Intake Pumps			
1	Small Pump No.1, 12 MGD, AEG Motor, MAN Pump Horizontal type	C	Motor is in repairing with vendor	Motor needs to be repaired. Performance Test is required for pump life evaluation
2	Small Pump No.2, 12 MGD, AEG Motor, MAN Pump Horizontal type	A	Pump is in running condition	Performance Test is required for pump life evaluation
3	Large Pump No.3, 24 MGD, AEG Motor, MAN Pump Horizontal type	C	Motor is out of order	Motor need to be repaired. Performance Test is required for pump life evaluation
4	Large Pump No.4, 24 MGD, AEG Motor, MAN Pump Horizontal type	C	Pump is in repairing with vendor	Motor needs to be repaired. Performance Test is required for pump life evaluation
5	Large Pump No.5, 24 MGD, AEG Motor, MAN Pump Horizontal type	C	Motor winding issues	Motor winding needs to be repaired. Performance Test is required for pump life evaluation
6	Large Pump No.6, 24 MGD, AEG Motor, MAN Pump Horizontal type	A	Pump is in running condition	Performance Test is required for pump life evaluation
	Low Capacity Pumps			
7	LCP No.1, 2.5 MGD, AEG Motor, MAN Pump	A	Pump is in running condition	Performance Test is required for pump life evaluation
8	LCP No.2, 2.5 MGD, AEG Motor, MAN Pump	A	Pump is in running condition	Performance Test is required for pump life evaluation

9	LCP No.3, 2.5 MGD, AEG Motor, MAN Pump	A	Pump is in running condition	Performance Test is required for pump life evaluation
10	LCP No.4, 2.5 MGD, AEG Motor, MAN Pump	A	Standby Pump is in running condition	Performance Test is required for pump life evaluation
	Valves			
11	Small Pumps Valves	A	Most valves are in running condition	Needs to change some valves
12	Large Pumps Valves	A	Most valves are in running condition	Needs to change some valves
13	LCP Pumps Valves	A	Most valves are in running condition	Needs to change some valves
	Drain Pumps			
14	Drain Pumps	C	Auto Drain sump pumps are not working, however a manual pump is installed for water drain pumping. water is spilling over the cable trenches	Auto pump system of drain needs to be repaired
	Overhead travelling crane			
15	20 Ton Crane.	A	Crane is in running condition	No action required
	ELECTRICAL			
	Medium Voltage (11 kV) Panels			
1	MV Panels (OCB type), 17 nos. Make: Alstom Pakistan	B	MV panels are operational but without protection. Relays are malfunctioning and not working properly, due to which when voltage surge occurs it damages the motors.	As OCB Panels have been obsoleted. Therefore, New MV VCB switchboard should be installed with relay protections
	Transformers			
2	Oil Type Transformers (630 kVA), 2 nos. Make: Johnson & Phillips	A	In satisfactory condition & operational	No action required
	Standby Generators			

3	3,600 KW Diesel Generator, rated at 11 kV Make: MAN	B	3600 kW DG set has been depreciated over the passage of time. it is in running condition under 60-65% of its rated capacity. This DG set serves on old pump house.	A centralized Standby DG Set system to be installed to serve for old and new pump house.
	Low Voltage (400V) Panels/MCC			
3	LV Panels Make: Alstom Pakistan	A	In satisfactory condition & operational	No action required
	Cable Transportation Systems			
4	Cable Trays	B	All metallic cable trays and their supports are rusted and in poor condition.	New trays with proper supports should be installed.
5	Trenches	B	All Trenches are filled with water for long time due to failure of auto water drain system.	Water should be drained and cables should be laid on proper cable ladders.
	Earthing System			
6	Earth System and their Pits	B	We found some earth pits but mostly earth pits are invisible due to sand and grass.	A major earth assessment exercise to be performed to measure and maintain the earth resistance as per code requirement. All electrical panels, transformers, DBs, MCCs and all mechanical equipment to be earth properly.

***Status Classes:**

A = Running and in satisfactory condition

B = Running but not in good condition

C = Out of order but present

D = currently not present

2.3 New Water Pumping Station

1. New pump house has only ground floor. All pumps, motors, 11 kV VCB panels, LV switchboards are installed at ground floor. There is no standby DG set for the new pump house.
2. There are total six pumps installed in the old pump room, comprising of 2 Nos. 17.5 MGD and 4 Nos. 35 MGD.
3. Capacity of new pump house is 157.5 MGD. Arrangement of pumps can be seen in the sketch. Refer Appendix-A
4. Common head of new pump is of 72 inches diameter.
5. There is no standby DG supply for the new pump house.
6. New pump has 15 ton gantry crane for the O&M of pumps and motors.
7. 19 Nos. 11 kV VCB panels are installed at the ground floor of new pump house. Detail of each panel can be seen in the single line diagram. Refer Appendix-C
8. There is a 110 volt DC system and 400/230 volt AC supply system also available in the new pump house to supply power to the auxiliaries of water pumps and VCBs.
9. New pump has a DC battery charger for charging the battery bank placed in the room.
10. All pumps are vertical type in the new pump house.
11. There is a surge vessel control panel is installed in the new pump house.
12. Motors make is 'ALSTOM' and pumps are of make 'KUBOTA'
13. Pumps and motors Status;
    a. Pump A-1, 17.5 MGD, (Pump is out order)
    b. Pump B-1, 35 MGD, (Ok and Running)
    c. Pump B-2, 35 MGD, (Ok and Running)
    d. Pump B-3, 35 MGD, (Pump is out of order)
    e. Pump B-4, 35 MGD, (Ok and Running)
    f. Pump A-2, 17.5 MGD, (Ok and Running)

2.3.1 Detail of Water Intake Pumps

As per design there are six intake pumps in total; there are four large 1350kW pumps (P101/1, to, P101/4) inclusive, and, two smaller 700kW pumps (P100/1, P100/2). Kubota has supplied all six pumps along with some other equipment associated with the cooling and lubrication water systems for status please refer to "New Pump House - Equipment Status Detail".

Each pump is mounted in its own sump, and each sump has its own set of level electrodes (LS-103/1, to LS-103/6 inclusive) for status please refer to “New Pump House - Equipment Status Detail”.

The 11kV pumps are under control via the LV switchboard. Normal operation is for three of the large pumps to run. The controls will allow for up to three large pumps to run or for up to two large pumps and two smaller pumps to run for status please refer to “New Pump House - Equipment Status Detail”.

The level switches will stop the pumps in the event of there being a low water level and will prevent a pump from starting should the water level be too low. The switches are all set at slightly differing levels, this is intentional and will prevent the simultaneous tripping of all the running pumps should there be a general low water level for status please refer to “New Pump House - Equipment Status Detail”.

As per design all six pumps are equipped with motor cooling and bearing lubrication systems which are fed with filtered raw water from the discharge header. Under normal running conditions the pumps will be disabled by flow switches in these systems should water flow not be present in them. Under no circumstances should the pump be run without these systems operational.

All of the lubrication and cooling systems incorporate strainers (V29, V37, V41, and V62 to V66). It is important that these are properly maintained and that their baskets are in place and undamaged. If this is not the case then it will be possible for contamination to be passed through the system, which may result in internal blockages at the bearings and / or motor that could in turn result in costly breakdowns for status please refer to ““New Pump House - Equipment Status Detail”.

To clean a strainer basket, the strainer must be isolated by closing the appropriate isolation valves either side of them. Strainers may be cleaned with the pump running by first putting the standby strainer into operation before isolating the strainer to be cleaned for status please refer to “New Pump House - Equipment Status Detail”.

Each strainer line in the cooling circuits also includes a pressure-relief valve V36, V44.

Note that as per design cooling system flow switches are linked into starter circuits and that timers are included to delay starts until the cooling and lubrication systems are flowing, and have been confirmed for status please refer to “New Pump House - Equipment Status Detail”.

As per design each pump has an electrically driven isolation valve on its discharge (V3/1, V3/2, and V4/1 to V4/4) these valves are remotely operated from the LV switchboard for status please refer to “New Pump House - Equipment Status Detail”.

Before starting pumps operator must ensure that the appropriate isolation valve in open, and those for any standby pumps are closed for status please refer to "New Pump House - Equipment Status Detail".

The pump house is equipped with 15 ton overhead travelling crane for status please refer to "New Pump House - Equipment Status Detail".

2.3.2 Equipment Status Detail (New Pump Station)

Due to failure of screen system, we assumed their auxiliaries are also not in working condition as mentioned in the below chart.

Table 2-2 Equipment Status Detail of New Pump Station

S.No.	Equipment Detail as per Design Manual/Drawings	*Current Status	Observations	Suggestions
Mechanical				
	Chain Raked Screens			
1	M100/1, 2.8 cu.m/sec 15 mm gap 6 m/min raking speed.	C	Chain Raked system is out of order	Repair work is required
2	M100/2, 2.8 cu.m/sec 15 mm gap 6 m/min raking speed.	C	Chain Raked system is out of order	Repair work is required
	Travelling Band Screens			
3	M101/1, 2.8 cu.m/sec 2.3 mm Aperture 3.3/3.6 m/min.	C	band screen is out of order	Repair work is required
4	M101/2, 2.8 cu.m/sec 2.3 mm Aperture 3.3/3.6 m/min.	C	band screen is out of order	Repair work is required
5	M101/3, 2.8 cu.m/sec 2.3 mm Aperture 3.3/3.6 m/min.	C	band screen is out of order	Repair work is required
	Band screen Isolation Electrically Actuated Penstocks			
6	V13/1, 60/30 c/w Auma Actuator, Rating 1.5m x 2.5m, Manufacturer: Simon Hartley.	C	Electrical Control system is out of order	Major work to restore Electrical system of penstock is required
7	V13/2, 60/30 c/w Auma Actuator, Rating 1.5m x 2.5m, Manufacturer: Simon Hartley.	C	Electrical Control system damaged	Major work to restore Electrical system of penstock is required

8	V13/3, 60/30 c/w Auma Actuator, Rating 1.5m x 2.5m, Manufacturer: Simon Hartley.	C	Electrical Control system damaged	Major work to restore Electrical system of penstock is required
	Intake Pumps			
9	P101/1, 1350kW, 1850 l/s, 56 m Head, Kubota, Serial Number 7A-0089-01A.	A	Pump is in running condition	No action required
10	P101/2, 1350kW, 1850 l/s, 56 m Head, Kubota, Serial Number 7A-0089-01A.	A	Pump is in running condition	No action required
11	P101/3, 1350kW, 1350kW, 1850 l/s, 56 m Head, Kubota, Serial Number 7A-0089-01A.	C	Pump has some Fault and is in repairing by vendor	Performance Test is required for pump life evaluation
12	P101/4, 1350kW, 1850 l/s, 56 m Head, Kubota, Serial Number 7A-0089-01A.	A	Pump is in running condition	No action required
13	P100/1, 700kW, 925 l/s, 56m Head, Kubota, Serial Number 7A-0089-02A.	C	Pump has some Fault and is in repairing by vendor	Performance Test is required for pump life evaluation
14	P100/2, 700kW, 925 l/s, 56m Head, Kubota, Serial Number 7A-0089-02A.	A	Pump is in running condition	No action required
	Small Pump Discharge Isolation Valves			
15	V3/1, Butterfly c/w Auma actuator+B168, Rating 800 mm 16 bar.	A	Valves are in working condition	No action required
16	V3/2, Butterfly c/w Auma actuator+B168, Rating 800 mm 16 bar.	A	Valves are in working condition	No action required
	Large Pump Discharge Isolation Valves			
17	V4/1, Butterfly c/w Auma actuator, Rating 1000 mm 16 bar.	A	Valves are in working condition	No action required
18	V4/2, Butterfly c/w Auma actuator, Rating 1000 mm 16 bar.	A	Valves are in working condition	No action required
19	V4/3, Butterfly c/w Auma actuator, Rating 1000 mm 16 bar.	A	Valves are in working condition	No action required

20	V4/4, Butterfly c/w Auma actuator, Rating 1000 mm 16 bar.	A	Valves are in working condition	No action required
	Pumping Station Isolation Valves			
21	V5/1, Butterfly c/w Auma Actuator, Rating 1800 mm 16 bar.	A	Valves are in working condition	No action required
22	V5/2, Butterfly c/w Auma Actuator, Rating 1800 mm 16 bar.	A	Valves are in working condition	No action required
	Surge Vessel Electrically Actuated Isolation Valves			
23	V6/1, butterfly c/w Auma Actuator, Rating 1200 mm 16 bar	A	Valves are in working condition	No action required
24	V6/2, butterfly c/w Auma Actuator, Rating 1200 mm 16 bar	A	Valves are in working condition	No action required
	Small Pump Discharge non-return Valves			
25	V1/1, Recoil, Rating 800 mm, 16 bar.	A	Valves are in working condition	No action required
26	V1/2, Recoil, Rating 800 mm, 16 bar.	A	Valves are in working condition	No action required
	Large Pump discharge non-return valves			
27	V2/1, Recoil, Rating 1000 mm, 16 bar.	A	Valves are in working condition	No action required
28	V2/2, Recoil, Rating 1000 mm, 16 bar.	A	Valves are in working condition	No action required
29	V2/3, Recoil, Rating 1000 mm, 16 bar.	A	Valves are in working condition	No action required
30	V2/4, Recoil, Rating 1000 mm, 16 bar.	A	Valves are in working condition	No action required
	Surge Vessel Discharge no-return valves			
31	V7/1, recoil, Rating 1200 mm, 16 bar.	A	Valves are in working condition	No action required
32	V7/2, recoil, Rating 1200 mm, 16 bar.	A	Valves are in working condition	No action required

	Pressure Gauges for surge vessels, band screen, flushing lines & raw water intake pumps Model MIX7 D63 BXX, MEX5 D63XXX & D201 - 20, Ranges 0- 16 bars, 0 - 60 m, 0 - 100 m.			
33	PI-107/1	C	screen system gauges are out of order	Repaired or Replacement is required
34	PI-107/2	C	screen system gauges are out of order	Repaired or Replacement is required
35	PI-102/1	C	screen system gauges are out of order	Repaired or Replacement is required
36	PI-102/2	C	screen system gauges are out of order	Repaired or Replacement is required
37	PI-102/3	C	screen system gauges are out of order	Repaired or Replacement is required
38	PI-104/1	C	screen system gauges are out of order	Repaired or Replacement is required
39	PI-104/2	C	screen system gauges are out of order	Repaired or Replacement is required
40	PI-104/3	C	screen system gauges are out of order	Repaired or Replacement is required
41	PI-104/4	C	screen system gauges are out of order	Repaired or Replacement is required
42	PI-104/5	C	screen system gauges are out of order	Repaired or Replacement is required
43	PI-104/6	C	screen system gauges are out of order	Repaired or Replacement is required
	Instrument Valve Manifolds for above pressure gauges			
44	PI-107/1	C	screen system gauges are out of order	Repaired or Replacement is required
45	PI-107/2	C	screen system gauges are out of order	Repaired or Replacement is required
46	PI-102/1	C	screen system gauges are out of order	Repaired or Replacement is required

47	PI-102/2	C	screen system gauges are out of order	Repaired or Replacement is required
48	PI-102/3	C	screen system gauges are out of order	Repaired or Replacement is required
49	PI-104/1	C	screen system gauges are out of order	Repaired or Replacement is required
50	PI-104/2	C	screen system gauges are out of order	Repaired or Replacement is required
51	PI-104/3	C	screen system gauges are out of order	Repaired or Replacement is required
52	PI-104/4	C	screen system gauges are out of order	Repaired or Replacement is required
53	PI-104/5	C	screen system gauges are out of order	Repaired or Replacement is required
54	PI-104/6	C	screen system gauges are out of order	Repaired or Replacement is required
	Ultrasonic Differential Level Instruments for chain raked screens and travelling band screens			
55	DLS-100, Model: Liquiflex PLC Transmitter & RZT 15 Transducer, Ranges up to 15 meters.	C	screen system level instrument are out of order	Repaired or Replacement is required
56	DLS-101, Model: Liquiflex PLC Transmitter & RZT 15 Transducer, Ranges up to 15 meters.	C	screen system level instrument are out of order	Repaired or Replacement is required
	Level Electrode switches (conductivity type) for intake pump sumps			
57	LS-103/1, Model AC1/X/FUSED/110V & HPE8/1, Ranges 3 meters approx. depth.	C	Level electrodes are out of order	Repaired or Replacement is required
58	LS-103/2, Model AC1/X/FUSED/110V & HPE8/1, Ranges 3 meters approx. depth.	C	Level electrodes are out of order	Repaired or Replacement is required
59	LS-103/3, Model AC1/X/FUSED/110V & HPE8/1, Ranges 3 meters approx. depth.	C	Level electrodes are out of order	Repaired or Replacement is required

60	LS-103/4, Model AC1/X/FUSED/110V & HPE8/1, Ranges 3 meters approx. depth.	C	Level electrodes are out of order	Repaired or Replacement is required
61	LS-103/5, Model AC1/X/FUSED/110V & HPE8/1, Ranges 3 meters approx. depth.	C	Level electrodes are out of order	Repaired or Replacement is required
62	LS-103/6, Model AC1/X/FUSED/110V & HPE8/1, Ranges 3 meters approx. depth.	C	Level electrodes are out of order	Repaired or Replacement is required
	Surge Protection Air Compressor			
63	M102, 16 l/s FAD at 6 bar 7.5kW, Model LE75-10 (Atlas Copco).	A	Compressor is in good condition	No action required
	Overhead travelling crane			
64	M101/1, 15 Tonne, Double Girder EOT Crane.	A	Working in good condition	No action required
65	M103/2, 15 Tonne, Double Girder EOT Crane.	A	Working in good condition	No action required
66	M103/3, 15 Tonne, Double Girder EOT Crane.	A	Working in good condition	No action required
	Stop Logs Sets			
67	V11/1	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced
68	V11/2	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced
69	V12/1	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced
70	V12/2	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced
71	V12/3	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced
72	V12/4	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced

73	V12/5	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced
74	V12/6	C	Stop Logs are not in working condition	Needs to evaluate if it can be repaired or replaced
ELECTRICAL				
	Medium Voltage (11 kV) Panels			
1	MV Panels (VCB type), 19 nos. Make: Alstom Pakistan	A	In satisfactory condition & operational	No action required
	Transformers			
2	Oil Type Transformers (630 kVA), 2 nos. Make: J&P (Johnson & Phillips)	A	In satisfactory condition & operational	No action required
	Low Voltage (400V) Panels/MCC			
3	LV Panels Make: Alstom Pakistan	A	In satisfactory condition & operational	No action required
	Cable Containment Systems			
4	Cable Trays (metallic)	B	All metallic cable trays and their support are in satisfactory condition	No action required
5	Trenches	B	Trenches are Ok.	No action required
	Earthing System			
6	Earth System and their Pits	B	We found some earth pits but mostly earth pits are invisible due to sand and grass.	A major earth assessment exercise to be performed to measure and maintain the earth resistance as per code requirement. All electrical panels, transformers, DBs, MCCs and all mechanical equipment to be earth properly.

***Status Classes:**

A = Running and in satisfactory condition

B = Running but not in good condition

C = Out of order but present

D = currently not present

2.4 Ancillary Buildings / Systems

2.4.1 Intake Structure for water

A New intake structure was constructed adjacent to old existing structure. The inlet channel receives water from the Hub Canal. As per design there are two duty chain raked bar screens each being preceded by a set of stop logs. These are followed by three (two duty, one standby) travelling band screens. At the outlet of each band screen is an electrically driven penstock. These are followed by a total of six vertical pumps each on its own pump bay and preceded by a set of stop logs.

The main discharge pipework includes two large surge control vessels, and is connected to the existing raw water main which serves the Hub Water Treatment Works.

The Pump House is equipped with a 15t overhead travelling crane.

The main control and isolation valves are electrically actuated.

2.4.2 Water Screening System

There is an automatic water screening system present at the pumping station, but due to lack of maintenance it is out of order.

There are three gates in the screen which used to work automatically in the past, which are

- Chain Racked Screen
- Band Screen

2.4.2.1 Chain Racked Screen

As per design there are two duty chain screens (M100/1 & M100/2) for status of the screens, please refer to ""New Pump House - Equipment Status Detail".". These units are manufactured by Three Star Engineering.

The operation of the screens is normally automatic although a facility for manual operation is also provided for status of screens please refer ""New Pump House - Equipment Status Detail"."

The automatic control of the screens is by timer with an overriding control by differential water level across the screens. Timers are adjustable from the Screens Motor Control Centre. These timers have been set during commissioning to enable the screens to run for approximately 3 minutes every 20 minutes for status please refer "New Pump House - Equipment Status Detail".

An ultrasonic level instrument (DLS 100) detects the differential level. The settings are adjustable and have been set during commissioning. At a differential level of 80mm across the screens they will start and continue to run until the differential has been reduced to 50mm. There is an alarm setting should the differential across the screens reach 100mm for status please refer "New Pump House - Equipment Status Detail".

As per design operation should a screen trip, there is an alarm sounded at the screens Motor Control Centre for status please refer "New Pump House - Equipment Status Detail". Should it be necessary to operate the screens manually then this is done using push buttons at the Screens Motor Control Centre.

2.4.2.2 Band Screen

As per design there are two duty chain screens (M100/1 & M100/2) for status of the screens please refer to "New Pump House - Equipment Status Detail". These units are manufactured by Three Star Engineering.

The operation of the screens is normally automatic although a facility for manual operation is also provided for status of screens please refer "New Pump House - Equipment Status Detail".

The automatic control of the screens is by timer with an overriding control by differential water level across the screens. Timers are adjustable from the Screens Motor Control Centre. These timers have been set during commissioning to enable the screens to run for approximately 3 minutes every 20 minutes for status please refer "New Pump House - Equipment Status Detail".

An ultrasonic level instrument (DLS 100) detects the differential level. The settings are adjustable and have been set during commissioning. At a differential level of 80mm across the screens they will start and continue to run until the differential has been reduced to 50mm. There is an alarm setting should the differential across the screens reach 100mm for status please refer "New Pump House - Equipment Status Detail".

As per design operation should a screen trip, there is an alarm sounded at the screens Motor Control Centre for status please refer "New Pump House - Equipment Status Detail". Should it be necessary to operate the screens manually then this is done using push buttons at the Screens Motor Control Centre.

2.4.3 Main Rising Line

- 72 inches headers lines are emerged from old and new pump houses and connected with the common chamber.

- There are two 66 inches diameter main rising emerging from the common chamber transmit the water to the filtration plant.

2.4.4 Low Capacity Pump Yard & Surge Vessels

- There are total 4 Nos. low capacity pumps (400 volt rated) are installed in the open yard area.
- Capacity of each pump is 2.5 MGD.
- There is a LV power supply room beside the pumps wherein 3 Nos. LV panels are installed.

2.4.5 Surge Vessels

As per design under no circumstances must the pump station be operated without the surge protection system being fully operational. In the event that maintenance is necessary on the surge protection equipment then pump station must be shut down and precautions set in place to prevent it being put back into service until the surge protection system is fully charged and operational.

As per design the station is equipped with two duty surge vessels. They are connected to the main discharge pipework outside of the pump station and prior to the junction with existing pipeline from the existing pump station. The function of these vessels is to protect the pumping main from damage that may be caused by negative or positive pressures created within the system for any reason for status of surge vessels please refer to "New Pump House - Equipment Status Detail".

As per design the vessels are connected to the pumping main via non-return valves V7/1 & V7/2 equipped with bypasses. The non-return valves are arranged so that in the event of a sudden pressure drop in the pipeline water can flow freely from the vessels into the pipeline, thus maintaining positive pressure in the line. On the return of the pressure wave the non-return valves shut and water is bled back into the vessels via the bypass. This restricts the flow and thus damps down the hydraulic shock to the system for status please refer to "New Pump House - Equipment Status Detail".

The valves in the bypass loops V8/1 and V8/2 must not be shut during normal operation. To do so could cause catastrophic failure in the pipeline should a surge event occur. Should it be necessary to shut these valves during drain down and maintenance of the vessels then before the pump station is put back into operation the valves should be opened and the hand wheels removed to ensure that they cannot be accidentally closed for status please refer to "New Pump House - Equipment Status Detail".

Both vessels are duty units and thus the electrically driven isolation valves (V6/1, V6/2) and the manual isolation valves in the air feed pipework (V20/1, V20/2, V20/3) should be open at all times other than when maintenance or inspection is required to a vessel or its ancillary equipment. Each vessel is equipped with a set of level switched but only one set of these is functional at any time because the

vessels act in tandem for status of valves please refer to "New Pump House - Equipment Status Detail".

The air volume in the vessels is maintained by a compressor package. The compressor is switched on and off by the level switches for status of compressors please refer to "New Pump House - Equipment Status Detail".

The surge vessels and the main outlet pipeline have man access ways. No entry should be made without first ensuring that the system is fully drained and isolated (including electrically) and can pose no danger to operatives for status of pipelines please refer to "New Pump House - Equipment Status Detail".

Surge Vessel Compressor

Compressors are under automatic control and may start and stop without warning for status of compressors please refer to "New Pump House - Equipment Status Detail".

Butterfly Valves

Butterfly valves are needed for internal inspection and repacking of the gearbox for status of butterfly valves please refer to "New Pump House - Equipment Status Detail".

Actuators for Valves and Penstocks

The actuators are fitted with local pushbutton control facilities for opening and closing the valves as well as controls on the LV Switchboard for status please refer to "New Pump House - Equipment Status Detail".

2.4.6 Old Pump Station Transformer Room

- There are two 630 kVA, oil type transformers installed in the room.
- These transformer are being used for low voltage supply for the pumps and other buildings.
- Transformer are made by J&P (Johnson & Phillips).

2.4.7 New Pump Station Transformer Yard

- There are two 630 kVA oil type transformers installed in the open yard.
- These transformer are being used for low voltage supply for the pumps and other buildings
- Transformer are made by PEL.

2.4.8 K-Electric Room (Substation)

- There is a main 11 kV supply room along the boundary, where utility company's 11 kV VCB panels are installed.
- There are two 11 kV Feeders are coming to K-Electric room, first feeder is called 'HUB DAM feeder' which is dedicated for pumping station load. However, another

standby 11 kV feeder named 'MUMTAZ feeder' is also coming to room which can bear partial load of premises.

- Both 11 kV feeders are coming from the same Grid Station (Valika Grid).
- Maximum allowable limit of utility power is around 4.5 - 4.8 MW.

3 Filtration Plant

3.1 Building's Inventory

The following buildings and other ancillary building/rooms are present in the vicinity of filtration plant, which are:

1. Division/Sub-Division office
2. Canteen building
3. Laboratory
4. Water Filtration Building/Plant
5. Chemical Building
6. Chemical Section Panel Room
7. Alum & Lime Yard
8. Acid Section
9. Distribution chamber
10. Back wash balancing tank
11. Filtered water storage tanks
12. Holding tank
13. Generator Room

3.2 Water Filtration Plant

1. Alum solution is prepared in 04 Nos. Concrete tanks, then pumping it goes to distribution chamber for pre-dosing process. Refer Appendix-D for flow diagram of filtration plant.
2. Alum and chlorine dosing is 24 hours operations process.
3. Sulphuric Acid plant is out of order. Pipes and pumps are in a very worst condition.
4. Lime Water is prepared in 4 nos. steel tanks. However, currently pipes and pumps are in very bad condition while its auto system is also out of order.
5. Sulphuric acid must be dosed in distribution chamber at least.
6. Holding tank is under filter bed and condition is OK.

7. Auto system of filter beds are not working, only running manually. PLC is out of order.
8. Flow meters are not installed at distribution tank (at inlet and outlet), after holding tank. However, in the past flow meters were present but now they are not available.
9. Sand filters are present before filter beds.
10. Sand filters are being maintained on monthly and annual basis. Record is also maintained.
11. MCC-2 pumps of thickener tanks are working but maintenance is required.
12. Balancing tank and distribution chambers are open. These are to be covered with umbrella as dust & garbage through air are being added in it.
13. Operation & maintenance of filtration is satisfactory up to certain level but improvement can be done. Chemical dosing record is also maintained at site.
14. There is no screening of raw water at filtration plant.
15. Reservoir cleaning is required due to sand/mud. Last cleaning was done in 2003.
16. De-sledging of thickener and distribution chamber is maintained on daily/weekly basis.
17. Detector system on chlorine is present to maintain the quantity of chlorine dosing.
18. Auto chorine detection system shows leakage of chlorine and its quantity. In malfunction condition, it generates alarm.
19. Chlorine analyser are also present.
20. Auto alum feeding system are not present. It is done manually with collaboration of intake raw water received from pump.
21. Laboratory checks below values:
    i. Turbidity (sand/mud)
    ii. PH (control through alum), average value is 7.1
    iii. PPM (maintain by chlorine 2 parts)
    iv. Alkalinity (95-100)
    v. Chlorination
22. There are two lines of sand beds, one has 10 beds and other has 6.
23. Sand filters are in satisfactory condition (6-8 years may be used)
24. Mimic system is very old but in working condition.
25. Lab test perform on daily basis and record is maintained.
26. Chlorination test is done on per hour basis.

27. All test are being done on per hour basis.
28. Microbiological test only done in rainy seasons or low water level in canal, not in routine.
29. All tests are performed by KW&SB (Karachi Water & Sewerage Board), no 3rd party validation process is present.
30. PH meter is out of order.
31. Lab testing equipment are not being calibrated annually and also not maintained properly.
32. TDS is being maintained at 360-450.
33. Monitoring is working 24 hours in shift basis.
34. In order to understand power system of filtration plant, please refer Appendix-F

3.2.1 Equipment Status Detail (Filtration Plant)

Table 3-1 Equipment Status Details of Filtration Plant

S.No.	Equipment Detail	*Current Status	Observations	Suggestions
	MECHANICAL			
	Chlorine Yard			
1	40 Nos Chorine cylinders.	A	Portable re-filling cylinders are in good condition	No action required
2	Overhead Crane 5 Ton capacity.	A	Working in good condition	No action required
3	6 Nos Fume Extractor Fans.	A	Ducting, Low Pick-up Exhaust & Extractor Fans are in good condition	No action required
4	Safety Shower & Eye Wash.	C	Shower Head, Pull Handle & Plumbed Eyewash are out of order however piping is OK and plumbed eyewash valve is out of order	Replace out of order items
5	Crowcon Txguard Toxic Gas Detector.	A	Working in good condition	No action required
6	2 Nos Chlor-Scale chlorine weight monitor.	A	Working in good condition	No action required
7	Automatic chlorine dosing system complete.	A	Working in good condition	No action required

8	Portable Fire Extinguishers.	B	Fire Extinguishers are present but seems not properly maintained and fire cabinet is not well placed	Some repair work is required for fire cabinet
	Alum Yard			
9	4 Nos Alum Mixing Tanks.	A	Concrete alum dosing tanks are in good condition see structural report for its detail	No action required
10	Alum Dosing Pump - P214/1 - for Stream - A.	A	Pump is running in satisfactory condition	No action required
11	Alum Dosing Pump - P214/2 - for Stream - A.	A	Pump is running in satisfactory condition	No action required
12	Alum Dosing Pump - P215/1 - for Stream - C.	A	Pump is running in satisfactory condition	No action required
13	Alum Dosing Pump - P215/2 - for Stream - C.	A	Pump is running in satisfactory condition	No action required
14	Alum Dosing Pump - P215/2 - for Stream - C.	A	Pump is running in satisfactory condition	No action required
15	Alum Dosing Pump - P214/3 - for Stream - B.	A	Pump is running in satisfactory condition	No action required
16	Alum Dosing Pump - P214/4 - for Stream - B.	A	Pump is running in satisfactory condition	No action required
17	Piping, Fittings, Valves and accessories.	A	Alum dosing piping, valves, fittings and guages are in satisfactory condition	No action required
18	Mixer - M204/1.	A	Mixer motor and blade is in good condition	No action required
19	Mixer - M204/2.	A	Mixer motor and blade is in good condition	No action required
20	Mixer - M204/3.	A	Mixer motor and blade is in good condition	No action required
21	Mixer - M204/4.	A	Mixer motor and blade is in good condition	No action required
22	Portable Fire Extinguishers.	B	Fire Extinguishers are present but seems not properly maintained and fire cabinet is not well placed	Repair work is required for fire cabinet

	Lime Yard			
23	4 Nos Lime Slurry Batch Tanks Operational Capacity 18 cubic meters.	A	Tank condition is satisfactory	No action required
24	Svedala Lime Slurry Transfer Pumps - P217/1.	D	Pump is not present	Installation of new slurry pump is needed
25	Svedala Lime Slurry Transfer Pumps - P217/2.	D	Pump is not present	Installation of new slurry pump is needed
26	Svedala Lime Slurry Transfer Pumps - P217/3.	D	Pump is not present	Installation of new slurry pump is needed
27	Svedala Lime Slurry Transfer Pumps - P217/4.	D	Pump is not present	Installation of new slurry pump is needed
28	Piping, Fittings, Valves and accessories.	C	Piping is present and in good condition with valves	Connection with pumps(new) is required
29	Sack Splitter Dust Unit - V284/2.	A	Working in good condition	No action required
30	Sack Splitter Dust Unit - V284/3.	A	Working in good condition	No action required
31	Sack Splitter Dust Unit - V284/4.	A	Working in good condition	No action required
32	Sack Splitter Dust Unit - V284/1.	A	Working in good condition	No action required
33	Lime Mixer - M205/1.	A	Working in running condition	No action required
34	Lime Mixer - M205/2.	A	Working in running condition	No action required
35	Lime Mixer - M205/3.	A	Working in running condition	No action required
36	Lime Mixer - M205/4.	A	Working in running condition	No action required
	Acid Building			
37	4 Nos Sulphuric Acid Storage tanks.	D	Completely out of order and dismantled	Installation of all new acid dosing system is required
38	Acid Dosing Pump - P213/1.	D	Completely out of order and dismantled	Installation of all new acid dosing system is required

39	Acid Dosing Pump - P213/2.	D	Completely out of order and dismantled	Installation of all new acid dosing system is required
40	Acid Dosing Pump - P213/3.	D	Completely out of order and dismantled	Installation of all new acid dosing system is required
41	Piping, Fittings, Valves and accessories.	D	Piping is partially in good condition	Installation of all new acid dosing system is required
42	Acid Transfer Pump - P212/1.	D	Completely out of order and dismantled	Installation of all new acid dosing system is required
43	Acid Transfer Pump - P212/2.	D	Completely out of order and dismantled	Installation of all new acid dosing system is required
44	Piping, Fittings, Valves and accessories.	C/D	Piping is partially in good condition	Installation of all new acid dosing system is required
45	4 Nos Air Dryers.	D	Completely out of order and dismantled	Installation of all new acid dosing system is required
46	Safety Shower & Eye Wash.	D	Shower Head, Pull Handle & Plumbed Eyewash are out of order	Complete refurbishment is required
	Lime Saturator Tank			
47	Lime Saturator - 1 Tank.	A	Lime Saturator Tanks are in satisfactory condition	No action required
48	Lime Saturator - 2 Tank.	A	Lime Saturator Tanks are in satisfactory condition	No action required
49	Piping, Fittings, Valves and accessories.	B	Some of valves and pipes are rusted	Replacement of Rusted valves and piping is required
	Generator Room			
50	800 KVA FG Wilson 1500 R.P.M Diesel Generator.	A	Generator is in good condition but not functioning	Cause of generator non functionality needs to be evaluate
51	Bulk storage tank for diesel with piping and accessories.	A	Diesel storage tank, filling valves, fittings and pumps are in satisfactory condition	No action required

52	2 Nos. 1600 CFM Exhaust Fans for Generator Control Room.	B	Exhaust system is not in used but is in satisfactory condition	Minor work is required to re operate exhaust system
	Filter Bed			
53	Line 1 to 8.	A	Filter beds are in good condition however see structural report for detail	No action required
54	Line 9 to 16.	A	Filter beds are in good condition however see structural report for detail	No action required
55	Filter Backwash Pump - P200/1.	A	Backwash pump is in running condition	No action required
56	Filter Backwash Pump - P200/2.	A	Backwash pump is in running condition	No action required
57	Filter Backwash Pump - P200/3.	A	Backwash pump is in running condition	No action required
58	Piping, Fittings, Valves and accessories.	A	Generally all piping, valves & fittings of backwash pumps are in satisfactory condition however some valves need maintenance	No major action required
59	Service Water Tank Fill Pumps - P201/1.	A	Service water pump is in running condition	No action required
60	Service Water Tank Fill Pumps - P201/2.	A	Service water pump is in running condition	No action required
61	Service Water Tank Fill Pumps - P201/3.	A	Service water pump is in running condition	No action required
62	Piping, Fittings, Valves and accessories.	A	Generally all piping, valves & fittings of backwash pumps are in satisfactory condition however some valves need maintenance	No major action required
63	Chlorine Motive Water Pumps - P202/1.	A	Chlorine Motive pump is in running condition	No action required
64	Chlorine Motive Water Pumps - P202/2.	A	Chlorine Motive pump is in running condition	No action required
65	Chlorine Motive Water Pumps - P202/3.	A	Chlorine Motive pump is in running condition	No action required

66	Piping, Fittings, Valves and accessories.		Generally all piping, valves & fittings of backwash pumps are in satisfactory condition however some valves need maintenance	No major action required
	Filter Air Scour Blowers			
67	Water Treatment Turbo Blower - B200/1., 62.5 kW, 1470 RPM.	A	Duty blower is in good condition	No action required
68	Water Treatment Turbo Blower - B200/2., 62.5 kW, 1470 RPM.	A	Duty blower is in good condition	No action required
69	Water Treatment Turbo Blower - B200/3., 62.5 kW, 1470 RPM.	C	Standby Blower is out of order	Replacement or repaired of Standby blower is required
	Motor Control Center			
70	MCC-1	A	MCC is in working condition	No action required
71	MCC-2	A	MCC is in working condition	No action required
72	MCC-3	A	MCC is in working condition	No action required
	Wash water Recovery System			
73	Sludge Thickener - A Tank.	A	Sludge Tank is in good condition however for detail see structural report	No action required
74	Sludge Thickener - B Tank.	A	Sludge Tank is in good condition however for detail see structural report	No action required
75	Thickener Feed Pumps - P211/1.	A	Thickener Feed pump is in running condition	Some maintenance is required
76	Thickener Feed Pumps - P211/2.	A	Thickener Feed pump is in running condition	Some maintenance is required
77	Thickener Feed Pumps - P211/3.	A	Thickener Feed pump is in running condition	Some maintenance is required
78	Piping, Fittings, Valves and accessories.	A	Generally all piping, valves & fittings of thickener feed pumps are in satisfactory condition however some valves/fittings need maintenance	Some maintenance is required

79	Wash water Balance Tank - M201.	A	Balancing Tank is overall in good condition however, some stirrer are not working properly.	Minor repair or replacement work may be equired
80	Thickener Flow Splitter Chamber.	A	Valve chamber, piping, valves, and fittings of splitter flow chamber is in satisfactory condition	No action required
	Distribution Chamber			
81	Raw Water Distribution Chamber.	A	Distribution chamber is in good condition however see structural report for detail	No action required
82	Piping, Fittings, Valves and accessories.	A	Valve chamber, piping, valves, and fittings of distribution system is in satisfactory condition	No action required
	Holding Tank			
83	Holding Tank	A	Tank is in satisfactory condition	No action required
	Reservoir			
84	Reservoir	A	Tank is not in good condition due to mud	Proper Cleaning is required
ELECTRICAL				
	Medium Voltage (11 kV) Panels			
1	MV Panels (VCB type), 19Nos. Make: Alstom Pakistan	-	There is no MV panels present in the filtration plant. A feeder from pump station is coming to 11 kV LSB which is directly connected with transformer.	No Action is required
	Transformers			
2	Oil Type Transformers (800 kVA), 1 no.	A	Transformer is placed in open yard and found in running condition	No Action is required
	Standby Generators			

3	800 kVA standby 415/230 volt Diesel Generator.	B	Standby DG set found in good condition, but it is not in operation due to some minor fault.	Fault to be assessed and rectified
	Low Voltage (400V) Panels/MCC			
3	LV Panels Make: Alstom Pakistan	A	In satisfactory condition & operational	No action required
	Cable Containment Systems			
4	Cable Trays (metallic)	B	Metallic cable trays are partially rusted but found ok.	No major action is required
5	Trenches	B	Trenches are found ok.	No action is required.
	Earthing System			
6	Earth System and their Pits	B	We found some earth pits but mostly earth pits are invisible due to sand and grass.	A major earth assessment exercise to be performed to measure and maintain the earth resistance as per code requirement. All electrical panels, transformers, DBs, MCCs and all mechanical equipment to be earth properly.

***Status Classes:**

A = Running and in satisfactory condition

B = Running but not in good condition

C = Out of order but present

D = currently not present

4 MEP Equipment Checklists

4.1 Site Observations Checklist for Old Pumping Station

Table 4-1 Typsa's Checklist and HPK's Comments (Old Pumping Station)

TYPSA Checklist			HPK Comments
Pump Station DESIGN	Current used and extra available power for the plant Drawings: Layout Flow diagrams Others	Ask about the current power/energy consumption and future needs. Ask if the requested drawings are available.	As-built electrical drawings are not available at site. However, we prepared single line diagram of complete power system. Refer Appendix-B. We also prepared flow diagram of entire process. Please refer Appendix-E.
INLET AND OUTFALL SCREEN / TRASHRACK AND WETWELL / SUMP	The inlet screen in the PS seems to have a similar condition to the one mentioned for the WTP.	Is there a bar separation in the screen?	Yes there is bar separation in screen.
		Is there an automatic cleaning for the screen?	There is a system but out of order.
		Does the screen get clogged due to the algae?	Screen system is out of order.
		Is there a deposit to keep the algae and waste?	Screen system is out of order.
		Are these algae going through the screen interfering in the performance of the sand filters?	Screen system is out of order.
PIPES	We need to assess if the pipes within the PS are in good condition and how they stand with regard to their theoretical life span	If the drawings are not available, could we make a basic piping inventory list? Number, type, rating.	KWSB said they will share drawings also we have note dimensions we can make basic piping drawings. PN25, GG 25 Cast Iron, DIN 600 Valves.
		Can pipes be divided into circuits based on process type and potential degradation mechanisms?	All piping are being used and in same overall condition which can be like rated 20-30%. This is not extra ordinary bad for 36 Years old pipes.
		Corrosion	Corrosion observed in piping but for this old pipes overall conditions are not that bad for piping

		Leaks	No major Leaks observed. At Pumps outlet Coupling there is leakages which is going to trench with power cables lying in water. This is due to fault in auto water drain pumping system, they are now operating manually.
		Previous temporary repairs	They have repaired in past.
		Clamp condition	No Major Issue.
		Coating condition	Normal condition.
		Vibrations?	No major vibration observed.
		Misalignments	No major misalignments observed.
		Pipe support deterioration	Nothing major observed.
		Flange joint inspection for distortion and leakage and flange face inspection, ring groove and gasket for corrosion, erosion, cracking, and mechanical damage	No major corrosion observed apart from overall condition.
		Internal inspection in opened flanges for deposition, corrosion, localized corrosion, erosion, etc.	Some open flanges and dismantled flanges are found corroded.
		Internal inspection of dismantled valves for look for corrosion, erosion, mechanical damage and cracking (if possible)	Some dismantled valves have heavy corrosion and damaged.
		Inspection of dead legs for corrosion	Corrosion found on some dead legs.
		Are there O&M records available?	Some record is available.
		Have non-destructive evaluation (NDE) techniques been used to assess the thickness and condition of pipes?	No
PUMPS	We need to assess if the pipes within the PS are in good condition and how they stand	Are performance tests and mechanical running tests available for the pumps? These are usually conducted after the installation.	Very old pumps these data may not be available.

	with regard to their theoretical life span. The visual inspection should look for damages of conditions that may lead to future damages and breakdowns.	Are any other tests such as NPSH test or vibration tests available?	Very old pumps these data may not be available.
		Inspection of metal surfaces	No current inspection tests available.
		Inspection of casings	No current inspection tests available.
		Visual examination of welded on connections, flanged connections, or threaded connections (do they have steel plugs?)	Yes they have steel plugs in some areas.
		Visual examination of vibrations, noise, or temperature	Vibrations, Noise or Temperature seems not bad in pump room.
		General inspection for workmanship, defects, and damage.	Main issues are with pumps and motors. Their vendors repair them.
		Visual inspection of painting and coating condition (look for spatters, blow-holes, and other defects)	Painting and coating seems overall not bad. Blow-holes not generally found.
		Are exposed shafts and shaft couplings covered with waterproof material and sealed?	No
		Visual check of spare parts, loose items and accessories for their dimensions, materials, workmanship and quantity,	Major Spare Parts are not found.
CONTROL PANEL	We need to assess the general condition	Is a wiring schematic at hand in door pockets or in a nearby folder?	Wiring schematic not found.
		Is the control panel correctly oriented and located within the PS?	This is okay
		Is everything labelled?	May be in the past but currently labeling not visible
		Inspection of enclosure (paint damages or similar issues)	Overall panels paint is not in bad condition
		Are verified signed-off electrical inspection reports available?	No report is available
		Are pilot lights operational?	Partially in operation

		Are all wires labelled inside the panel?	Not labelled
		Are all placards/closets in place?	No.
		Is the surrounding free of debris or dirt?	Overall satisfactory condition
OTHER ISSUES AND O&M RECORDS	Ask the main operator if they have any issues related to the operation, which will help the performance of the PS, for example: Would flow meters help to have a better control of the PS? Is it necessary to have a better pre-treatment (screens) to avoid algae from going to the sand filters? Do they have any issue related to automatic control and electrical issues? Are there any Operation and Maintenance records available? If they are not available, could we write up and recall some past repairs and issues? Are the offices and appurtenant facilities in good condition? Others?		Yes, Flow meters would help in better performance of pump house and would have good impact in filtration plant. It is necessary to have better pre-treatment (screens) to avoid algae from going to the sand filters. They have lot of issue of automatic controls as well as electrical issues. They have some record available. They have done some past major repairs please refer detailed report. Facilities are not in good condition please see detail report. They want canal to be covered, sometimes animals, dead bodies fell in canal which creates lot of problems for pump house and filtration plant. They maintained record of water pumped by just MGD of pumps in operation with no actual flow rate. Flow meters are needed.

4.2 Site Observations Checklist for New Pumping Station

Table 4-2 Typsa's Checklist and HPK's Comments (New Pumping Station)

TYPSA Checklist			HPK Comments
Pump Station DESIGN	Current used and extra available power for the plant Drawings: Layout Flow diagrams Others	Ask about the current power/energy consumption and future needs. Ask if the requested drawings are available.	As-built electrical drawings are not available at site. However, we prepared single line diagram of complete power system. Refer Appendix-C. We also prepared flow diagram of entire process. Please refer Appendix-E
INLET AND OUTFALL SCREEN/TRASHRACK AND WETWELL/ SUMP	The inlet screen in the PS seems to have a similar condition to the one mentioned for the WTP.	Is there a bar separation in the screen?	There is Screen System but not in working which creates problems in next stage i.e., Filtration specially outlet screen system, big impurities and sometimes animals fall even dead bodies, which becomes difficult to handle for staff.
		Is there an automatic cleaning for the screen?	There is system but out of order.
		Does the screen get clogged due to the algae?	Screen is partially clogged due to algae
		Is there a deposit to keep the algae and waste?	There is no proper system to manage algae and waste
		Are these algae going through the screen interfering in the performance of the sand filters?	Yes these algae are going to system which creates these problems
PIPES	We need to assess if the pipes within the PS are in good condition and how they stand with regard to their theoretical life span	If the drawings are not available, could we make a basic piping inventory list? Number, type, rating.	They have drawings, KWSB can provide drawings also we can make basic diagram with major dimensions.

		Can pipes be divided into circuits based on process type and potential degradation mechanisms?	Process is same they have two types of pumps based on capacities 17.5 MGD and 35 MGD. Pipes are in good condition.
		Corrosion	No major corrosion found in new PH.
		Leaks	There is no major leaks found.
		Previous temporary repairs	Pumps A-1, B-3 are not working and in repairing.
		Clamp condition	Clamps are in good condition.
		Coating condition	Coating is visibly in good condition no blistering or rusting spotting found in general.
		Vibrations	No major vibration felt in pump house suggesting no major misalignments, bearing faults or overheating.
		Misalignments	No misalignments found in big pipes. In other smaller diameter pipes have also no major misalignments.
		Pipe support deterioration	Some pipe supports are found corroded.
		Flange joint inspection for distortion and leakage and flange face inspection, ring groove and gasket for corrosion, erosion, cracking, and mechanical damage	Flange joints for big pipes are in good condition with no distortion, leakages, ring groove damage, gasket are not visible but chance are good that gaskets are in good conditions.
		Internal inspection in opened flanges for deposition, corrosion, localized corrosion, erosion, etc.	Some opened flanges are found corroded slightly.

		Internal inspection of dismantled valves for look for corrosion, erosion, mechanical damage and cracking (if possible)	Some valves found there which are not in use are corroded.
		Inspection of dead legs for corrosion	Dead legs are not found in new PH.
		Are there O&M records available?	They have maintenance record. KWSB can provide that record.
		Have non-destructive evaluation (NDE) techniques been used to assess the thickness and condition of pipes?	No NDE tests record available.
PUMPS	We need to assess if the pipes within the PS are in good condition and how they stand with regard to their theoretical life span. The visual inspection should look for damages of conditions that may lead to future damages and breakdowns.	Are performance tests and mechanical running tests available for the pumps? These are usually conducted after the installation.	Third party test are not available.
		Are any other tests such as NPSH test or vibration tests available?	No recent third party tests are available.
		Inspection of metal surfaces	Metal surfaces of pumps are in good condition.
		Inspection of casings	Casings are in good condition.
		Visual examination of welded on connections, flanged connections, or threaded connections (do they have steel plugs?)	There are flanged connections and steel plugs are not found.
		Visual examination of vibrations, noise, or temperature	No major vibrations, noise or temperature issues are found concerning Karachi hot weather, but moist is an issue for panels it creates flash there though no major fire event reported ever.

		General inspection for workmanship, defects, and damage.	New PH is general in good condition staff is there for maintaining they do not have in-house capacity to repair big pumps or motors, they use some vendors for that.
		Visual inspection of painting and coating condition (look for spatters, blow-holes, and other defects)	Painting, Coating are in good condition no blow-holes, spatters and other defects are found.
		Are exposed shafts and shaft couplings covered with waterproof material and sealed?	Only coating is present on pipes and accessories but there are no other waterproof material or sealed.
		Visual check of spare parts, loose items and accessories for their dimensions, materials, workmanship and quantity,	They have some record of items and inventory. In new PH no loose items are found overall.
CONTROL PANEL	We need to assess the general condition	Is a wiring schematic at hand in door pockets or in a nearby folder?	Wiring schematic not found.
		Is the control panel correctly oriented and located within the PS?	This is okay
		Is everything labelled?	May be in the past but currently labeling not visible on all equipment
		Inspection of enclosure (paint damages or similar issues)	Overall panels paint is not in good condition
		Are verified signed-off electrical inspection reports available?	No report is available
		Are pilot lights operational?	Partially in operation
		Are all wires labelled inside the panel?	No
		Are all placards/closets in place?	No
		Is the surrounding free of debris or dirt?	Yes

OTHER ISSUES AND O&M RECORDS	Ask the main operator if they have any issues related to the operation, which will help the performance of the PS, for example: Would flow meters help to have a better control of the PS? Is it necessary to have a better pre-treatment (screens) to avoid algae from going to the sand filters? Do they have any issue related to automatic control and electrical issues? Are there any Operation and Maintenance records available? If they are not available, could we write up and recall some past repairs and issues? Are the offices and appurtenant facilities in good condition? Others?	New PH has no major issues regarding operation other than the usage of new line. They have controls and flow meters on every pump. Screen system would help in smooth operation. Humidity in Panel Room is an issues. Pumps A-1 17.5 MGD and B-3 35 MGD are in repairing with some vendors

4.3 Site Observations Checklist for Filtration Plant

Table 4-3 Typsa's Checklist and HPK's Comments (Filtration Plant)

TYPSA Checklist			HPK Comments
INLET SCREEN / TRASHRACK	The inlet screen is located before the raw water distribution chamber (see pics 9230 and 9231). It seems that there is a lot of algae going through. It is important to avoid any algae going to the filter to avoid reduce their performance.	Is there a bar separation in the screen?	No Screen System present on filtration Plant. Screen system is present in pump station but not functional, so any big obstacles coming from pump station should be removed there. Also Raising main pipes comes buried to filtration plant so screen may not be required.
		Is there an automatic cleaning for the screen?	Screen is not available
		Does the screen get clogged due to the algae?	Screen is not available
		Is there a deposit to keep the algae and waste?	Screen is not available
		Are these algae going through the screen interfering in the	Screen is not available

		performance of the sand filters?	
CHEMICAL DOSING	There are 4 chemicals which are dose in the WTP, which are: acid Alum Chlorine Lime	Are all chemical dosing pumps working properly?	Only Alum & Chlorine pumps are working. Acid & Lime pumps, piping & all accessories are out of order.
		Any leak from any chemical storage tank?	No leakage found from tanks. Acid Tanks are ok but pumps and piping are damaged.
		Is there a Flow meter to monitor the dose of all the chemicals?	Yes. There are meters and gauges on piping located on basement for Alum and Chlorine. They have digital sensors for chlorine level.
RAW WATER – DISTRIBUTION CHAMBER	The function of this distribution chamber is to distribute the Flow to the two lines of sand filters	Ask the main operator if: Is the flow distribution equally distributed to the two lines of sand filters?	Not Equal distribution.
		The chemical (Sulphur acid & alum) are dosed in this tank. Are these dosing pipelines in good condition?	Sulphuric Acid facility is not being used and is in abandoned state. Alum and Chlorine pipelines are ok. No major rusting found in main pipes. On basement some smaller diameter pipes are rusted.
LINE 1: FILTERS FROM 1 TO 8	The sand filter has been divided in two lines:	Are all the filters in good condition or will it be necessary to change the media (sand)?	Filters are in good condition as per KWSB person. It's difficult to see filters condition as filter bed are operational and filled with water. Filtration was previously automated but now being operated manually due to PLC faults.

	Line 1 : filters 1 to 8	Are the filters backwash pumps in good condition or it will be necessary to change some?	Filters backwash pumps are in good condition.
LINE 2: FILTERS FROM 9 TO 16	Line 2: filters 9 to 16	Are the blowers in good condition or it will be necessary to change some?	Out of 3 Blowers 2 are in good condition while 1 is out of order.
WASHWATER BALANCE TANK	The function of this tank is to hold the backwashing water from the filters.	Is this tank in good condition or anything else is required?	Balance Tank is in good condition. However, its stirrer is not working
WASHWATER RECOVERY SYSTEM	The function of this pumping station is to move the backwashing water to the sludge thickening	Are these pumps in good condition or it will be necessary to change some?	OK
SLUDGE GRAVITY THICKENER	The function of these tanks is to remove the sludge from the backwashing water	Are these sludge gravity thickeners working properly? How do they collect the sludge?	OK Sludge gravity thickener is in good condition. They have manual record of maintenance. They collect it manually by opening some valve and drain it to (Drain)Nallah by gravity and then dump to some designated space at some long distance.
RESERVOIR	We need to be able to outline the “flow line” from the WTP to the reservoir, and from the reservoir to Karachi end users.	Can we get the as-built drawings of the reservoir and WTP? Can we find out about operation and maintenance issues related to the reservoir?	Refer civil team report.
OTHER ISSUES	Ask the main operator if they have any issues related to the operation, which will help the performance of the WTP, for example:		
	Would flow meters help to have a better control of the plant?		Yes. Flow meters will help. They had flow meter in past.
	Is it necessary to have a better pre-treatment (screens) to avoid algae from going to the sand filters?		Sedimentation tank is not necessary.
	Would it help to introduce a sedimentation tank before the filter to improve the performance?		May be but apparently we don’t think
	Do they have any issue related to automatic control and electrical issues?		Yes. They have issues for automated controls like inlet and

		outlet flow meter are not there.
	Others?	No.

5 Major Observations, Suggestions & Recommendations

5.1 List of Major Issues

Table 5-1 Major Issues and their Suggestions

S.no.	Major Issues of New, Old Pump Station and Filtration Plant	HPK's Suggestions
1	*Screening System:* Screening System is not available in the Old pump station. Debris and other solid particles come from source of water i.e. from canal. Screen system is present for new pump house but is out of order.	Screening System should be repaired.
2	*Flow meters:* Flow meters are not present in the old pump station new pump station.	Flow meters are required at inlet and outlet.
3	*DG set supply for New pump station:* No backup power supply option is available for new pump station. In case of any power breakdown, new pump station cannot be taken online from any other source. Please note, power failures are frequent from the power supply from K-Electric.	New DG set should be added considering both pump stations load and condition of existing DG set in old pump station.
4	*Lime dosing system:* Lime dosing system is not functional at the filtration plant. Mixers are ok but lime slurry pumps are dismantled.	Lime dosing system should be repaired.
5	*Sulphuric Acid Dosing System:* Sulphuric Acid Dosing System is not functional at the filtration plant.	Acid dosing system should be repaired.
6	*Earthing System of MEP Equipment:* Condition of earthing pits, cable laying and termination are not in satisfactory condition.	Measurement of earth resistance should be done to check the effectiveness of earth system and all metallic enclosure & body of electric equipment must be ensured.
7	*Blower of filter bed:* *3rd standby* Blower of filter bed is not functional at the filtration plant.	Standby blower should be replaced/repaired.
8	*Balancing tank:* Balancing tank operation auto system is not functioning correctly at the filtration plant.	Balancing tank auto system should be corrected.

9	*Drainage sump pumps of old pump station:* *Auto* Sump pump system for drainage of water from trenches and other lower sections is all faulty. That's why, water is accumulated in all the trenches of pump station.	Auto Sump drain system should be corrected.
10	*Oil Circuit Breakers (OCBs) of 11 kV Switchgears of Old pump station:* OCBs MV switchgear are installed in the old pump station. System is operational. However, now OCBs technology is obsolete.	OCBs should be replaced with new VCB based MV switchgear with proper panel's auxiliaries and electronic protection relays.
11	*Moisture Issue in 11 kV Panels and other electrical enclosure:* Accumulation of moisture is found in all the metal-clad panels. De-humidification relay and heater are faulty in the MV panels.	De-humidification system is required.
12	*Shortage of Utility Supply/Load:* As discussed earlier in this report, Ultimate Power Supply is not sufficient as per the requirement.	More power should be sanctioned from Utility and power feeding cables to be checked accordingly.

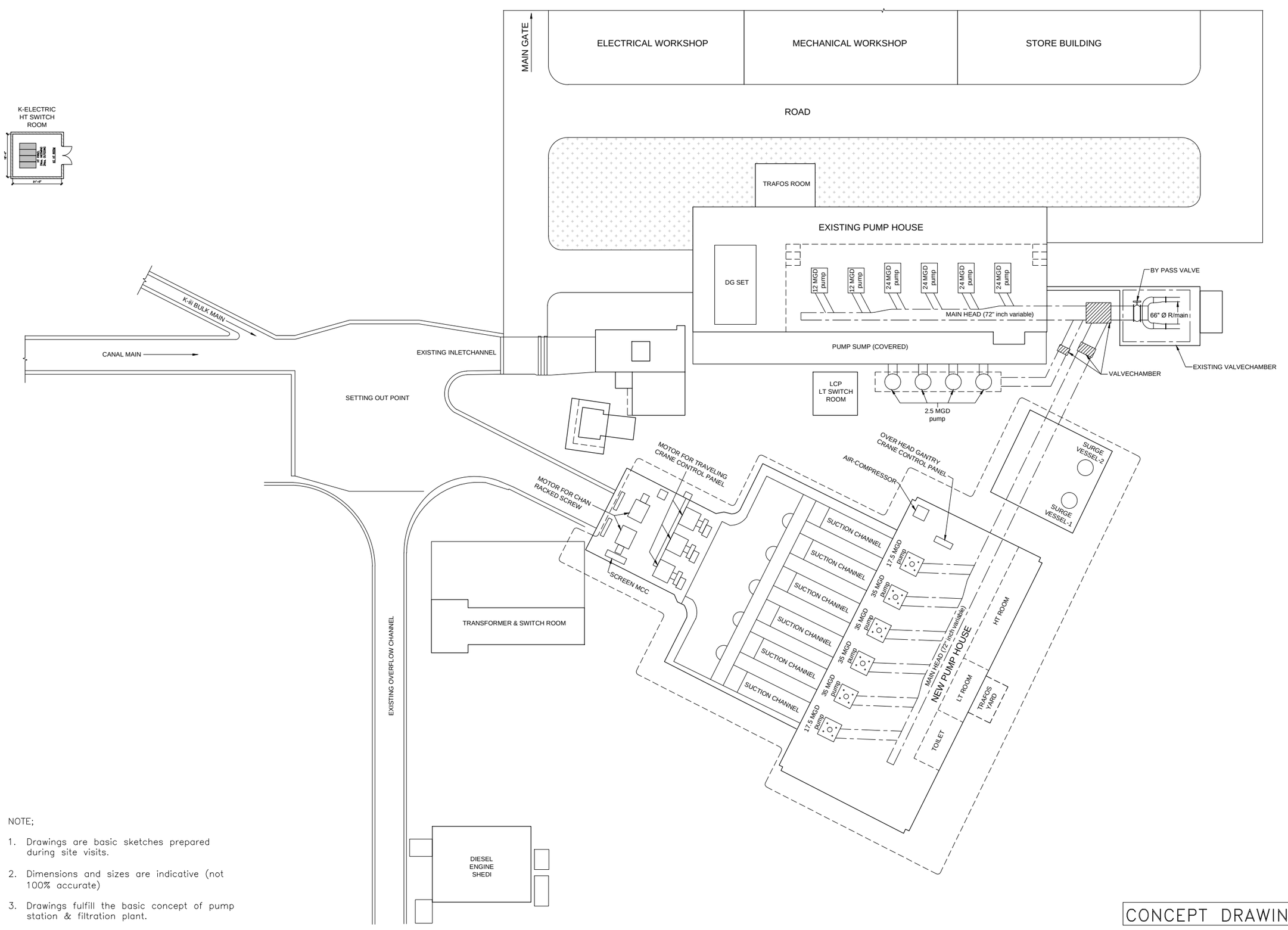
5.2 Other Related Observations

Table 5-2 Some Related Issues and their Suggestions

S.no.	Some Related Observations	HPK's Suggestions
1	Condition Assessment Tests for motors of pumps.	To check the current health and future expectancy life, following tests are suggested for MV motors: 1. Partial Discharge 2. Capacitance & Dissipation Factor 3. Insulation Resistance 4. DC winding resistance measurement 5. Dielectric response analysis (optional) 6. Voltage withstand test 7. Pole drop test
2	Condition Assessment Tests for MV Cables & LV cables	To check the current health and future expectancy life, following tests are suggested: 1. Partial Discharge 2. Insulation Resistance (Megger) of cable

3	Condition Assessment Tests for MV VCB Panel/Switchgear	To check the current health and future expectancy life, following tests are suggested: 1. Contact Resistance 2. Partial discharge 3. Resistance of insulation 4. Vacuum Condition
4	Condition Assessment Tests for Oil filled Transformers	To check the current health and future expectancy life, following tests are suggested: 1. Oil sampling and analysis 2. Electrical Transformer tests (e.g. insulation resistance, turns ratio, winding resistance etc.) 3. Partial Discharge
5	*Installation of LED lights:* Peripheral area lighting is not present. Inside pump stations and filtration plant lighting is old florescent lights based. Moreover, significant number of lights are not operational.	All lighting should be re-designed on LED based fixtures and external area light (within vicinity) should also be considered.

Appendix A (Old & New Pump Station Equipment Layout)



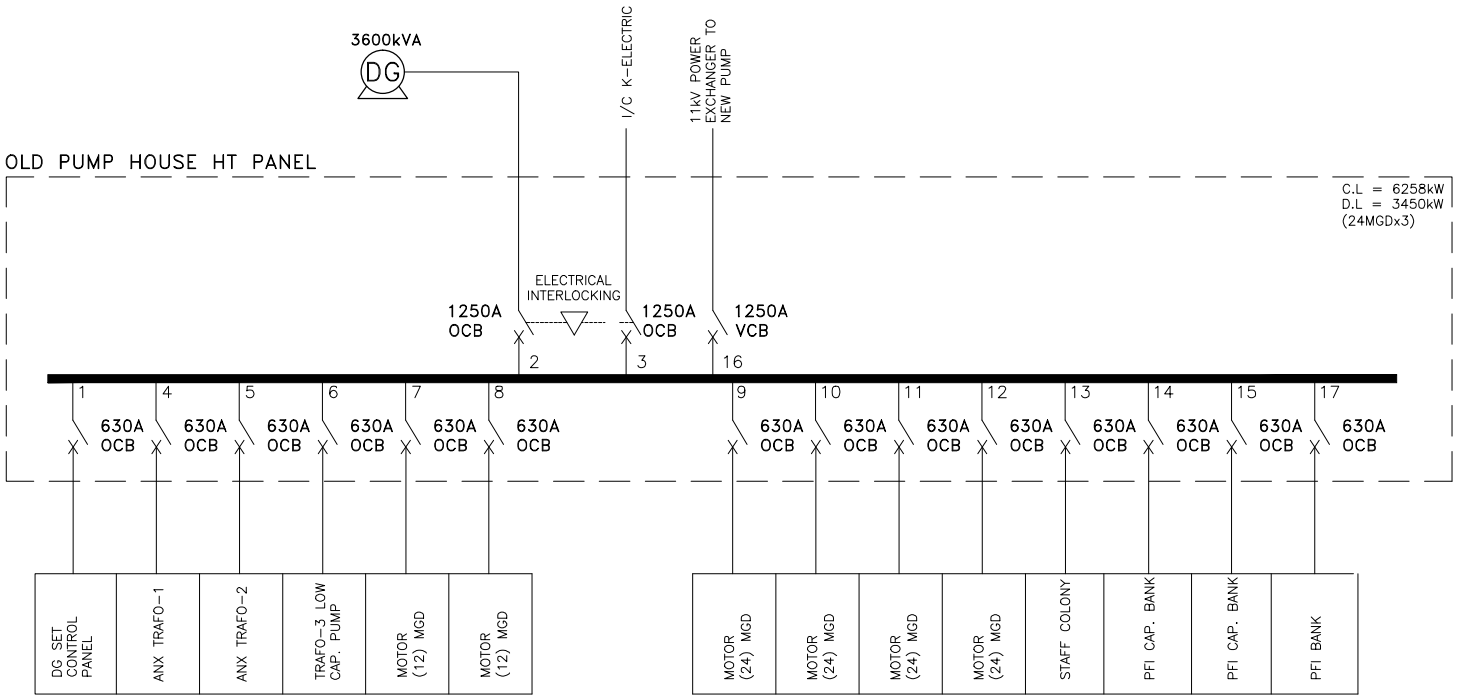
NOTE;

1. Drawings are basic sketches prepared during site visits.
2. Dimensions and sizes are indicative (not 100% accurate)
3. Drawings fulfill the basic concept of pump station & filtration plant.

CONCEPT DRAWING

PROJECT HUB DAM KARACHI SINDH PAKISTAN	CONSULTANT Halcrow Pakistan (Pvt) Limited (An independent Company formerly part of Halcrow Group) 3rd Floor, Nawa-e-Waqt House, Mauve Area, Sector G-7/1, Zero Point, Islamabad, Pakistan Tel: +92 51 2203451 E-mail: hpk@halcrowpk.com www.halcrowpk.com	DRAWN F.I CHECKED K.A DATE SEP. 2020	DRAWING TITLE OLD & NEW PUMP HOUSE EQUIPMENT LAYOUT	SHEET PS-01

Appendix B (11 kV SLD of Old Pump Station)



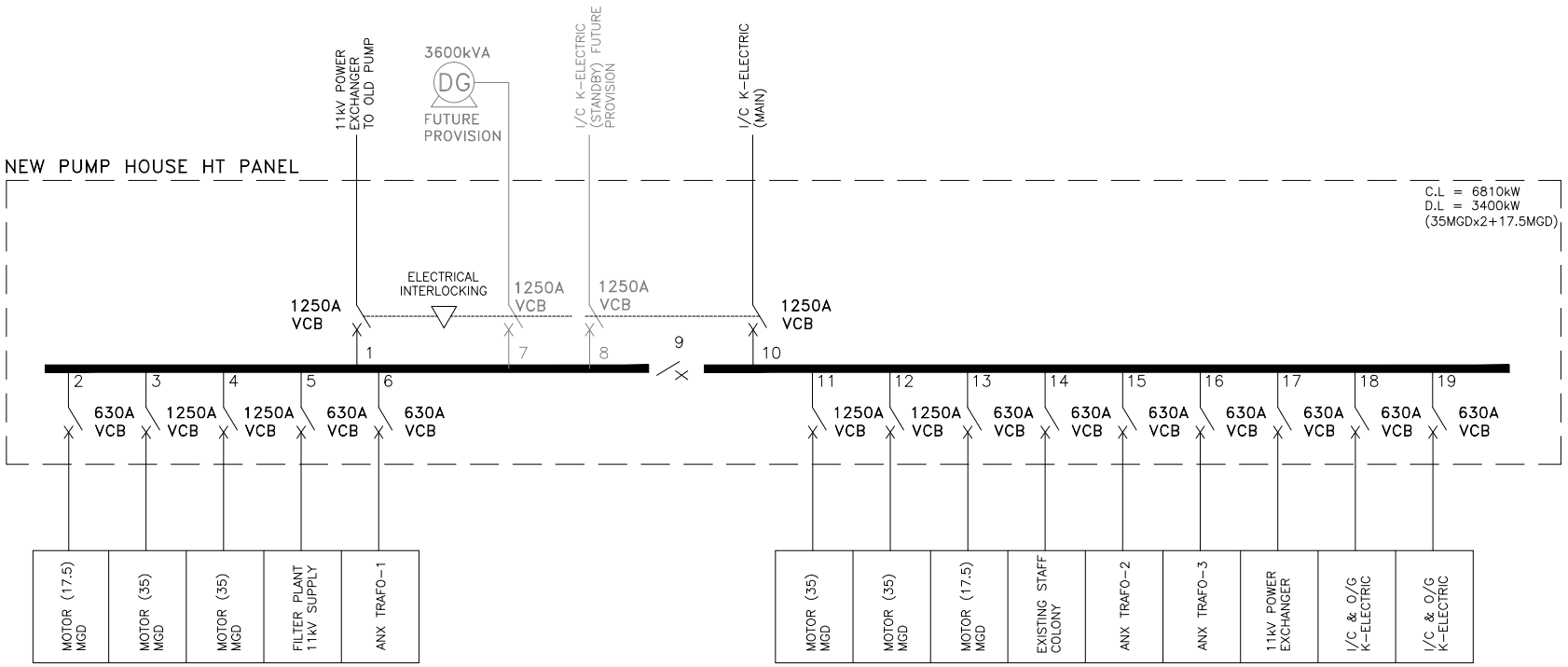
NOTE;

1. Drawings are basic sketches prepared during site visits.
2. Dimensions and sizes are indicative (not 100% accurate)
3. Drawings fulfill the basic concept of pump station & filtration plant.

CONCEPT DRAWING

PROJECT	CONSULTANT	DRAWN	DRAWING TITLE	SHEET
HUB DAM KARACHI SINDH PAKISTAN	Halcrow Pakistan (Pvt) Limited (An Independent Company formerly part of Halcrow Group) 3rd Floor, Nawa-e-Waqt House, Mauve Area, Sector G-7/1, Zero Point, Islamabad, Pakistan Tel: +92 51 2203451 E-mail: hpk@halcrowpk.com www.halcrowpk.com	F.I CHECKED K.A DATE SEP. 2020	OLD PUMP HOUSE 11kV SINGLE LINE DIAGRAM	PS-04

Appendix C (11 kV SLD of New Pump Station)



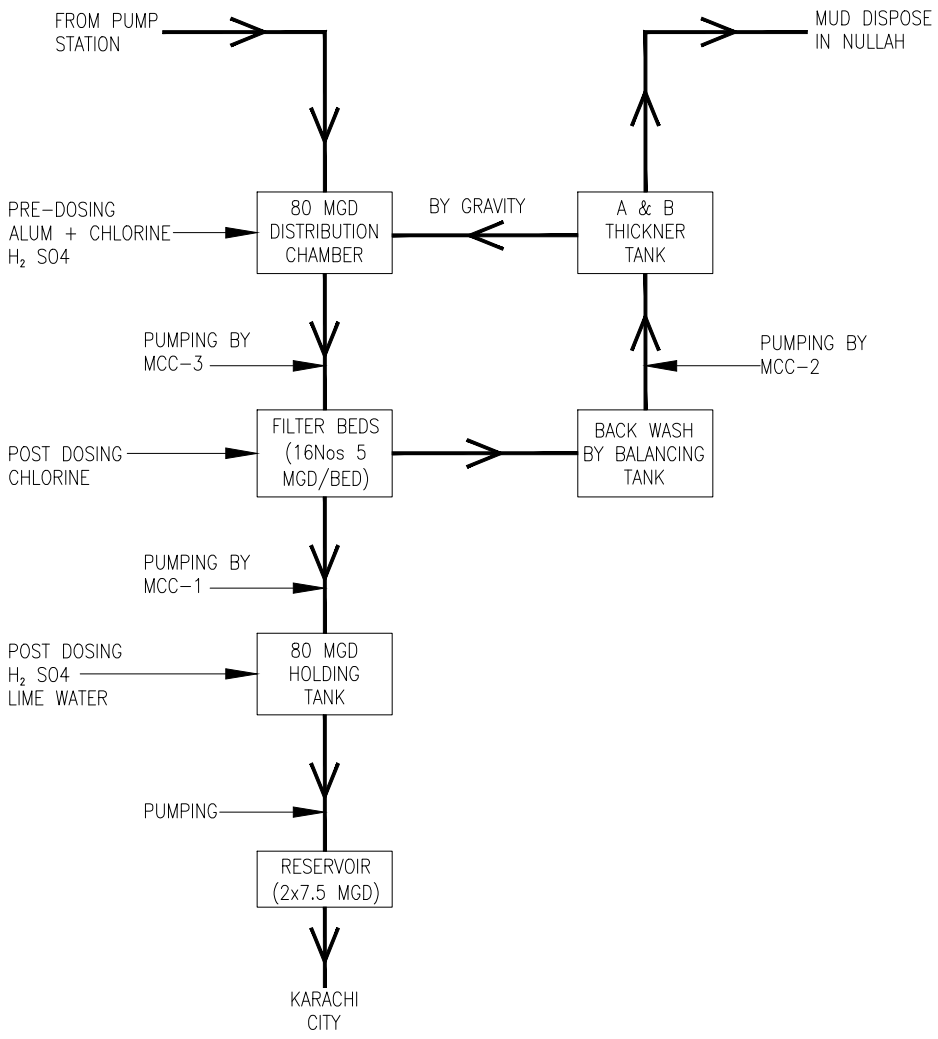
NOTE;

1. Drawings are basic sketches prepared during site visits.
2. Dimensions and sizes are indicative (not 100% accurate)
3. Drawings fulfill the basic concept of pump station & filtration plant.

CONCEPT DRAWING

PROJECT	CONSULTANT	DRAWN	DRAWING TITLE	SHEET
HUB DAM KARACHI SINDH PAKISTAN	Halcrow Pakistan (Pvt) Limited (An Independent Company formerly part of Halcrow Group) 3rd Floor, Nawa-e-Waqt House, Mauve Area, Sector G-7/1, Zero Point, Islamabad, Pakistan Tel: +92 51 2203451 E-mail: hpk@halcrowpk.com www.halcrowpk.com	F.I CHECKED K.A DATE SEP. 2020	NEW PUMP HOUSE 11kV SINGLE LINE DIAGRAM	PS-05

Appendix D (Flow Diagram of Filtration Plant)



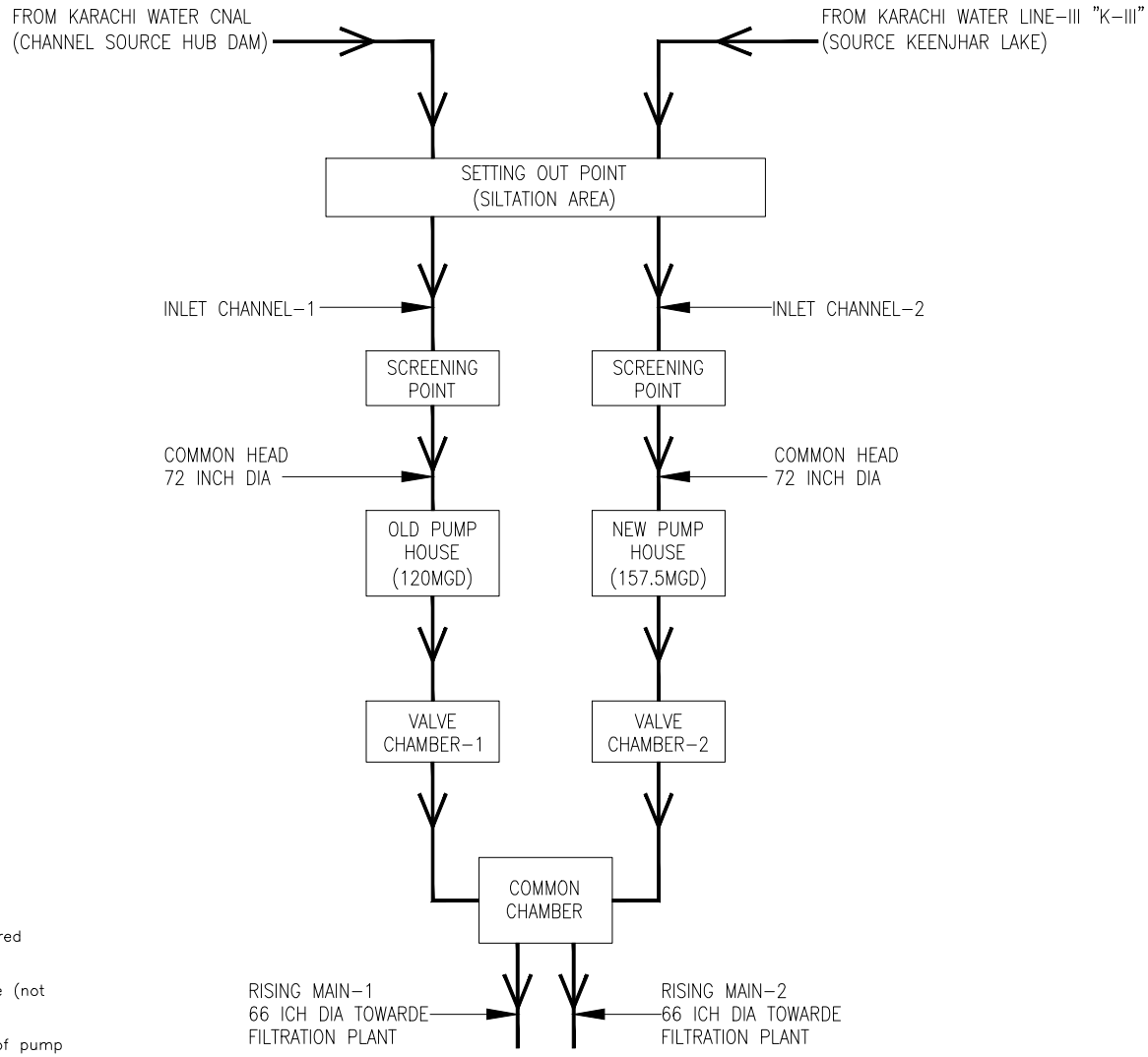
NOTE;

1. Drawings are basic sketches prepared during site visits.
2. Dimensions and sizes are indicative (not 100% accurate)
3. Drawings fulfill the basic concept of pump station & filtration plant.

CONCEPT DRAWING

PROJECT	CONSULTANT	DRAWN	DRAWING TITLE	SHEET
HUB DAM KARACHI SINDH PAKISTAN	Halcrow Pakistan (Pvt) Limited (An Independent Company formerly part of Halcrow Group) 3rd Floor, Nawa-e-Waqt House, Mauve Area, Sector G-7/1, Zero Point, Islamabad, Pakistan Tel: +92 51 2203451 E-mail: hpk@halcrowpk.com www.halcrowpk.com HPK	F.I CHECKED K.A DATE SEP. 2020	FILTRATION PLANT FLOW DIAGRAM	FP-02

Appendix E (Flow Diagram of Pump Station)



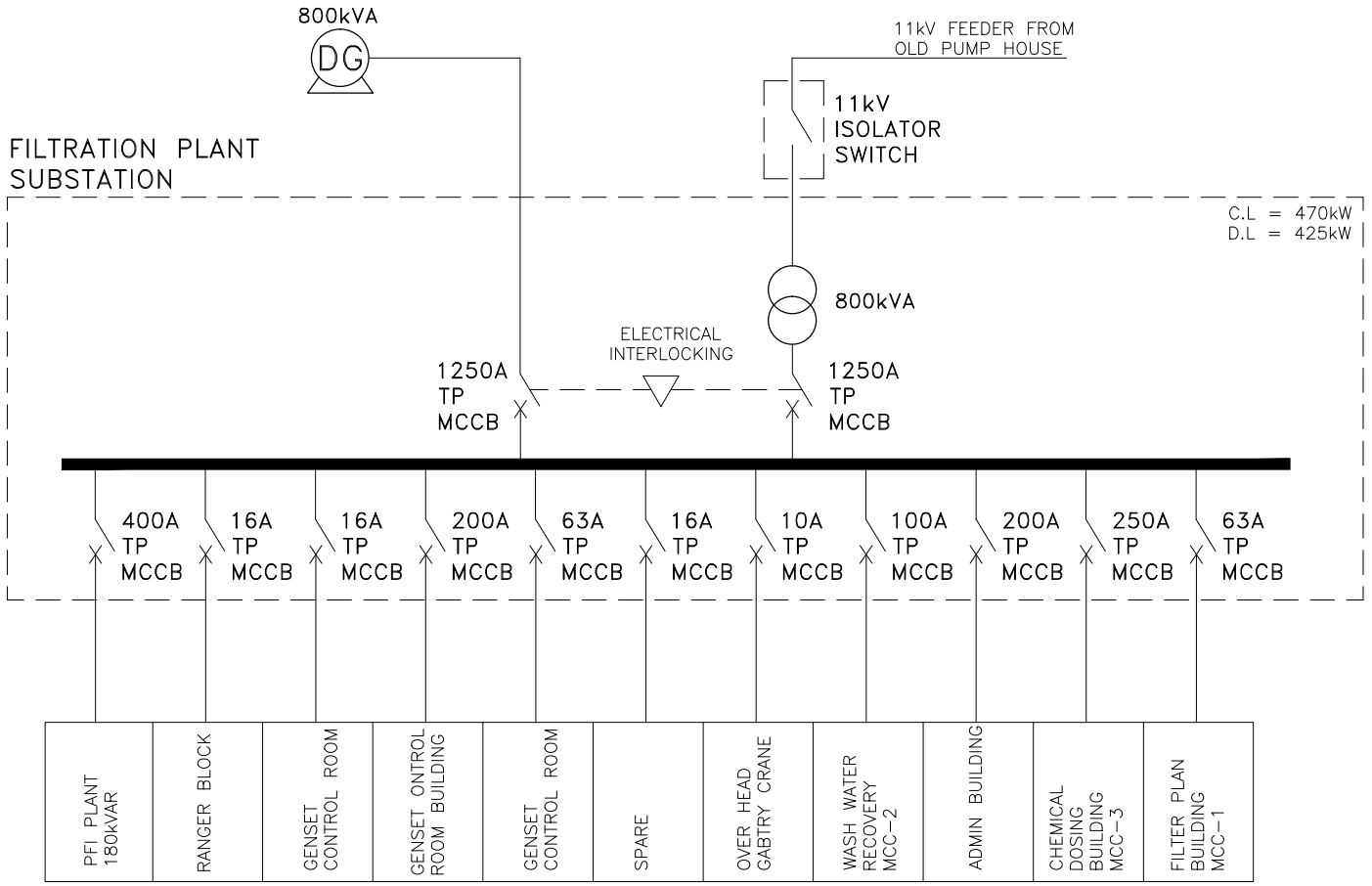
NOTE;

1. Drawings are basic sketches prepared during site visits.
2. Dimensions and sizes are indicative (not 100% accurate)
3. Drawings fulfill the basic concept of pump station & filtration plant.

CONCEPT DRAWING

PROJECT	CONSULTANT	DRAWN	DRAWING TITLE	SHEET
HUB DAM KARACHI SINDH PAKISTAN	Halcrow Pakistan (Pvt) Limited (An Independent Company formerly part of Halcrow Group) 3rd Floor, Nawa-e-Waqt House, Mauve Area, Sector G-7/1, Zero Point, Islamabad, Pakistan Tel: +92 51 2203451 E-mail: hpk@halcrowpk.com www.halcrowpk.com	F.I CHECKED K.A DATE SEP. 2020	PUMPING STATION FLOW DIAGRAM	PS–07

Appendix F (Main SLD of Filtration Plant)



NOTE;

1. Drawings are basic sketches prepared during site visits.
2. Dimensions and sizes are indicative (not 100% accurate)
3. Drawings fulfill the basic concept of pump station & filtration plant.

CONCEPT DRAWING

PROJECT	CONSULTANT	DRAWN	DRAWING TITLE	SHEET
HUB DAM KARACHI SINDH PAKISTAN	Halcrow Pakistan (Pvt) Limited (An Independent Company formerly part of Halcrow Group) 3rd Floor, Nawa-e-Waqt House, Mauve Area, Sector G-7/1, Zero Point, Islamabad, Pakistan Tel: +92 51 2203451 E-mail: hpk@halcrowpk.com www.halcrowpk.com	F.I CHECKED K.A DATE SEP. 2020	FILTRATION PLANT MAIN MV/LV SINGLE LINE DIAGRAM	FP-01

Appendix G (Site Photos)

Site Pictures – Karachi Water Canal Rehabilitation Project

24 MGD Pump Old PH		Dismantled Valve Old PH
Large & Small Pumps old PH		Old PH piping
Sump Drain Pumps Old PH		Sump Drain System Old PH

Dismantled New Pump

New Pump Name Plate

Branch Pipe New PH

Main Pipe New PH

Main Line to Vessel		Inlet System

Chlorine Cylinders		Toxic Gas Detector

Safety Shower Chemical Building

Fire Cabinet Chemical Building

Chlorine Dosing Pumps

Lime Dust Collector

Lime Slurry Pumps

Chlorine Dosing System

Acid Building

Acid System Piping

Acid Tanks		Chlorine fume Extractor Fan

Chlorine Meter		Generator Room Exhaust

Filtration Pumps		**Filter Bed**
Blowers		**Balancing Tank**

CONSULTANCY SERVICES FOR SELECTION # 1267471 KARACHI WATER CANAL PROJECT

ENVIRONMENTAL ASSESSMENT OF KARACHI CANAL

September 2020

TYPSA

HPK

DOCUMENT HISTORY

Project Name

Report Name

This document has been issued and amended as follows:

Version	Date	Description	Prepared by	Reviewed by	Approved by
1	29/09/2020	Draft	Aqeel Ahmed Magsi	Azeem Akram	Margaret Trias

CONTENTS

1 Introcduction 4

1.1 Karachi Water Supply Canal PPP 4

2 Scope of Works 5

2.1 Purpose and objectives 5

3 Study Methodology 6

3.1 General 6
3.2 Methodology 6
3.3 Field Observations: 6
3.3.1 Land to Each Side of the Canal 6
3.3.2 Areas of visible seepage and water loss from the canal 7
3.3.3 Aqueducts: 7
3.3.4 Wetlands: 12
3.3.5 Open ponds: 12
3.3.6 Shrub, Herb and Grass Mix: 12
3.3.7 Utility lines 13
3.3.8 Water off takers along the canal 15
3.3.9 Observations on flora and fauna 17

4 Environmental Management 19

4.1 Information from KWSB regarding community engagement and interaction with respect to environmental issues 19

TABLE S

3-1: Flora of the Project Area 17

3-2: Birds of the Project Area 18

1 INTROCDUCTION

1.1 Karachi Water Supply Canal PPP

Project Background

Water is one of the basic necessities of life; life cannot sustain itself without water. Scarcity of this precious commodity creates significant stress in human life and tends to negatively affect human performance and behaviour. As such, therefore, access to adequate supply is not only recognized as a basic right of every citizen of the country but provision of adequate supply is mandated on the government in the constitution, particularly so in urban environs. Supplying of water in Karachi City of Pakistan is becoming a big challenge for the Karachi Water and Sewerage Board (KWSB) due to increasing in population of city area and growing demand. To enhance the capacity of the canal by rehabilitation at Hub dam to curtail water losses due to leakage and other anthropogenic activities, the Government of Sindh has appointed the International Finance Corporation (IFC) to provide transaction advisory to support KWSB in structuring and selecting credible private sector developer who will undertake the rehabilitation and maintenance of canal work.

In cognizance of the growing water need of the city, a water supply scheme from the Hub Dam was planned and executed in the late 70s. The scheme is designed to bring 100 mgd of water from the Hub Dam and it was finally commissioned in 1981. The scheme relies on availability of water received from catchments after rains. There have been instances, when due to draught conditions in the Hub Dam catchment area, the water level in the dam went down to such an extent that water to the city could not be supplied. The main Hub Canal offtakes from the Hub Dam and travels approximately 8 kms in the South-Westerly direction. This section of the canal is designed to carry water destined for the Hub Pumping Station in addition to water for the Lasbela Canal with off takes from the Head Works at far end of this section.

Hub dam is a large water storage reservoir, constructed on Hub River for supply of Municipal, Industrial and Irrigation water to Sindh and Balochistan. The Main Canal discharges from the dam and bifurcates into two branches after flowing about 8km at Head Regulator called the Lasbela Canal and branches off at this location and travels in a Southerly direction. The Hub Canal continues in in a South-Westerly direction onwards. There are no flow measurement devices installed at the head works, the flow estimates being derived indirectly from the sluice gate opening levels.

Hub Canal

Hub canal off-takes from the combined channel at chainage 258+00 which off-takes from Hub Dam. The Karachi Water Supply Canal is approximately 21.2 or 22 km flowing in a South-westerly to Westerly direction, and total Chainge 685+000 long open lined channel. The uninterrupted and Pollutant water is supplied through this canal, terminates at KW&SB Pumping Station near Manghopir-Karachi. This stretch of the Hub Canal is under KWSB ownership. The canal design capacity at the head is 113 mgd although it is reported that it is not able to pass this discharge. There are 11 concrete bridge aqueducts along this length.

2 SCOPE OF WORKS

2.1 Purpose and objectives

The Objective of the field visit is to identify preliminary environmental features and collection of information during the initial site visit should provide the basis for further scoping studies to be carried out at a later stage. Site visit observations contributed to the identification of preliminary environmental features and constraints along the full length of the canal: from the KWSB plant to the head works at the bifurcation (with canal to Baluchistan).

The site visit observations will aim to meet the following main objectives:

I. Identifying and characterizing sensitive “areas” that may potentially be affected by the project. Sensitive areas might be:

- Surface water bodies: streams (ephemeral and permanent, ponds, etc.). Streams under the canal aqueducts might be a result of canal seepage or natural streams (permanent or temporary during monsoon season). All of the water bodies should be described (as either permanent or temporary, and provide an opinion to weather these streams are fully or partly due to canal seepage, and located on a kmz file after the site visit.
- Vegetated areas: these green areas may be a result of seepage or natural streams, provide an opinion of whether these areas are clearly a result of seepage or not (as much as possible). This may be difficult to determine if seepage is underground.
- Also identify if the communities using these areas use trees and timber for firewood (if you see fire pits or see people gathering wood for fire).
- Identify and take notes on any flora and fauna (including nests and other signs of wildlife) observed during the site visit, and if possible take photographs (identify birds by their common name and scientific name, herpetofauna, amphibians, mammals etc. and any species of trees and flora that may provide significant habitat or are endangered species).

II. Identifying locations with obvious signs of soil or water contamination or areas with excessive waste accumulation.

III. Identify any sources of waste or effluents that may contaminate of impact water quality in the canal.

IV. If you are travelling with KWSB staff, they may be aware of such areas so please consult them on these issues.

V. All features and sensitive areas identified during the site visit must be geolocated (obtain coordinates to be able to place them on a kmz file.

Other information that is required but that can be obtained from a desk-top exercise is also described in this document.

The purpose of the field visit is to;

- Undertake an E&S scoping study for the Project and allied components
- Provide support on Project E&S issues during the advisory transaction

3 STUDY METHODOLOGY

3.1 General

Karachi Canal site visit was undertaken on 19th and 20th September, 2020 (Saturday & Sunday) from early morning (0700 hrs till late evening 0700) and captures all important environmental aspects. The climate of the Karachi can be characterized by dry, hot and humid conditions and in general terms it is moderate, sunny and humid. The weather condition during the field visit remained clear, hot and humid.

The “project area” referred to includes at least a 200 m radius from the project foot print or canal and activities or greater in areas where seepage are contributing to groundwater and surface water that allows for agricultural activities /crops and other domestic and drinking water purpose.

3.2 Methodology

To collect the primary information from field visit, following methodology was adapted,

- Walkthrough along the water canal to identify spatial activities
- In house meeting with the KWSB staff at field Identified communities, structures, agriculture and other spatial activities at Project area
- Coordinates of the important areas of interest has been obtained using GPS along with photographs for authentication.
- Collection of information about sensitive receptors and for further scoping studies.
- Understanding the administrative structure within project area
- Identify the current canal water uses by community members
- Identify areas of obvious visible seepage
- Identify any environmental, cultural, sacred features which may pose a constraint to the project.

A joint field visit was carried out for environmental assessment with the support of Mr. Imtaiz Afridi, Assistant Executive Engineer Karachi Water and Sewerage Board (KWSB) and Environmental Support Consultant Muhammad Shayan Ansari and Aqeel Ahmed Magsi to collect the primary information from field visit.

3.3 Field Observations:

3.3.1 Land to Each Side of the Canal

The area surrounding the Karachi Water Supply Canal is passing through mostly plain areas along dominated by hard rocky hills, small agricultural lands, trees thickets and few orchards observes. Some of the utility lines are also crossing over the Karachi Canal, particularly near Northern Bypass and Hamdard University road. The Project area contains fertilized soil which support heavy vegetation during rainy season and allow cultivation where there the water is available. The heavy vegetation at Project area occurs due to moon soon rainy season and seepage at different locations. The initial

study has pointed out location for heavy vegetation; however the detail study will identify the specific reason for vegetation in the area.

Furthermore, livestock are allowed to bathe and drink water from this canal and this is a major reason behind canal water contamination. There are no specific allocated common grazing lands for grazing of the livestock. All communities have goats which move around the area for feeding at adhoc grazing locations and drinking water from canal.

In addition, agricultural activity and households that benefit from seepage of canal water or collect water from the canal may be impacted adversely due to stopping of seepage or if they are stopped from collecting/ fetching water for their use. The agriculture field within the influence area of the project cultivate land has been identified

3.3.2 Areas of visible seepage and water loss from the canal

The canal is in poor condition currently and the lining is fractured and cracked at numerous locations all along its length. Weeds and bushes have grown in these cracks and crevices, not only hampering smooth flow but also further damaging the lining as they grow and flourish. At almost all such locations, where the lining has given way, the exposed Geo Membrane has also been compromised. The seepage from the canal due to deterioration of structure (including main canal and aqueduct) was frequent. The seepage has created number of small wetlands on both sides of canals which have thick vegetative cover of grasses (typha and phragmites) and trees/bushes of mainly mesquite/Devi (Prosopis juliflora). At some points, trees of neem (Azadirachta indica) and bargad (Ficus benghalensis) are also planted providing shade to local communities.

The main purpose and primary objective of Hub canal to address the impending water crisis in the city of Karachi. In addition, numerous private connections sanctioned from this canal, the water is pumped through a pipe connection furthermore the present use of the canal is for recreational activities (people swimming, Bathing / washing cloth etc) unsightly, causes unpleasant odours through the urban reaches of the canal. Individuals can be observed filling containers for home consumption, and others filling small tanks/ bowsers carried by animal drawn or motorcycle drawn trailers. As a result, it is apparent that the demand for water supply from the canal has increased relative to the assumptions made in the original design.

Furthermore, it has observed that the people were coming to the canal side for recreation activity. (Note: there is no specific points for recreational activities but as people feel convenient). People come here for camping, enjoying with water, cook foods and bathing from the canal water. There are many natural water channels observed in the Project area, where causeway has already been developed for run of water. Meanwhile, the road crossing over the canal at different location has been identified. These locations will help considering precautions during Project activities

3.3.3 Aqueducts:

A total number of eleven (11) aqueducts are located on the hub canal to carry out the water from head of the canal to Hub pumping station. The bottom liner has deteriorated completely and has resulted in seepage around the canal area. In general, the conditions of aqueducts were poor and seepage was clearly visible and has resulted in permanent wetland around the area. Aqueducts were surrounded by thick vegetation herb, shrubs and grass mix.

Figure: Aqueduct 01

25°11’25.8”N, 67°03’41.28”E

25°11’25.8”N, 67°03’41.28”E

Figure: Aqueduct 02

25°11’19.80”N, 67°03’37.69”E

25°11’19.67”N, 67°03’37.67”E

Figure: Aqueduct 03

25°11’16.20”N, 67°03’34.83”E

25°11’16.64”N, 67°03’35.07”E

Figure: Aqueduct 04

25°10’40.54”N, 67°03’22.43”E

25°10’39.66”N, 67°03’22.28”E

25°10’39.76”N, 67°03’22.32”E

25°10’39.76”N, 67°03’22.32”E

Figure: Aqueduct 06

25°10’14.46”N, 67°03’23.26”E

25°10’14.46”N, 67°03’23.26”E

25°10’14.43”N, 67°03’23.22”E

25°10’14.30”N, 67°03’21.56”E

Figure: Aqueduct 07

25°09’24.28”N, 67°03’22.23”E

25°09’23.93”N, 67°03’22.38”E

Figure: Aqueduct 08

25°08’48.52”N, 67°03’12.26”E

25°08’48.79”N, 67°03’11.69”E

Figure: Aqueduct 09

25°07’45.60”N, 67°02’59.81”E

25°07’45.57”N, 67°02’59.88”E

Figure: Aqueduct 10

25°06’11.00”N, 67°02’37.58”E

Figure: Aqueduct 11

25°02’46.89”N, 67°01’37.02”E

25°02’47.00”N, 67°01’37.91”E

3.3.4 Wetlands:

Reed beds are common within the project area, running alongside the canal and it has been formed due to continuous water seepage from the canal and it shall remain as stable habitats for as long as they continue to be recharged with seepage water from the Karachi Canal. Reed beds are formed within the ROW limit and will be under the footprint of proposed rehabilitation work.

3.3.5 Open ponds:

Temporary water bodies (open pond) were also found which the resultant of seasonal rainfall is. Recently, Karachi receives the heavy rainfall during the month of July and August and therefore, the footprint of rainfall was evident. At few places, open ponds were formed because of the water passing through the culverts.

3.3.6 Shrub, Herb and Grass Mix:

As the canal passes through the hilly areas grasses and shrubs are also found. As the distance from the canal edges increase, the water depth of reed beds reduces and the reed bed become sporadic, interrupted by areas of grasses or shrubs as shown in figure below:

3.3.7 Utility lines

Electricity poles: A number of transformer, heavy transmission line and electricity poles are situated within the ROW particularly over and adjacent to northern bypass road,

25°01’29.80”N, 67°01’12.90”E

25°01’28.55”N, 67°01’11.71”E

Gas Pipeline:

Two gas pipelines of 20 & 18 inch diameter are crossing the canal. The former gas pipeline is feeding the Sharshah, while the other is supplying gas to Attock refinery at hub chowky, upon inquiry from the KWSB staff; it was found that both gas pipelines belongs to the Sui Southern Gas Company (SSGCL) Limited

25°04’5”N, 67°02’29.77”E

25°04’54.45”N, 67°02’29.76”E

25°04’45.63”N, 67°02’25.56”E

25°04’34.80”N, 67°01’18.44”E (Small Industry Pipe Line)

Spoil heap:

A number of soil heaps covered with vegetation are located along the canal area and its quantity needs to be estimated in order to select an area for disposal during the construction phase.

25°01’26”N, 67°01’10”E

25°01’24”N, 67°01’11”E

25°01'20"N, 67°01'11"E

25°01'2"N, 67°01'11"E

3.3.8 Water off takers along the canal

Hamdard University:

Water for the Hamdard University has been sanctioned from this canal. The water is pumped out through a pipe connection.

Sindh Small Industry Corporation:

A 12" inch diameter water pipe line sanctioned to the Sindh small industry cooperation currently water connection is not in operational phase due to unavailability of the project site and few other remaining KWSB department requirements.

Localized Domestic and Husbandry Demand:

There are local settlements along the canal and the residents use this canal for bathing, washing and take water for domestic and husbandry. Overall in the sub-project area people own famous breeds of buffaloes, cows and goats and sheep. Livestock is the main source of milk, meat and ghee for the local population. Livestock is also a source of income as people of the area keep cow/bulls, goat and sheep to sell annually at Karachi market.

Illegal Water Offtake:

At one location, a temporary pipe arrangement was seen, designed to take water from the canal. The connection appeared unsanctioned. Given the temporary nature (use of flexible suction pipes) one can argue that such connections can vary in numbers over the days very easily. Limited agricultural activity was observed along the canal alignment, particularly in stretches closer to the Hub Pumping Station.

Recreational facilities:

Even though the canal water is used for drinking purpose, it was observed that people were using it for bathing purpose especially during the weekends and summer season. The violation of law/rule also subject to the no proper signage placement around the canal and lack of patrolling from the concerned departments. Along with this, the nearby community particularly people living around the Landfill area were also seen washing there cloths around the canal area.

3.3.9 Observations on flora and fauna

The study area of the Project includes impact area of the project and its area of influence. The impact area of the Project includes all permanent and temporary areas (the footprint) that will be covered under rehabilitation works of the Karachi canal. The basic objective for environmental Local Specialist was to record observations on flora and fauna of the project area (with common names, and scientific names) and to identify any sensitive/natural/greener area within the project area.

This segment of the Karachi Water Canal is passing through mostly plain areas along small hills and agricultural fields/orchards. The seepage from the canal due to deterioration of structure (including main canal and aqua ducks) was frequent. The seepage has created number of small wetlands on both sides of canals which have thick vegetative cover of grasses (typha and phragmites) and trees/bushes of mainly mesquite/Devi (Prosopis juliflora). At some points, trees of neem (Azadirachta indica) and bargad (Ficus benghalensis) are also planted providing shade to local communities and nesting places for avian species and squirrels.

Thick vegetative cover provides shelter to local avian species including Black and Grey francolins, small mammals and herpetofauna. The wetlands created by seepage water and hill torrents are wintering habitat for a number of migratory water birds. One Common sandpiper (Actitis hypoleucos), early arriver was recorded/photographed at Canal bank. Cattle egrets (Bubulcus ibis) were common on these wetlands.

This part of the project area is in built environment. Planted trees (Neem and Conocarpus) and electricity poles provide shelter and roosting places. The birds observed/photographed include Black kites (Milvus migrans), House crows (Corvus splendens) and Blue Rock/feral pigeons. The tall grasses and cavities in buildings are habitat for common reptiles.

3-1: Flora of the Project Area

	Local / Common Name	Scientific Name
	Ak	Calotropis procera
	Bargad	Ficus benghalensis
	Bhang	Canabis sativus
	Devi/Mesquite	Prosopis juliflora
	Conocarpus	Conocarpus acuminatus
	Common Grass	Cynodon dactylon
	Jangli Ber	Ziziphus nummularia

	Local / Common Name	Scientific Name
	Kana	Saccharum spontaneum
	Khajoor/Dates	Phoenix dactylifera
	Lawi/Tamarix	Tamarix aphylla
	Nara/Phragmites	Phragmites karka
	Neem	Azadirachta indica
	Typha	Typha latifolia
	Sufaida/Eucalyptus	Eucalyptus globulus
	Tali/Shisham	Dalbergia sissoo

3-2: Birds of the Project Area

	Common Name	Scientific Name
	Bank myna	Acridotheres ginginianus
	Black crowned finch lark	Eremopterix nigreceps
	Black kite	Milvus migrans
	Black partridge	Francolinus francolinus
	Blue rock pigeon	Columba livia
	Brown hill warbler	Prinia criniger
	Cattle egret	Bubulcus ibis
	House crow	Corvus splendens
	House sparrow	Passer domesticus
	Indian myna/Common myna	Acridotheres tristis
	Indian pond heron	Ardeola grayii
	Indian roller	Coracias benghalensis
	Indian tree-pie	Dendrocitta vagabunda
	Koel	Eudynamys scolopacea
	Little brown dove	Streptopelia senegalensis
	Little green bee-eater	Merops orientalis
	Pied bushchat/Pied chat	Saxicola caprata
	Purple sunbird	Nectarinia asiatica
	White-cheeked bulbul	Pycnonotus leucogenys

Aquatic life of the Project Area

The project area is blessed with different types of wetlands including Karachi Canal itself. These wetlands must be with aquatic life including fish, Freshwater turtles and amphibians in addition to invertebrate life forms. However, a comprehensive survey is required to confirm their presence in the project area.

4 ENVIRONMENTAL MANAGEMENT

One of the most important and prevailing issues in Karachi is increasing volumes of solid waste which is mainly due to lack of financial and technical resources available for the city in general. The municipal body of Karachi struggles to manage solid waste in an environmentally sound manner and the amount of solid wastes is expected to substantially increase with rapid growth of population and economic activities within the city. In recent years the amount of waste generated within the city has substantially increased up to approximately 14,000 to 16,000 tons per day. It is also estimated that by the end of year 2020, solid waste generation may reach up to 18,000 to 20,000 tons per day. The current solid waste management practices of the city are poor and needs adequate attention of the authorities. In addition EIA study of waste management facility also revealed that there were no engineered landfill sites (both hazardous and non-hazardous) in the city; however, the available site referred to as “Landfill Sites” are merely open dumping sites prominently located at; Jam Chakro, Dhabeji, Mehran Town and Govnd Pas. Looking at the increasing amount of solid waste generation presently Gond Pass and Jam Chakro landfill sites are used for the main dumping site in Karachi.

The proposed project consists of Repair / Rehabilitation of the KWSB section of the existing Hub Canal in a length of about 22 km supplying water to the city of Karachi from Hub Dam in the Northern periphery of Karachi to the Hub pumping station. The closest waste management facilities in the project area is Jam Chakro landfill site where municipal solid waste, hazardous waste, recycling facilities (plastics, paper/cardboard, scrap metal, composting facilities) where Karachi waste dumped. Open burning of the waste was observed therefore it generates the environmental issues due to the open burning of the waste.

4.1 Information from KWSB regarding community engagement and interaction with respect to environmental issues

- There are no stakeholder’s engagement programs for the local community for the project along the canal
- There are no awareness raising campaign or signage were not recoded during the field visit to prevent the local people to polluting the during the recreational activities

Draft Field Visit Report

Karachi Water Canal- HUB DAM

Prepared by: Tasneem Maqbool

Dated: 24-08-2020

On behalf of HALCROW Pakistan

Contribution; Karachi water and Sewerage Board

Information Obtained: One Day Field Visit

Secondary information through literature review

Mapping by- Google earth

Table of Contents

1. Introduction 2

2. Purpose and Objective 2

3. Applicability 2

4. Methodology 3

5. Identified communities, structures, agriculture and other spatial activities at Project area 3

6. Stakeholder Consultation during field visit 6

7. Field Observation 6

8. Brief about Local Communities at Project area 7

9. Focus Group Discussion 8

10. Other infrastructure 8

11. Findings and Recommendations 9

12. Filed Visit Photos 10

Table

Table 1: Structures and communities along with spatial activities 3
Table 2: Stakeholder Consultation 6

1. Introduction

Supplying of water in Karachi City of Pakistan is becoming a big challenge for the Karachi Water and Sewerage Board (KWSB) due to increasing in population of city area and growing demand. To enhance the capacity of the canal by rehabilitation at Hub dam to curtail water losses due to leakage and other anthropogenic activities, the Government of Sindh has appointed the International Finance Corporation (IFC) to provide transaction advisory to support KWSB in structuring and selecting credible private sector developer who will undertake the rehabilitation and maintenance of canal work.

To understand the E&S risk and potential impacts affecting the Project, IFC has obtained the services of consultant who will inform IFC advisory, the client, and the bidders about the related gaps in information and ways to close such gaps and support the Project development in line with IFC Performances Standards "(IFC PS").

This document is the initial draft of the field visit that contains the information obtained from local communities residing in surrounding of the water canal.

2. Purpose and Objective

The Objective of the field visit is to identify preliminary environmental and social features and constrains by;

- Identifying and characterizing "sensitive receptors" within the project affected area that may potentially be affected by the project.
- Understanding the administrative structure within the project affected area, identifying communities, administrative boundaries and community leaders.
- Identifying current canal water uses by community members (recreation, bathing, washing etc.)
- Identifying areas of obvious visible seepage from the canal or the aqueducts.
- Identifying any environmental, cultural, sacred features which may pose a constraint to the project.

The purpose of the field visit is to;

- Undertake an E&S scoping study for the Project and allied components
- Provide support on Project E&S issues during the advisory transaction

3. Applicability

The team has identified the "sensitive receptors" and other administrative structure within the Project area. The "project area" referred to include at least a 200 m radius from the canal and greater in areas where seepage are contributing to groundwater and surface water that allows for agricultural activities and other domestic and drinking water purpose.

The Sensitive receptors has been considered in two main categories:

- Water criteria: agricultural activity and households benefitting from the seepage from the canal and are adversely impacted if seepage stopped.

- Vicinity criteria: sensitive receptors that may be affected by the project's construction activities because they are located near the canal and water treatment plant (noise, dust, property damage claims, rehabilitation required post-construction etc.)

4. Methodology

To collect the primary information from field visit, following methodology was adapted,

- Stakeholder Consultation with local people from surroundings
- Focus group discussion with males and females of the communities living within impacted zone
- Walkthrough along the water canal to identify spatial activities
- In house meeting with the KWSB staff at field

Coordinates of the important areas of interest has been obtained using GPS along with photographs for authentication.

5. Identified communities, structures, agriculture and other spatial activities at Project area

The Project area contains the agriculture areas and dense vegetation. However, some communities living nearby canal for agriculture activities. The location of structures, cross ways, agriculture fields and natural water channels are given below,

Table 1: Structures and communities along with spatial activities

Communities at Project Area				
S.No.	**Village / Goth**	**Coordinate**	**Status**	**Remarks**
1	Scattered Settlements (6 to 7 number of houses)	25° 1'38.27"N 67° 1'20.90"E	Informal Users	Came for agriculture activities
2.	Jam Chakro (4 to 5 Nos. houses)	25° 1'48.26"N 67° 1'29.36"E	Nomads	Migrated with Livestock from Thatta due to unavailability of water
3	Maharaj Community (5 to 6 Nos. houses)	25° 5'1.83"N 67° 2'26.62"E	Nomads	Migrated from Kashmore for agriculture work
4	Patai Brohi (40 Nos. of houses)	25° 6'41.94"N 67° 2'51.61"E	Permanent	They do faming, animal husbandry, labor, govt. and private jobs
Structures				
S.No.	**Structure**	**Coordinate**	**Status**	**Remarks**
1.	Communication Tower	25° 1'13.30"N 67° 1'11.15"E	Active	
2.	Recreational activities	25° 4'33.70"N 67° 2'7.85"E	Active	
Cross Ways				
S.No.	**Structure**	**Coordinate**	**Status**	**Remarks**
1.	Cross way	25° 1'29.28"N 67° 1'11.89"E	Permanent	Use for vehicles
2.	Cross way	25° 4'47.40"N 67° 2'26.21"E	Permanent	Use for vehicles

3.	Cross way	25°11'35.94"N 67° 3'48.05"E	Permanent	Use for vehicles
4.	Cross way	25°12'40.69"N 67° 4'57.93"E	Permanent	Use for vehicles
5.	Cross way	25°14'26.23"N 67° 6'49.81"E	Permanent	Use for vehicles
Natural Water Channel (Rain drainage)				
S.Nos.	**Natural Structure**	**Coordinates**	**Status**	**Remarks**
1.	Natural water channel	25° 6'10.72"N 67° 2'38.50"E	Functional	Crossed through overhead concrete bridges
2	Natural water channel	25° 7'43.86"N 67° 2'59.82"E	Functional	Crossed through overhead concrete bridges
3	Natural water channel	25° 8'48.61"N 67° 3'14.11"E	Functional	Crossed through overhead concrete bridges
4	Natural water channel	25° 9'23.08"N 67° 3'22.53"E	Functional	Crossed through overhead concrete bridges
5	Natural water channel	25°10'14.16"N 67° 3'22.71"E	Functional	Crossed through overhead concrete bridges
6	Natural water channel	25°10'24.03"N 67° 3'26.42"E	Functional	Crossed through overhead concrete bridges
7	Natural water channel	25°10'39.72"N 67° 3'22.12"E	Functional	Crossed through overhead concrete bridges
8	Natural water channel	25°11'15.92"N 67° 3'35.86"E	Functional	Crossed through overhead concrete bridges
9	Natural water channel	25°11'19.54"N 67° 3'38.23"E	Functional	Crossed through overhead concrete bridges
10	Natural water channel	25°11'24.52"N 67° 3'41.33"E	Functional	Crossed through overhead concrete bridges
11	Natural water channel	25°12'23.27"N 67° 4'38.16"E	Functional	Crossed through overhead concrete bridges
12	Natural water channel	25°12'29.12"N 67° 4'42.05"E	Functional	Crossed through overhead concrete bridges
13	Natural water channel	25°12'50.51"N 67° 5'21.52"E	Functional	Crossed through overhead concrete bridges
14	Natural water channel	25°13'18.45"N 67° 6'14.92"E	Functional	Crossed through overhead concrete bridges
15	Natural water channel	25°13'53.62"N 67° 6'45.21"E	Functional	Crossed through overhead concrete bridges
Vegetation and Agriculture				
S.Nos.	**Land use**	**Coordinate**	**Status**	**Remarks**
1	Agriculture field	25° 1'36.28"N 67° 1'18.07"E	Thick	
2	Agriculture field	25° 2'27.72"N 67° 1'21.14"E	Thick	
3	Agriculture field	25° 2'38.21"N 67° 1'23.92"E	Thick	
4	Agriculture field	25° 1'44.63"N 67° 1'27.75"E	Thick	

5	Agriculture field	25° 3'57.14"N 67° 1'53.60"E	Thick	
6	Agriculture field	25° 4'59.36"N 67° 2'30.02"E	Thick	
7	Agriculture field	25° 5'30.69"N 67° 2'33.06"E	Thick	
8	Agriculture field	25° 2'6.36"N 67° 1'18.51"E	Small	
9	Agriculture field	25° 1'42.24"N 67° 1'30.60"E	Small	
10	Agriculture field	25° 2'17.12"N 67° 1'17.33"E	Small	
11	Vegetated Area	25° 1'30.09"N 67° 1'10.63"E	Thick	
12	Vegetated Area	25° 1'33.99"N 67° 1'15.25"E	Thick	
13	Vegetated Area	25° 3'39.49"N 67° 1'45.91"E	Thick	
14	Vegetated Area	25° 4'8.88"N 67° 2'3.14"E	Thick	
15	Vegetated Area	25° 4'24.33"N 67° 2'4.86"E	Thick	
16	Vegetated Area	25° 4'31.42"N 67° 2'9.35"E	Thick	
17	Vegetated Area	25° 4'52.98"N 67° 2'27.88"E	Thick	
18	Vegetated Area	25° 5'39.16"N 67° 2'35.84"E	Thick	
19	Vegetated Area	25°11'53.23"N 67° 4'2.15"E	Thick	Hilly area
20	Vegetated Area	25° 1'9.40"N 67° 1'13.53"E	Small	
21	Vegetated Area	25° 1'9.41"N 67° 1'12.74"E	Small	
22	Vegetated Area	25° 1'14.98"N 67° 1'12.77"E	Small	
23	Vegetated Area	25° 3'3.24"N 67° 1'39.43"E	Small	
24	Vegetated Area	25° 4'4.50"N 67° 2'1.96"E	Small	Seepage

6. Stakeholder Consultation during field visit

The people in and surrounding the Project area have been consulted are list below,

Table 2: Stakeholder Consultation

S#	Name of the Person	Name of Village
1.	Zubaida w/o Mohd Anwar Brohi	Patai Goth
2.	Mahnaz w/o Mohd Qasim Brohi	Patai Goth
3.	Naseema w/o Abdul Hameed	Patai Goth
4.	Haseena w/o Gul Mohd Brohi	Patai Goth
5.	Khadija w/o Allah Bux	Patai Goth
6.	Dur Bibi w/o Mohd Yaqoob	Patai Goth
7.	Razia d/o Abdul Khaliq	Patai Goth
8.	Sakina w/o Ghulam Ali	Patai Goth
9.	Allah Bux Brohi	Patai Goth
10.	Deena w/o Malji Maharaj	Nomads
12.	Soni w/o Laloo Maharaj	-do-
13.	Imtiaz Afridi (Asst Engineer	KSWB
13.	Sikandar Zardari (Superintendent Engineer)	KWSB

7. Field Observation

The Land of the Project area contains hard rocky plan surface and some fertilized soil. Around 30% of the Project area contains fertilized soil which support heavy vegetation during rainy season and allow cultivation where there the water is available. The heavy vegetation at Project area occurs due to moon soon rainy season and seepage at different locations. The initial study has pointed out location for heavy vegetation, however the detail study will identify the specific reason for vegetation in the area. During consultation with local people, they said, these vegetation is permanent, however it decreases during dry season. Meanwhile, the agriculture activities is carried out using canal water, as there is no any other source of water available for agriculture or any other activities.

Communities living at the Project area are dependent on the canal water as they have livestock and agriculture activities. This canal water is used for drinking (both human and livestock), domestic use (washing and bathing), utensil and agriculture field. Communities collects the fire woods for cooking fuel. All people in the Project area are either informal users or nomad who has no formal rights to occupy land except one village who are permanently living in the area. Nomads and Informal land users have been settled here by the influential people of the area.

It has observed that the people was coming to the canal side for recreation activity. (Note: there is no specific points for recreational activities but as people feel convenient). People come here for camping, enjoying with water, cook foods and bathing from the canal water.

There are many natural water channels observed in the Project area, where causeway has already been developed for run of water. Meanwhile, the road crossing over the canal at different location has been identified. These locations will help considering precautions during Project activities.

The Project area does not have any administrative structure, whereas one primary school was observed in the village Patai Goth.

The illegal water collection / fetching observed during the field survey. This water uses to serve the nearby area and agriculture land as well as uses to sell the water in city area.

8. Brief about Local Communities at Project area

The communities living nearby the water canal at Project area are as under;

8.1. Jam Chakro Goth

This community is dependent on livestock (i.e. animal husbandry) however few people work as labor in the nearby villages for agriculture work. They have migrated from the Thatta district due to lower rainfalls and the lack of the employment. Usually community uses the canal water for domestic and drinking purposes. During visit it was observed that all the livestock and people are bathing in the canal. However, women were busy in washing cloths and utensils from the canal water. There is no electricity in this settlements. They usually charge their mobile from nearest communities and /or from the nearest hotel. There is no hospital and clinic nearby area, people usually go to civil hospital Gadap for the health checkup. However, these people are well aware of the daily updates because of in close contact with the city area.

8.2. Maharaj Community Goth

They are the Nomad people and belongs to minority tribe Maharaj, They have migrated from the upper side of the Sindh province called Kashmore. Generally the these tribes roams around in search of the agriculture labor. They have links with the landlords here and when they get the call they promptly travel and join the agriculture land of the owner. Meanwhile, these nomads also go for the petty jobs like mason work, driving or sell toys and other miscellaneous things. Solar system were installed in the community as there is no electricity available to them. For the health facility, they prefer going to civil hospital as there is cheap health checkup.

8.3. Village Patai Brohi

This is the permanent settlements with occupation of faming, animal husbandry, labor, govt. and private jobs. The Brohi tribes are conservative and they never allow women for any decision making even for basic rights. It was also observed during the visit that all women are not allowing the polio vaccination team as they have myth that children will die when get the vaccine. There is lack of awareness about vaccination in the area.

There is a primary school inside the Patai Village where children of the communities learn basic education. There is no any health facility nearby area, however, some private clinics operates at City area. People mostly attend the Govt. hospital for checkups, it is because of the low cost. The nearest Govt hospital is Civil Hospital Gaddap.

9. Focus Group Discussion

9.1. Focus Group Discussion with males

Male of the local communities have been consulted for the purpose of getting their views and consent regarding Project. They were optimistic regarding development in the area but having concern for the water supply issue incase if they have been restricted to use water for the agriculture. Since, most of these people are living near canal for agriculture activities and livestock. Meanwhile, they were asking about the employment and other small business opportunities to be created by the Project during construction. During discussion, people did not raise any concern regarding impact may cause due to Project construction activities as they understand that the construction impact is the short term.

9.2. Focus Group Discussion with Females

Rural women are the worst victims of water scarcity; however, in some communities, evidence indicates that women are emerging as a "herald of change."

In the project area, the women were aggressive and reluctant to talk on water issues. The "Maharaj" and "Kachhi" community women have words that we shift to the water areas by their male family head. Wherever we get some agriculture labor, we migrate and shift to those areas.

In the Patai Brohi Village women were belongs to the Brohi tribe. Mostly women are seclude and live in strict traditional norms. As the Brohi tribes are conservative and shifted from Balochistan, they never allow women for agriculture activity but they are vigorously engaged in livestock activity. Apart from this they have good skills of handicraft, they have excellent designs of baloch dress and spend from 1-3 months on embroidery of the dress. They never sale it but make it for their own and dowry of girls.

The teo tribes "Maharaj" and "Kachhi" are migrant. Historically they migrate for the sake of employment, as they have experience of agriculture labor, so whenever they get agriculture job they move to those areas.

Women in the Project area did not raise any serious concern about Project footprints but discuss to make arrangement for Gender management during construction as there will be the influx of Project Workers and Machineries in surrounding of their houses at construction period.

In the semi urban and rural areas there is some limitations for the women in terms of the Land Ownership rights (Housing & Agriculture) as its male domain and they never get inheritance rights, rights neither after death of the husband. Which is indicator of violation of basic women rights. Generally it is also observed that in these tribes of Brohi and Baloch women have no decision rights to take decision even for the personnel moralities.

10. Other infrastructure

A waste management area has identified near the project area (> 1km away from water canal) where waste of the Karachi town is dumped. People raised concern that they have been impacted due to the

burning of plastics, paper/cardboard, scrap metal. It makes the environment polluted as vectors spreads all over the area as well as create rotten smell that terribly effect the life of communities.

Beside the agriculture field there are some marble industry, cattle farms and chicken farming places. These places are approximately 3km to 5km away from water canal.

11. Findings and Recommendations

Livestock

- Livestock are allowed to get bath and drink water which is a major contamination of the canal water
- There is no such allocated common grazing lands. Land for the grazing of the livestock. As the livestock are not appropriately managed.
- All communities have goats which moves around the area for feeding at grazing locations and drinking water from canal.

Agriculture

- Agricultural activity and households benefitting from the canal water either by seepage or fetching water from the canal and would be adversely impacted due to stopping of seepage and fetching.
- It is identified that the agriculture field within the influence area of the project cultivate land. The small farmers have 4-10 acres and they have sanctioned water and that may potentially be affected by the project.
- Wheat is the major cash crop of the area.

Interaction with Community

- Being open canal, people in the area use the water for multiple uses, so they get impacted if the restriction imposed
- As alternative, people in the area use rain water for agriculture field who are either away from canal or have no access to fetch water from canal..

Solid waste Management

- There should be some arrangements for solid waste managements near canal water. Consider using of solid waste for reuse, recycle or recover, rather directly burning and dumping in the area

Role of KWSB

- The communities has mentioned that the representatives of KWSB are closely in contact with them. They appreciate the KWSB as proactive approach to supply the treated water to maximum population of the surrounding.

Gender Development

- Women has limited economic opportunities in the area. Initiate microcredit loan which will enhance women’s participation in the local economy and allow them to earn their livelihood via small-scale loans for livestock. The involvement of women in development

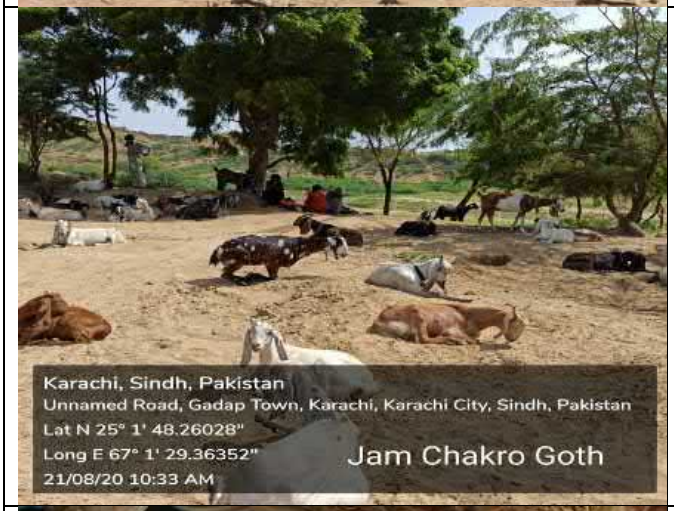
by utilizing their skills that can be built up by vocational training, enhancement of skill in embroidery, sewing, knitting, and so on, will empower women in income generation.

- Women are positive to obtain opportunities, however they said there is no any NGOs working for their development

12. Filed Visit Photos

Karachi, Sindh, Pakistan
Unnamed Road, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 1' 41.44368"
Long E 67° 1' 28.03584"
21/08/20 10:28 AM
Public collect water

Karachi, Sindh, Pakistan
Karachi Northern Bypass, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 4' 47.44164"
Long E 67° 2' 26.214"
21/08/20 11:22 AM
Vegetation near canal after monsoon

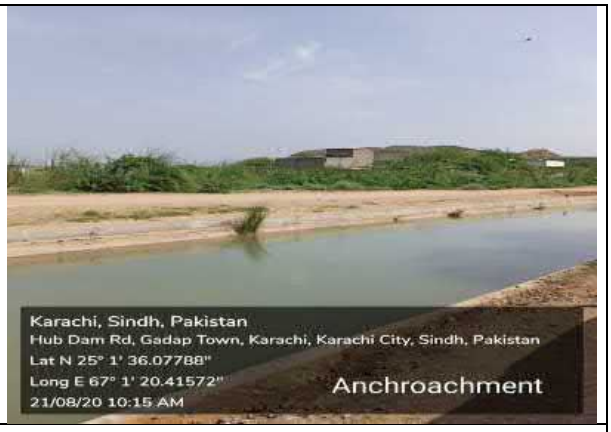

Karachi, Sindh, Pakistan
Unnamed Road, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 1' 48.26028"
Long E 67° 1' 29.36352"
21/08/20 10:33 AM
Jam Chakro Goth

Karachi, Sindh, Pakistan
Unnamed Road, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 6' 34.80228"
Long E 67° 2' 54.12732"
21/08/20 12:49 PM

Karachi, Sindh, Pakistan
Unnamed Road, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 5' 1.83408"
Long E 67° 2' 26.26404"
21/08/20 12:25 PM
Maharaj Village

Karachi, Sindh, Pakistan
Unnamed Road, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 5' 2.42988"
Long E 67° 2' 31.29612"
21/08/20 12:17 PM
Village - Maharaj (Nomads)

Karachi, Sindh, Pakistan
Unnamed Road, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 1' 48.936"
Long E 67° 1' 29.38152"
21/08/20 10:35 AM
Livestock at Jam Chakro village beside canal

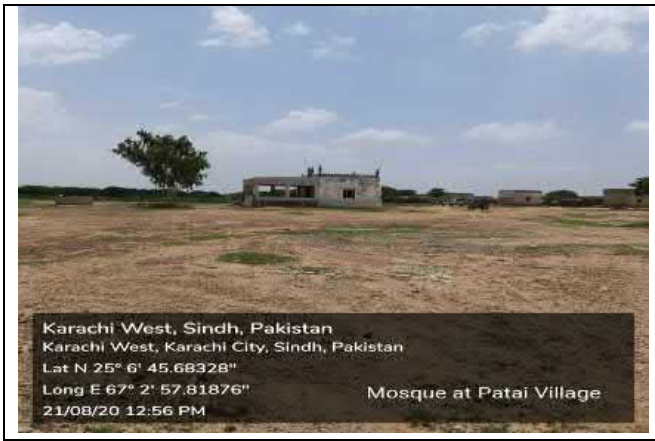

Karachi, Sindh, Pakistan
Hub Dam Rd, Gadap Town, Karachi, Karachi City, Sindh, Pakistan
Lat N 25° 1' 36.07788"
Long E 67° 1' 20.41572"
21/08/20 10:15 AM
Anchroachment

Boys School at Patal Village

Hub, Balochistan, Pakistan
Unnamed Road, Hub, Las Bela, Balochistan, Pakistan
Lat N 25° 4' 1.4718"
Long E 66° 52' 46.13628"
21/08/20 01:23 PM
Drainage of bathroom

Consultation with Males

Women consultation at Vill : Patai

 Karachi West, Sindh, Pakistan Karachi West, Karachi City, Sindh, Pakistan Lat N 25° 6' 45.68328" Long E 67° 2' 57.81876" 21/08/20 12:56 PM Mosque at Patai Village	Karachi, Sindh, Pakistan Unnamed Road, Gadap Town, Karachi, Karachi City, Sindh, Pakistan Lat N 25° 5' 2.25636" Long E 67° 2' 25.81692" 21/08/20 12:20 PM Solar panel at Maharaj village

Annex 1.1.2 Initial biodiversity field visit

CONSULTING SERVICES KARACHI WATER CANAL PPP

REPORT REGARDING RECONNISANCE SURVEY OF THE KARACHI WATER CANAL PROJECT

***

The following team of Halcrow Pakistan undertook a reconnaissance/field survey of Karachi Water Canal Project on 21st August 2020;

Mr. Umeed Khalid (Biodiversity Local Specialist)
Ms. Tasneem Maqbool (Social Development Local Specialist)
Mr. Aqeel Magsi (Environmental Local Specialist)

The team enjoyed the support and hospitality of Mr. Sikandar Ali Zardari, Chief Engineer Karachi Water and Sewerage Board (KWSB) and Mr. Daud Sheikh of Halcrow Pakistan and other officers/staff of KWSB. The Karachi Canal Project Area can be divided into following segments, if we move the downstream starting from Hub Dam;

a. WAPDA Canal (from Hub Dam to Zero Point/Head Works)
b. Zero Point to Pumping Station
c. Pumping Station and Administrative Block/Storage tanks

The basic objective of this reconnaissance survey was

i. Collection of information about sensitive receptors and for further scoping studies.
ii. Understanding the administrative structure within project area
iii. Identify the current canal water uses by community members
iv. Identify areas of obvious visible seepage
v. Identify any environmental, cultural, scred features which may pose a constraint to the project.

The reconnaissance survey was undertaken on 21st August 2020 (Friday) from morning (0900 hrs. till evening 1600 hrs.). The weather remained clear, hot and humid. However, at the end of field visit, torrential rain started in Karachi City.

The basic objective for Biodiversity Local Specialist was to record observations on flora and fauna of the project area (with common names, and scientific names) and to identify any sensitive/natural/greener area within the project area. The survey team mostly moved as one team for first half day of the field visit. But later the Environment/Biodiversity team worked separately and the Social Development Local Specialist collected community data with the support of KWSB officers.
The field observations of the Biodiversity Local Specialist are summarized below;

A. Hub Dam to Zero Point/Head Works

This segment of the canal (WAPDA Canal) is staring from the Hub Dam/Reservoir which enjoys the status of a Ramsar Site, and Wildlife Sanctuary as part of the Kirthar Protected Areas Complex (KPAC). The Hub Dam and surroundings are also very important due to its status as **Ramsar site and Important Bird Area (IBA) recognized by the Birdlife International**.

However, if we see the administrative structure, from the starting point up to Zero Point, this portion of canal is out of scope of KWSB, hence may be out of project area. This portion of canal (about 8 km) is under the administrative control of Water and Power Development Authority (Federal Government). The most of the area is rocky and in buffer zone of KPAC, hence enjoy protected status. The vegetation is sparse, but due to recent rains in this area giving green look. Typical bushes of *Euphorbia caducifolia* are present giving a Kirthar look. The reservoir area and surroundings are wintering habitat for migratory birds. Reptiles and resident avian species also recorded. Some observations of Chinkara/Gazelle (*Gazella bennettii*) were also reported by the media during lockdown period when community remained at their homes due to Covid 19.

B. Zero Point/Head Works to Pumping Station

This segment of the Karachi Water Canal is passing through mostly plain areas along small hills and agricultural fields/orchards. The seepage from the canal due to deterioration of structure (including main canal and aqua ducks) was frequent. The seepage has created number of small wetlands on both sides of canals which have thick vegetative cover of grasses (typha and phragmites) and trees/bushes of mainly mesquite/Devi (*Prosopis juliflora)*. At some points, trees of neem (*Azadirachta indica*) and bargad (*Ficus benghalensis*) are also planted providing shade to local communities and nesting places for avian species and squirrels.

Thick vegetative cover provide shelter to local avian species including Black and Grey francolins, small mammals and herpetofauna. The wetlands created by seepage water and hill torrents are wintering habitat for a number of migratory waterbirds. One Common sandpiper (*Actitis hypoleucos)*, early arriver was recorded/photographed at Canal bank. Cattle egrets (*Bubulcus ibis*) were common on these wetlands.

C. Pumping Station to Administrative Block/Storage tanks

This part of the project area is in built environment. Planted trees (Neem and Conocarpus) and electricity poles provide shelter and roosting places. The birds

observed/photographed include Black kites (*Milvus migrans)*, House crows (*Corvus splendens*) and Blue Rock/feral pigeons. The tall grasses and cavities in buildings are habitat for common reptiles.

CONCLUSION

In my humble opinion, if the Hub Dam and canal area upto Zero point is out of scope of project area, then there is no other "sensitive receptor" as far as biodiversity aspect is concerned. However, detailed surveys may give final judgment about project site.

The common names/scientific names of biological attributes (flora and fauna) are given in following tables (I to IV).

Table I - Flora of the Project Area

	Local / Common Name	Scientific Name
1.	Ak	*Calotropis procera*
2.	Bargad	*Ficus benghalensis*
3.	Bhabar	*Acacia nilotica*
4.	Bhang	*Canabis sativus*
5.	Devi/Mesquite	*Prosopis juliflora*
6.	Conocarpus	*Conocarpus acuminatus*
7.	Common Grass	*Cynodon dactylon*
8.	Jangli Ber	*Ziziphus nummularia*
9.	Kana	*Saccharum spontaneum*
10.	Karir	*Capparis decidua*
11.	Khajoor/Dates	*Phoenix dactylifera*
12.	Lawi/Tamarix	*Tamarix aphylla*
13.	Nara/Phragmites	*Phragmites karka*
14.	Neem	*Azadirachta indica*
15.	Thohar/Euphorbia	*Euphorbia caducifolia*
16.	Typha	*Typha latifolia*
17.	Sufaida/Eucalyptus	*Eucalyptus globulus*
18.	Tali/Shisham	*Dalbergia sissoo*

Table II - Birds of the Project Area

	Common Name	Scientific Name
1.	Bank myna	*Acridotheres ginginianus*
2.	Black crowned finch lark	*Eremopterix nigreceps*
3.	Black drongo/King crow	*Dicrurus macrocercus*
4.	Black kite	*Milvus migrans*
5.	Black partridge	*Francolinus francolinus*
6.	Blue rock pigeon	*Columba livia*
7.	Brown hill warbler	*Prinia criniger*
8.	Cattle egret	*Bubulcus ibis*
9.	Collared dove	*Streptopelia decaocto*
10.	Common babbler	*Turdoides caudatus*
11.	Common sandpiper	*Actitis hypoleucos*
12.	Crested lark	*Galerida cristata*
13.	Great grey shrike	*Lanius excubitor*
14.	Grey partridge	*Francolinus pondicerianus*
15.	Hoopoe	*Upupa epops*
16.	House crow	*Corvus splendens*
17.	House sparrow	*Passer domesticus*
18.	Indian myna/Common myna	*Acridotheres tristis*
19.	Indian pond heron	*Ardeola grayii*
20.	Indian roller	*Coracias benghalensis*
21.	Indian tree-pie	*Dendrocitta vagabunda*
22.	Koel	*Eudynamys scolopacea*
23.	Little brown dove	*Streptopelia senegalensis*
24.	Little green bee-eater	*Merops orientalis*
25.	Pied bushchat/Pied chat	*Saxicola caprata*
26.	Purple sunbird	*Nectarinia asiatica*
27.	Red-vented bulbul	*Pycnonotus cafer*
28.	Red-wattled lapwing	*Hoplopterus indicus*
29.	White-cheeked bulbul	*Pycnonotus leucogenys*

Table III - Possible Mammals of the Project Area

No.	Common Name	Scientific Name
1.	Asiatic jackal	*Canis aureus*
2.	Balochistan gerbil	*Gerbillus nanus*
3.	Black naped hare	*Lepus nigricollis*
4.	Chinkara/Gazelle	*Gazella bennettii*
5.	Common red fox	*Vulpes vulpes*
6.	Five stripped-palm squirrel	*Funambulus pennantii*
7.	House mouse	*Mus musculus*
8.	House rat	*Rattus rattus*
9.	Indian crested porcupine	*Hystrix indica*
10.	Indian gerbil	*Tatera indica*
11.	Indian grey mongoose	*Herpestes edwardsi*
12.	Jungle cat	*Felis chaus*
13.	Little Indian field mouse	*Mus booduga*
14.	Long eared desert hedgehog	*Hemiechinus collaris*
15.	Ratel/Honey badger	*Mellivora capensis*
16.	Small Indian mongoose	*Herpestes javanicus*
17.	Wild boar	*Sus scrofa*

Table IV - Possible Reptiles of the Project Area

No.	Common Name	Scientific Name
1.	Black rock agama	*Laudakia melanurus*
2.	Dhaman/Rat snake	*Ptyas mucosus*
3.	Fat tailed/Leopard gecko	*Eublepharis macularius*
4.	Garden lizard	*Calotes versicolor*
5.	Glossy bellied racer	*Coluber ventromaculatus*
6.	Indian spiny-tailed lizard	*Uromastyx hardwickii*
7.	Indian cobra	*Naja naja naja*
8.	Indian/Bengal monitor	*Varanus bengalensis*
9.	Indian desert monitor	*Varanus griseus koniecznyi*

No.	Common Name	Scientific Name
10.	Indian sand boa	*Eryx johnii johnii*
11.	Krait	*Bungarus caeruleus*
12.	Pakistan ribbon snake	*Psammophis leithii*
13.	Saw scaled viper	*Echis carinatus pyramidum*
14.	Spotted house gecko	*Hemidactylus brookii brookii*
15.	Yellow bellied house gecko	*Hemidactylus flaviviridis*

Aquatic life of the Project Area

The project area is blessed with different types of wetlands including Karachi Canal itself. These wetlands must be with aquatic life including fish, Freshwater turtles and amphibians in addition to invertebrate life forms. However, a comprehensive survey is required to confirm their presence in the project area.

FLOW MEASUREMENT

CONSULTING SERVICES KARACHI WATER CANAL PPP

Report

Measurement of Flow at WAPDA Canal downstream of Hub Dam

23rd February 2021

Dr. Syed Imran Ahmed
Professor, Department of Civil Engineering
NED University of Engineering & Technology, Karachi

CONTENTS

1 Background 5
2 Methodology 5
3 Results 10
3.1 Upstream Location 10
3.2 Downstream Location 11
4 Conclusion 13
5 References 13
6 Annexures 14
6.1 Pictures 14

LIST OF TABLES

Table 1: Details of Pumping Locations 7
Table 2: Upstream Location Details 7
Table 3: Downstream Location Details 7
Table 4: Data collected at upstream location 11
Table 5: Data collected at downstream location 12
Table 6: WAPDA Canal Flows 13

LIST OF FIGURES

Figure 1: ADV Flow Tracker 5
Figure 2: Observations from ADV Meter being recorded 6
Figure 3: WAPDA Canal & its Upstream & downstream locations 6
Figure 4: WAPDA Canal & Possible Pumping Locations 7
Figure 5: Upstream cross section of gauging location 8
Figure 6: Upstream Location WAPDA Canal 8
Figure 7: Downstream cross section of gauging location 9
Figure 8: Ending of the WAPDA Canal 9
Figure 9: Upstream Velocity at Mid Span 10
Figure 10: Upstream Flow at Mid Span 10
Figure 11: Downstream Velocity at Mid Span 11
Figure 12: Downstream Flow at Mid Span 12
Figure 13: Possible Pumping Location 14
Figure 14: Possible Pumping Location 14
Figure 15: Possible Pumping Location 15
Figure 16: Tanker taking water from the canal 15
Figure 17: Starting point of the KW&SB Canal 16

1 BACKGROUND

Hub Dam is a reservoir on the Hub River which runs from Baluchistan. It is situated 56 kilometers from Karachi. It is located at the border of two provinces i.e. Sindh and Baluchistan in Karachi and Lasbela Districts. The dam is extended to 24300 acres with gross storage capacity of 857000-acre feet [1]. It is the Pakistan's third-largest dam [1]. It is an important source that provides the drinking water to Karachi, metropolitan city of Pakistan. [1]

Hub Dam is situated at about 41 kilometers North of Karachi city on the provincial border of Baluchistan and Sindh. The dam is a large water reservoir which supplies water for irrigation to the district of Lasbela, Baluchistan and part of the domestic water supply for Karachi. The allocation of water for Lasbela is 27.6% and for Karachi being 62.4%. The dam was constructed in 1981 on Hub River which originates from Khirthar Mountains. The total drainage area of the river is 9391 km^2. [2]

This document reports the assignment of measurement of flow at WAPDA Canal downstream of Hub Dam known as the Hub Canal which is designated to fetch water towards Hub pumping station in the vicinity of Karachi. This pumping station further pumps water to the city of Karachi.

2 METHODOLOGY

The upstream and downstream locations were selected to measure the flow in WAPDA Canal. Planning methodology and instrumentation was done keeping the geometry of the canal in view.

The cross sectional length of the canal at the point of upstream location is 33 feet while at its downstream location it decreases to 32.5 feet. The cross sectional length of the canal was divided into 10 panels; such that the length of each panel is 3 feet. For both locations; only the length of the last panel was adjusted. It was also observed that at the slope of canal there was an accumulation of weed and silt.

For confident results and to eliminate possible instrumental and human errors, Acoustic Doppler Velocity (ADV) Meter was used to record the velocity at the middle of each panel. The instrument was submerged in the canal at 0.6 of the depth from the water level.

Acoustic Doppler Velocity (ADV) Meter - Acoustic Doppler velocimetry (ADV) is designed to record instantaneous velocity components at a single-point with a relatively high frequency. Measurements are performed by measuring the velocity of particles in a remote sampling volume based upon the Doppler shift effect to a sampling point. SONTEK Flow Tracker instrument used is shown in figure 1.

Figure 1: ADV Flow Tracker

Figure 2: Observations from ADV Meter being recorded

During the field visits three different locations were observed where pumping motors were installed to pump the water from the canal. Two of them were near the upstream location while the third one was in the middle of the Hub Canal. The details of these possible pumping locations are given below.

Figure 3: WAPDA Canal & its Upstream & downstream locations

Table 1: Details of Pumping Locations

Pumping Location	Northing	Easting
Pumping Location 1	2792405.00	309966.00
Pumping Location 2	2790455.00	308832.00
Pumping Location 3	2789746.00	306831.00

As the canal progresses downstream, it is intercepted by cross drainage and topographical requirement for aqueducts which have rectangular cross sections. The flow at upstream of the canal is measured between the chainage of 15+00 and 16+00 feet. This is also the point where the water from the canal is being pumped through a pumping motor. The cross section of the upstream location is trapezoidal and has a width of 33 feet.

Figure 4: WAPDA Canal & Possible Pumping Locations

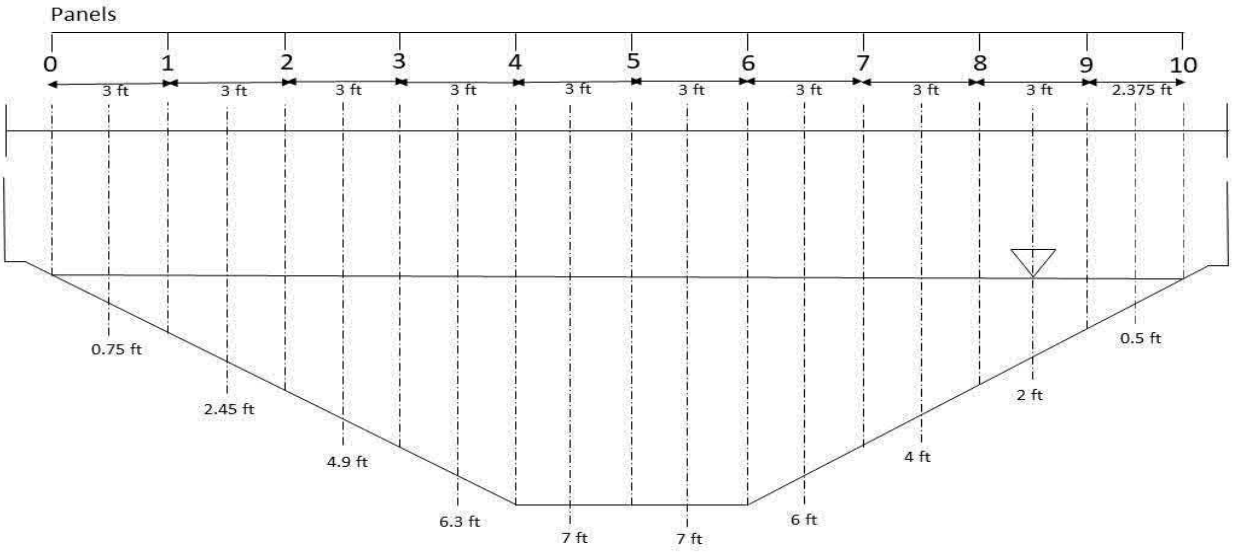
Table 2: Upstream Location Details

Chainage (feet)	Chainage (km)	Northing	Easting
15+00-16+00	0+457 – 0+487	2792413.46	309984.61

The downstream location selected to gauge the flow is also a trapezoidal cross section having width of 32.5 feet and is situated just before the Regulatory Head works where the Hub Canal further divides into KW&SB Canal and Lasbela Canal.

Table 3: Downstream Location Details

Chainage (feet)	Chainage (km)	Northing	Easting
252+00	7+680	2787893.31	304966.56



Upstream Cross Section between Chainage 15+00 & 16+00

The upstream and downstream cross sections where flow is gauged for this assignment are shown in figure 2 and 3 respectively.

Figure 5: Upstream cross section of gauging location

Figure 6: Upstream Location WAPDA Canal

The cross-sectional length of the upstream location was divided into 10 panels. The length of the first 9 panels was 3 feet while the last panel had a length of 2.375 feet. Two panels had triangular area, six panels had trapezoidal area while two panels in between had rectangular area. The slope of the channel was observed at the end of the 3rd panel from the left and at the start of 6th panel from the right. The maximum depth of the channel was recorded at 7 feet.

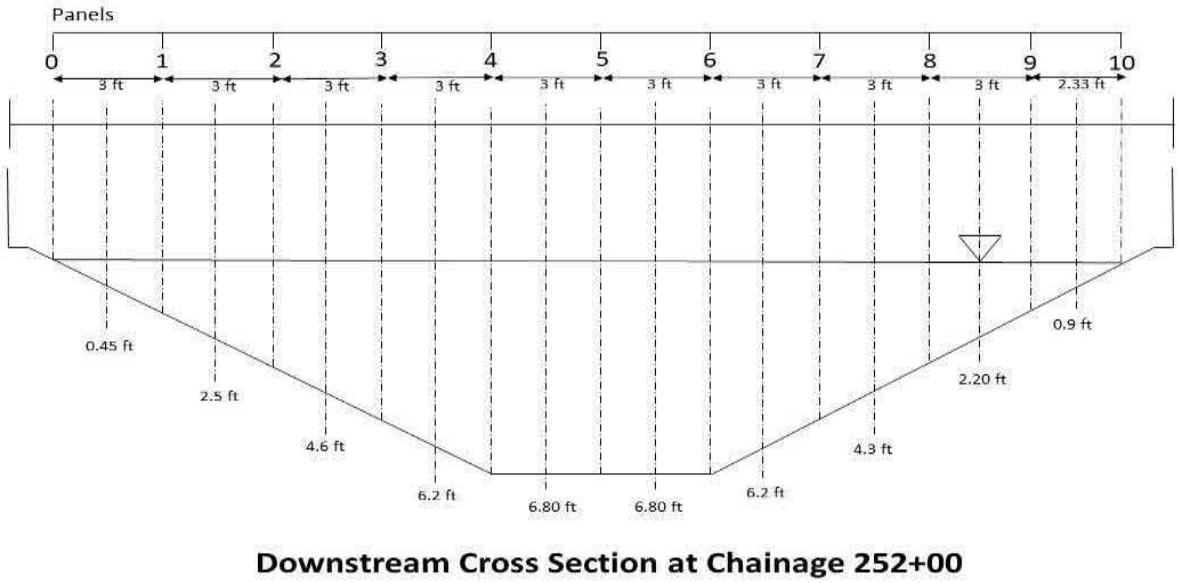


Figure 7: Downstream cross section of gauging location

The cross-sectional length of the downstream location was divided into 10 panels. The length of the first 9 panels was 3 feet while the last panel had a length of 2.33 feet. Two panels had triangular area, six panels had trapezoidal area while two panels in between had rectangular area. The slope of the channel was observed at the end of the 3rd panel from the left and at the start of 6th panel from the right. The maximum depth of the channel was recorded at 6.80 feet.

Figure 8: Ending of the WAPDA Canal

3 RESULTS

Flow is calculated using mid-section where each mid-section is counted separately and represented by its velocity measured at mid span of the panels. The mid-section discharge equation is used by the flow tracker's (ADV) computer.

3.1 UPSTREAM LOCATION

This section presents the measured velocities and flow at upstream location of the canal. Figure 9 and 10 show the velocity and flow trend across the cross section. Raw data is also shown in table 1.

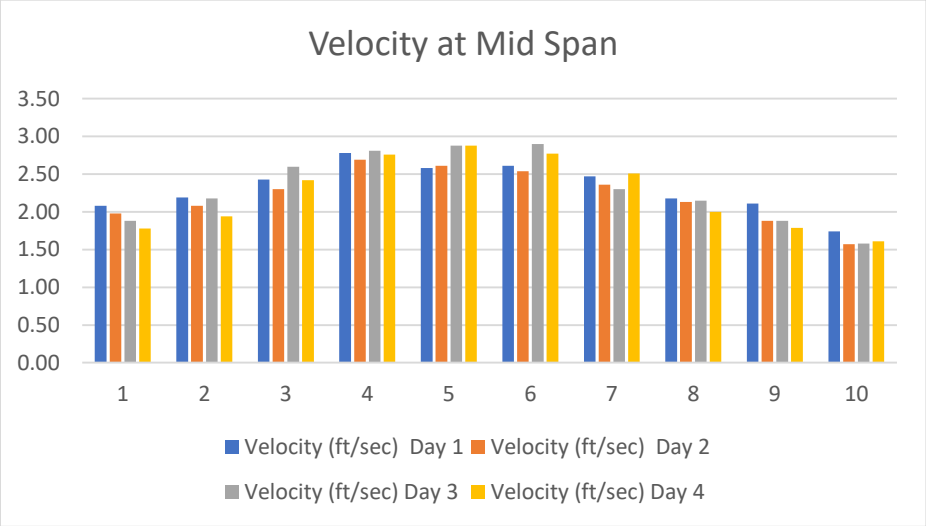


Figure 9: Upstream Velocity at Mid Span

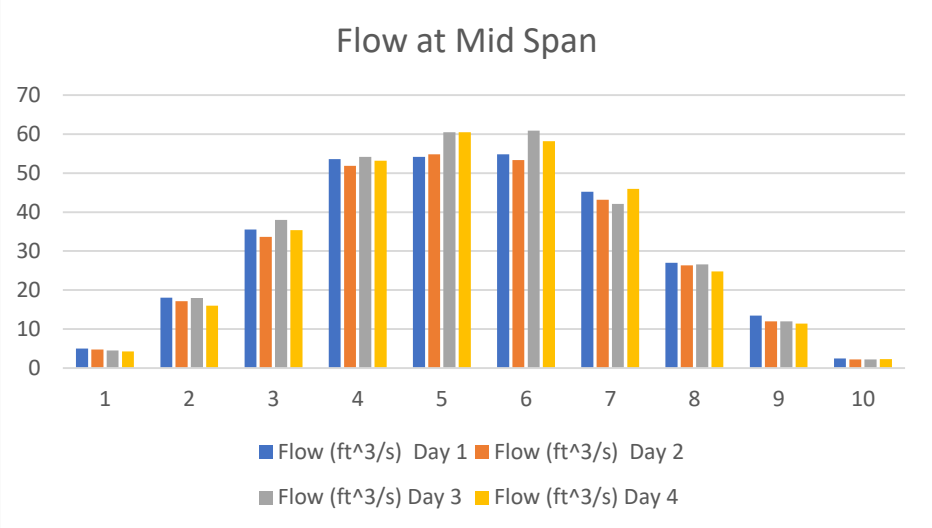


Figure 10: Upstream Flow at Mid Span

Table 4: Data collected at upstream location

Section	Panel Width	Panel Depth	Velocity (ft/s)				Area (ft^2)				Flow (ft^3/s)			
	Ft	ft	DAY 1	DAY 2	DAY 3	DAY 4	DAY 1	DAY 2	DAY 3	DAY 4	DAY 1	DAY 2	DAY 3	DAY 4
1	3	0.75	2.08	1.98	1.88	1.78	2.40	2.40	2.40	2.40	4.99	4.75	4.51	4.27
2	3	2.45	2.19	2.08	2.18	1.94	8.25	8.25	8.25	8.25	18.07	17.16	17.99	16.01
3	3	4.9	2.43	2.30	2.60	2.42	14.63	14.63	14.63	14.63	35.54	33.64	38.03	35.39
4	3	6.3	2.78	2.69	2.81	2.76	19.28	19.28	19.28	19.28	53.58	51.85	54.16	53.20
5	3	7.00	2.58	2.61	2.88	2.88	21.00	21.00	21.00	21.00	54.18	54.81	60.48	60.48
6	3	7.00	2.61	2.54	2.90	2.77	21.00	21.00	21.00	21.00	54.81	53.34	60.90	58.17
7	3	6	2.47	2.36	2.30	2.51	18.30	18.30	18.30	18.30	45.20	43.19	42.09	45.93
8	3	4	2.18	2.13	2.15	2.00	12.38	12.38	12.38	12.38	26.98	26.36	26.61	24.75
9	3	2.00	2.11	1.88	1.88	1.79	6.38	6.38	6.38	6.38	13.45	11.99	11.99	11.41
10	2.38	0.5	1.74	1.57	1.58	1.61	1.43	1.43	1.43	1.43	2.48	2.24	2.25	2.29
										Cusecs	309.28	299.32	319.00	311.91
										Cumec	8.75	8.47	9.03	8.83
										MGD	166.37	161.01	171.60	167.78

3.2 DOWNSTREAM LOCATION

This section presents the measured velocities and flow at downstream location of the canal. Figure 11 and 12 show the velocity and flow trend across the cross section respectively. Raw data collected for downstream location is also shown in table 4.

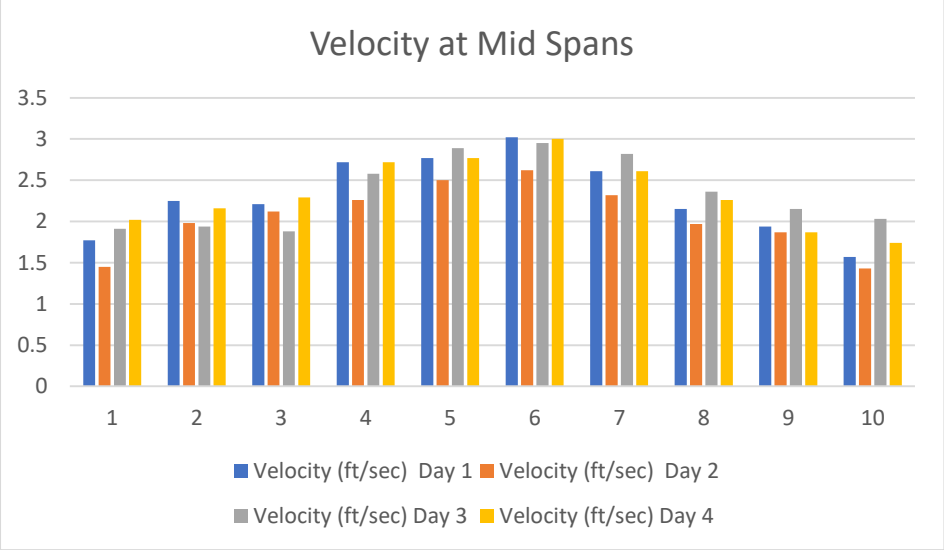


Figure 11: Downstream Velocity at Mid Span

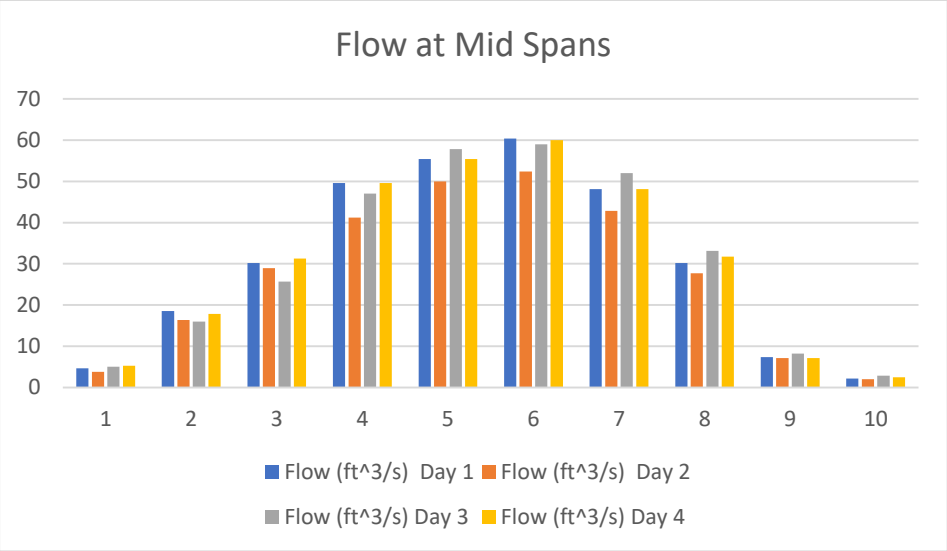


Figure 12: Downstream Flow at Mid Span

Table 5: Data collected at downstream location

Section	Panel Width	Panel Depth	Velocity (ft/s)				Area (ft^2)				Flow (ft^3/s)			
	ft	ft	DAY 1	DAY 2	DAY 3	DAY 4	DAY 1	DAY 2	DAY 3	DAY 4	DAY 1	DAY 2	DAY 3	DAY 4
1	3	0.45	1.77	1.45	1.91	2.02	2.63	2.63	2.63	2.63	4.65	3.81	5.01	5.30
2	3	2.5	2.25	1.98	1.94	2.16	8.25	8.25	8.25	8.25	18.56	16.34	16.01	17.82
3	3	4.6	2.21	2.12	1.88	2.29	13.65	13.65	13.65	13.65	30.17	28.94	25.66	31.26
4	3	6.2	2.72	2.26	2.58	2.72	18.23	18.23	18.23	18.23	49.57	41.19	47.02	49.57
5	3	6.80	2.77	2.50	2.89	2.77	20.00	20.00	20.00	20.00	55.40	50.00	57.80	55.40
6	3	6.80	3.02	2.62	2.95	3.00	20.00	20.00	20.00	20.00	60.40	52.40	59.00	60.00
7	3	6.2	2.61	2.32	2.82	2.61	18.45	18.45	18.45	18.45	48.15	42.80	52.03	48.15
8	3	4.3	2.15	1.97	2.36	2.26	14.05	14.05	14.05	14.05	30.21	27.68	33.16	31.75
9	3	2.20	1.94	1.87	2.15	1.87	3.81	3.81	3.81	3.81	7.38	7.12	8.18	7.12
10	2.33	0.9	1.57	1.43	2.03	1.74	1.40	1.40	1.40	1.40	2.20	2.00	2.84	2.44
										Cusecs	306.7	272.27	306.714	308.814
										Cumecs	8.68	7.70	8.68	8.74
										MGD	165	146.46	164.988	166.118

4 CONCLUSION

From the results presented in section 4, it is concluded that for upstream location, the flow is calculated to be **166 MGD, 161 MGD, 172 MGD** and **167 MGD** for **Day 1, Day 2, Day 3,** and **Day 4,** respectively, and for the downstream location it is **165 MGD, 146 MGD, 166 MGD,** and **166 MGD** for **Day 1, Day 2, Day 3** and **Day 4,** respectively.

Table 6: WAPDA Canal Flows

WAPDA CANAL FLOWS (Downstream Hub Dam)

S. No.	Date	Location	Chainage	Flow (ft^3/s)	Flow (MGD)
1	17-Feb-21	Upstream	15+00 - 16+00	309	166
2	18-Feb-21			299	161
3	19-Feb-21			319	172
4	20-Feb-21			311	167
S. No.	**Date**	**Location**	**Chainage**	**Flow (ft^3/s)**	**Flow (MGD)**
1	17-Feb-21	Downstream	252+00	307	165
2	18-Feb-21			272	146
3	19-Feb-21			309	166
4	20-Feb-21			308	166

5 REFERENCES

1- "Hub Dam Wildlife Sanctuary". Sindh Wildlife Department. Archived from the original on June 27, 2013. Retrieved May 21, 2012.

2- Ahmed, S. 2008. Water Apportionment of Hub-Dam Water Conflict and Strategy for Resolution. Policy Briefings (4). TA-4560 (Pak) Project for Supporting Implementation of IWRM Policy in Baluchistan-Government of Baluchistan.

6 ANNEXURES

6.1 PICTURES

Figure 13: Possible Pumping Location

Figure 14: Possible Pumping Location

Figure 15: Possible Pumping Location

Figure 16: Tanker taking water from the canal

Figure 17: Starting point of the KW&SB Canal

Report

Measurement of Flow at Karachi Canal downstream of Hub Dam

2nd November 2109

Dr. Syed Imran Ahmed
Professor, Department of Civil Engineering
NED University of Engineering & Technology, Karachi

1 CONTENTS

2 Background 3
3 Methodology 3
4 Results 5
4.1 Upstream Location 5
4.2 Downstream Location 6
5 Conclusion 7
6 References 7

2 BACKGROUND

Hub Dam is a reservoir on the Hub River which run from Balochistan. It is situated 56 km from Karachi city in Karachi and Lasbela Districts on Sindh and Balochistan provinces border. The dam is extended to 24300 acres with gross storage capacity of 857000-acre feet [1]. It is the Pakistan's third-largest dam [1]. It is an important source that provides the drinking water to the metropolitan city Karachi. [1]

Hub-dam is situated at about 41km north of Karachi city on the provincial boarder of Baluchistan and Sindh. The dam is a large water reservoir which supplies water for irrigation to the district of Lasbela, Baluchistan and part of the domestic water supply for Karachi. The allocation of water for Lasbela is 27.6% and for Karachi being 62.4%. The dam was constructed in 1981 on Hub River which originates from Khirthar Mountains. The total drainage area of the river is 9391 Km2. [2]

This document reports the assignment of measurement of flow at one of the canals downstream of Hub Dam designated to fetch water towards Hub pumping station in the vicinity of Karachi. This pumping station further pumps water to the city of Karachi.

3 METHODOLOGY

The expected flow at the subject canal is 60 – 100 MGD with cross sectional length and depth varying from 7 – 20 ft and 4-8 ft respectively. Planning methodology and instrumentation was done keeping the geometry of canal in view.

For confident results and to eliminate possible instrument and human errors, two instruments were selected which work on different working principles.

Figure 1 Flow Velocity

Propeller based flow velocity meter – The Flow Probe can be used to measure the true average water velocity of a channel's flow. As long as the turbo-prop sensor is in the flowing water, the computer will average the water velocity. One reading is taken per second, and a continuous average water velocity is displayed. 20 second average was used from this instrument across the cross-sectional breakup. This cross-sectional configuration is discussed later in the report.

Acoustic Doppler Velocity (ADV) Meter - Acoustic Doppler velocimetry (ADV) is designed to record instantaneous velocity components at a single-point with a relatively high frequency. Measurements are performed by measuring the velocity of particles in a remote sampling volume based upon the Doppler shift effect to a sampling point. SONTEK FlowTracker instrument used is shown in figure 2.

Figure 2 ADV FlowTracker

The upstream and downstream locations were selected to measure the flow in KWSB Canal. The canal starts with a rectangular cross section and soon transforms into a regular trapezoidal cross section. As the canal progresses

downstream, it is intercepted by cross drainage and topographical requirement for aqueducts which have rectangular cross sections. The flow at upstream of the canal is measured at the first aqueduct at Latitude 25.190258° Longitude 67.061447° which starts at approximately 1100 ft from the headworks. This aqueduct is 7.83 ft wide and 5.9 ft deep on average.

The downstream location selected to gauge the flow is a trapezoidal cross section having width of 22 ft and is situated at Latitude 25.024598° Longitude 67.019842°. The upstream and downstream cross sections where flow is gauged for this assignment are shown in figure 3 and 4 respectively.

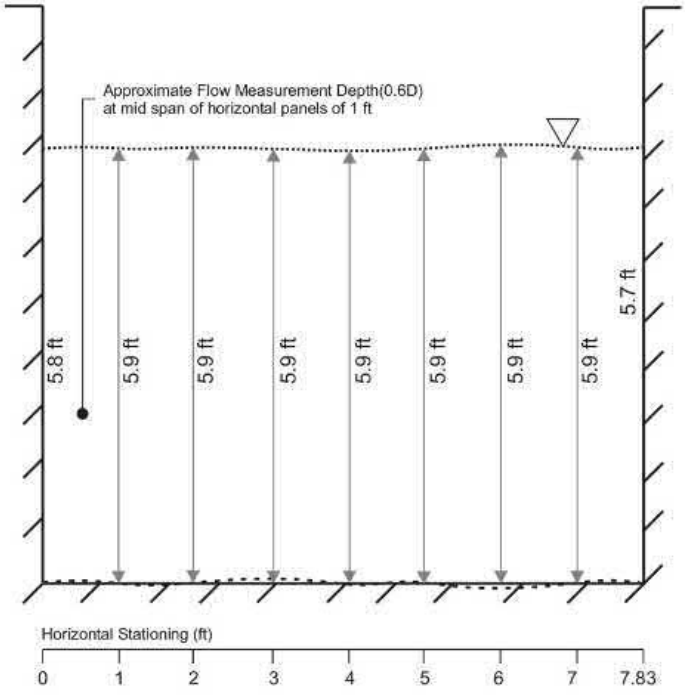


Figure 3 Upstream cross section of gauging location

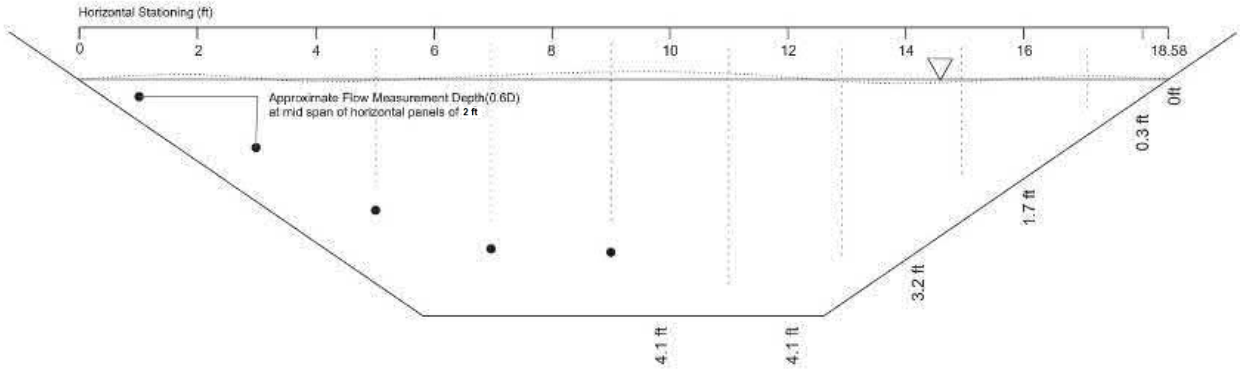


Figure 4 Downstream cross section of gauging location

4 RESULTS

Flow is calculated using mid-section where each mid-section is counted separately and represented by its velocity measured at mid span of horizontal stationing. The mid-section discharge equation is used by the flow tracker's(ADV) computer. Figure 5 shows the calculation mechanism of mis section method.

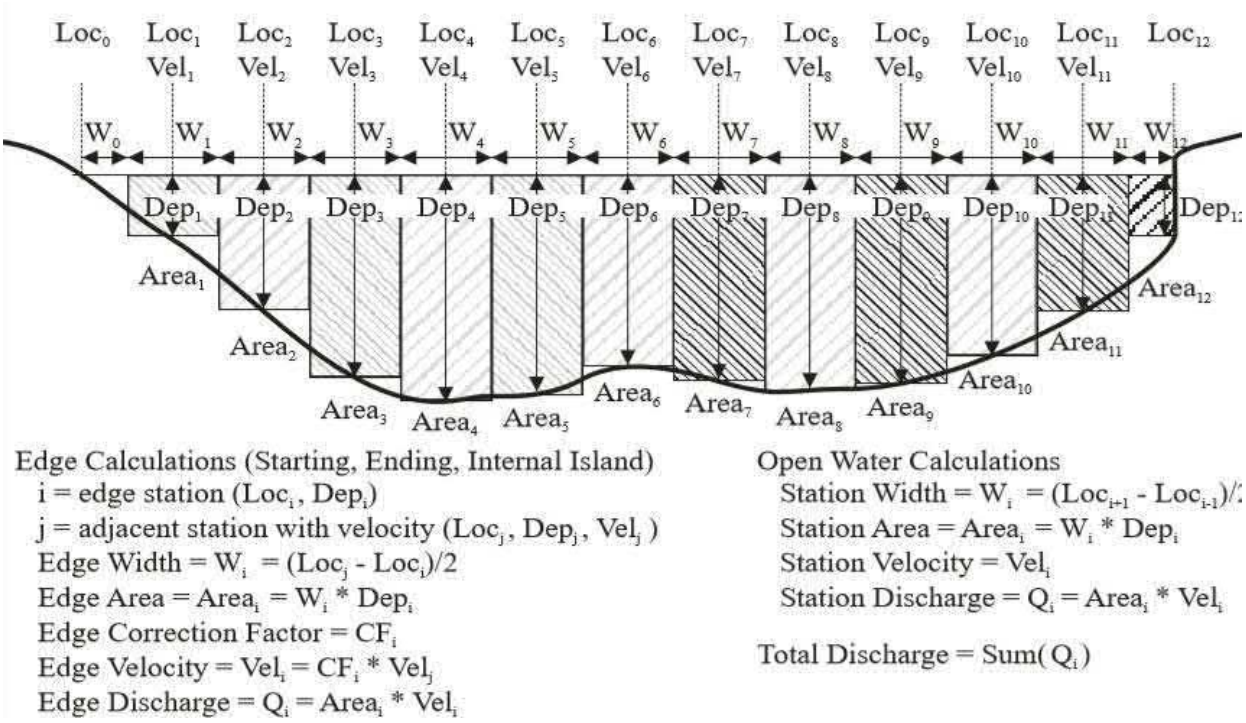


Figure 5 Illustration of mid-section technique for flow measurement

4.1 UPSTREAM LOCATION

This section presents the measured velocities and flow at upstream location of the canal. Figure 6 and 7 show the velocity and flow trend across the cross section. Raw data is also shown in table 1.

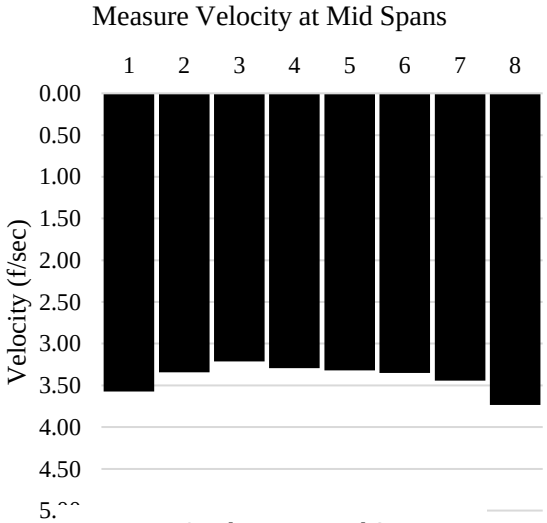


Figure 6 Velocities at Mid Spans

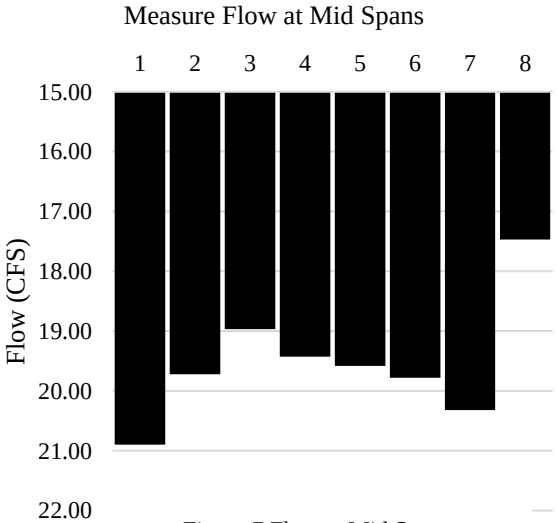


Figure 7 Flow at Mid Spans

Table 1 Data collected at upstream location

Data at Upstream Location						
Station	Depth	Area	Velocity	Velocity	Velocity	Flow
(ft)	ft	ft^2	cm/sec		ft/sec	cfs
0.00	5.80	-	-			
1.00	5.90	5.85	108.90	1.09	3.57	20.90
2.00	5.90	5.90	101.90	1.02	3.34	19.72
3.00	5.90	5.90	98.00	0.98	3.21	18.96
4.00	5.90	5.90	100.40	1.00	3.29	19.43
5.00	5.90	5.90	101.20	1.01	3.32	19.58
6.00	5.90	5.90	102.20	1.02	3.35	19.78
7.00	5.90	5.90	105.00	1.05	3.44	20.32
7.80	5.80	4.68	113.80	1.14	3.73	17.47
Total Cross-Sectional Flow (cfs)						**156.16**
Total Flow Volume in MGD						**82.76**

4.2 DOWNSTREAM LOCATION

This section presents the measured velocities and flow at downstream location of the canal. Figures 8 and 9 show the velocity and flow trend across the cross section respectively. Raw data collected for downstream location is also shown in table 2.

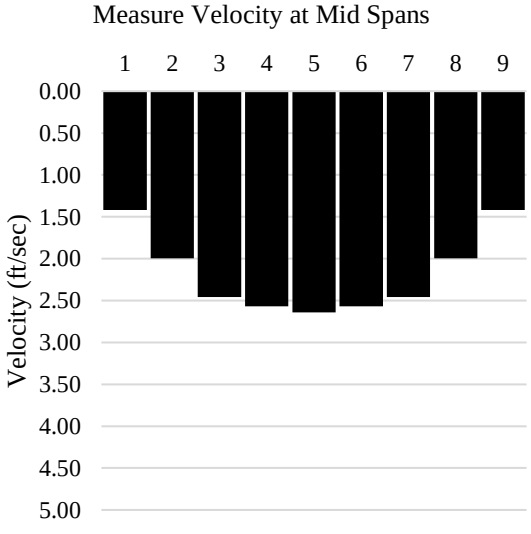


Figure 8 Velocities at Mid Spans

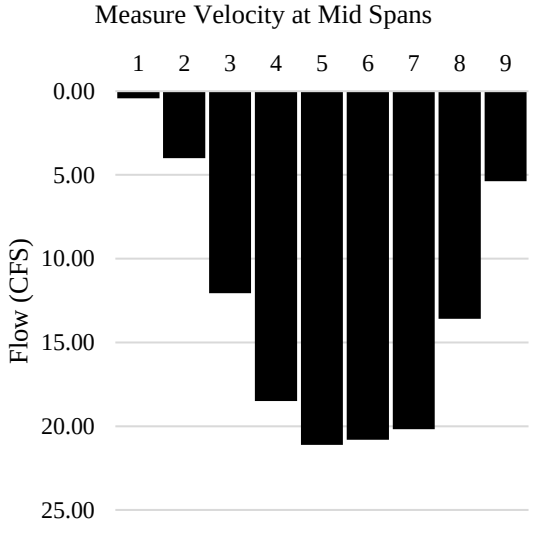


Figure 9 Flow at Mid Spans

Table 2 Data collected at downstream location

Data at Downstream Location						
Location	Depth	Area	Velocity	Velocity	Velocity	Flow
ft	ft	sft	cm/sec		ft/sec	cfs
0.00	0.00	-	-			
2.00	0.30	0.30	43.20	0.43	1.42	0.43
4.00	1.70	2.00	60.90	0.61	2.00	4.00
6.00	3.20	4.90	75.00	0.75	2.46	12.05
8.00	4.00	7.20	78.30	0.78	2.57	18.49
10.00	4.00	8.00	80.50	0.81	2.64	21.12
12.00	4.10	8.10	78.30	0.78	2.57	20.80
14.00	4.10	8.20	75.00	0.75	2.46	20.17
16.00	2.70	6.80	60.90	0.61	2.00	13.58
18.00	1.10	3.80	43.20	0.43	1.42	5.38
18.50	0.10	0.30	0.00	0.00	0.00	0.00
Total Cross-Sectional Flow (cfs)						**116.03**
Total Flow Volume in MGD						**61.50**

5 CONCLUSION

From the results presented in section 4, it is concluded that for upstream location, the flow is calculated to be **82.76 MGD** and for the downstream location it is **61.50 MGD**. The conveyance loss of the subject canal is calculated as **25.70 %**.

6 REFERENCES

1- "Hub Dam Wildlife Sanctuary". Sindh Wildlife Department. Archived from the original on June 27, 2013. Retrieved May 21, 2012.

2- Ahmed, S. 2008. Water Apportionment of Hub-Dam Water Conflict and Strategy for Resolution. Policy Briefings (4). TA-4560 (Pak) Project for Supporting Implementation of IWRM Policy in Baluchistan-Government of Baluchistan.

HYDROLOGICAL STUDY

CONSULTING SERVICES KARACHI WATER CANAL PPP

Contents

HYDROLOGICAL STUDY 1

1.1. BACKGROUND 1

1.2. REVIEW OF THE HYDROLOGICAL DATA 1

1.3. METHODOLOGY 3

1.4. ANALYSIS OF KARACHI WATER CANAL OUTFLOWS 6

1.5. ANALYSIS OF HUB DAM RESERVOIR WATER RESOURCES 10

1.6. MAIN RESULTS 15

1.7. CONCLUSIONS 16

TABLES

Table 1 Statistical results for the Karachi Water Canal at 100 MGD and 80 MGD, per month 7
Table 2 Statistical results for the Karachi Water Canal at 100 MGD and 80 MGD, per day 7
Table 3 Empirical distribution function adjustment 9
Table 4 Karachi Water Canal's characterization 10
Table 5 Hub Dam reservoir's characterization. Storage, per month 10
Table 6 Hub Dam reservoir's characterization. Level per month 11
Table 2 Hub Dam reservoir's characterization. Level per month (yearly data) 11
Table 8 Karachi Water Canal's characterization 13
Table 9 Karachi Water Canal's characterization 13

FIGURES

Figure 1. Hub Dam reservoir's water level (ft) 4
Figure 2. Comparison between Hub Dam's storage (A/F) and water flow at the Karachi KWSB Canal (MGD), per month 5
Figure 3. Comparison between Hub Dam's level (ft) and water flow at the Karachi KWSB Canal (MGD), per day 5
Figure 4. Hub Dam reservoir level (ft) vs KW canal flow (MGD), per month 6
Figure 5. Probability density function 8
Figure 6. Model/Empirical double probability plot 8
Figure 7. Correlation coef. Hub Dam level vs daily flow 10
Figure 8. Correlation coef. Hub Dam level vs monthly flow 11
Figure 9. Probability density function 12
Figure 10. Model/Empirical double probability plot 12
Figure 11. Hub Dam reservoir' storage vs rainfall 14
Figure 12. Hub Dam reservoir vs pumping level 14
Figure 13. Hub Dam reservoir' s level vs rainfall 15

HYDROLOGICAL STUDY

CONSULTING SERVICES KARACHI WATER CANAL PPP

1.1. BACKGROUND

The objective of this Annex is to support the decision-making process in order to analyse the water availability at Hub Dam and also to define the design flow for the KWSB Karachi canal rehabilitation.

At his regard, the analysis of the water resources availability and the water demands' satisfaction has been conducted. For this purpose, an analysis of the hydrology of the area has been carried out. The Karachi water supply infrastructure has as its starting point at the Hub Dam reservoir, so the water resource analysis requires:

- An assessment of the available water resources provided by the Hub water basin.
- A knowledge of the water demands satisfied by the Karachi canal and it is backing up

On the other hand, the analysis of available water resources in the basin requires accounting for:

- Rainfall and how it is divided into runoff that eventually gets as inflows to the Hub Dam reservoir, and groundwater resources.
- The basin is a system, and all the hydrological cycle processes evolve in time and space

In any case, a direct analysis is to resort to the Hub Dam reservoir water storage and the water discharge that the Karachi Water Canal has historically conveyed from the Head Regulator to the Hub Pumping Station downstream.

1.2. REVIEW OF THE HYDROLOGICAL DATA

The following data, provided by the KWSB and the WAPDA, have been analysed prior to conduct the hydrological study.

SENDER	DATED	FILE NAME	TYPE / SIZE	SUBJECT
KWSB	07/23/2020	HUB DAM DATA	Word - 333 kb	Hub dam reservoir data since 1-1-2007 to 9-31-2019
KWSB	07/28/2020	Drought Condition of Lasbela and Karachi Canal	Pdf - 5.2 Mb	Contract Documents between Pakistan Water & Power Development Authority and WAPDA and KWSB. (in 2001, 2009 and 2014)

SENDER	DATED	FILE NAME	TYPE / SIZE	SUBJECT
KWSB	09/12/2020	HUB DAM DATA Since Start and End	Word - 298 Kb	Hub dam reservoir data since 1-1-2007 to 6-30-2014
KWSB	09/15/2020	Hub Dam Data	Pdf - 763 kb	Hub Dam Project - Dam Monitoring Reservoir operation Data: From June 2006 to June 2019 Monthly Basis In flow (in A / F) - Out Flow (in A / F) Evaporation Seepage
KWSB	10/05/2020	HUB Dam Data	Word - 159 Kb	Hub dam reservoir data. Since 1-1-2015 to 31-9-2019 Discharge data (MGD)
	10/29/2020	Sup Halcrow daily rainfall 1990-2020 Karachi Maripur	Word - 153 Kb	Rainfall data in Karachi since 1-1-1990 to 30-09-2020
WAPDA	11/19/2020	DOC171120-17112020154239	Pdf - 7.13 MB	Hub Dam Project. Operational history of hub Dam Project. Dam monitoring. Water balance study
WAPDA	12/04/2020	WhatsApp Image 2020-12-04 at 12.34.15	JPEG - 198 kb	Discharge data (MGD)
WAPDA	12/10/2020	Hub Dam OPT DATA	XLS - 277 KB	Reservoir operation data from January 2010to September 2015
	01/07/2021	Hub Dam OPT DATA JAN2010 TOSEP2015	XLSX - 286 Kb	Reservoir operation data from January 2010 to June 2017
	01/18/2021	20210118_HUB Dam Rain Fall Data	PDF - 3.6 Mb	Monthly and daily rainfall since 1962 to 1973
	01/21/2021	HISTORICAL HUB DAM RESERVOIR FROM 2000TO2020	XLSX - 90.7 kB	Hub Dam Project. Operational history of hub Dam Project. Dam monitoring. Water balance study

The following data have been collected from the sources of information gathered:

- Daily series of rainfall data.
- Daily and monthly series of flow data derived to the Karachi canal.
- Daily and monthly data of reservoir levels.
- Monthly and annual data series of reservoir volume.

1.3. METHODOLOGY

The first activity has been to analyse the quality and suitability of the collected data to determine if that provided information allows to conduct with minimum precision an hydrological study. Therefore, a preliminary analysis of the available data has been carried out.

Daily data are available on reservoir levels and flows derived from the Karachi Canal (KWC). For these series, the days without data have not been taken into account. In the case of levels, there are no data that can be considered anomalous (values outside the limits of the reservoir).

The analysis focuses on:

- the statistical and probabilistic analysis of the historical time series:
    - Hub Dam reservoir storage volume (daily, monthly and yearly data)
    - Karachi Water Canal flow (daily and monthly)
- Analysis of censored data (zero values)
    - For Hub Dam reservoir storage volumes, all data available includes non-zero figures
    - For KWC, zero values have been considered just like any other numerical value because no-flow days are very relevant to the analysis
    - Outliers or flows beyond 100 MGD have been filtered to limit maximum values up to 100 MGD
- Correlations are also analyzed:
    - Hub Dam reservoir levels/storage vs. Rainfall
    - KWC Outflows vs. Hub Dam reservoir levels/storage
- Drought analysis:
    - A reliability, resilience and vulnerability estimation are made for Reservoir levels below 278 ft
    - For 80 and 100 MGD, there is a similar analysis
    - In addition, a theoretical reservoir volume is estimated for Lasbela and KWC

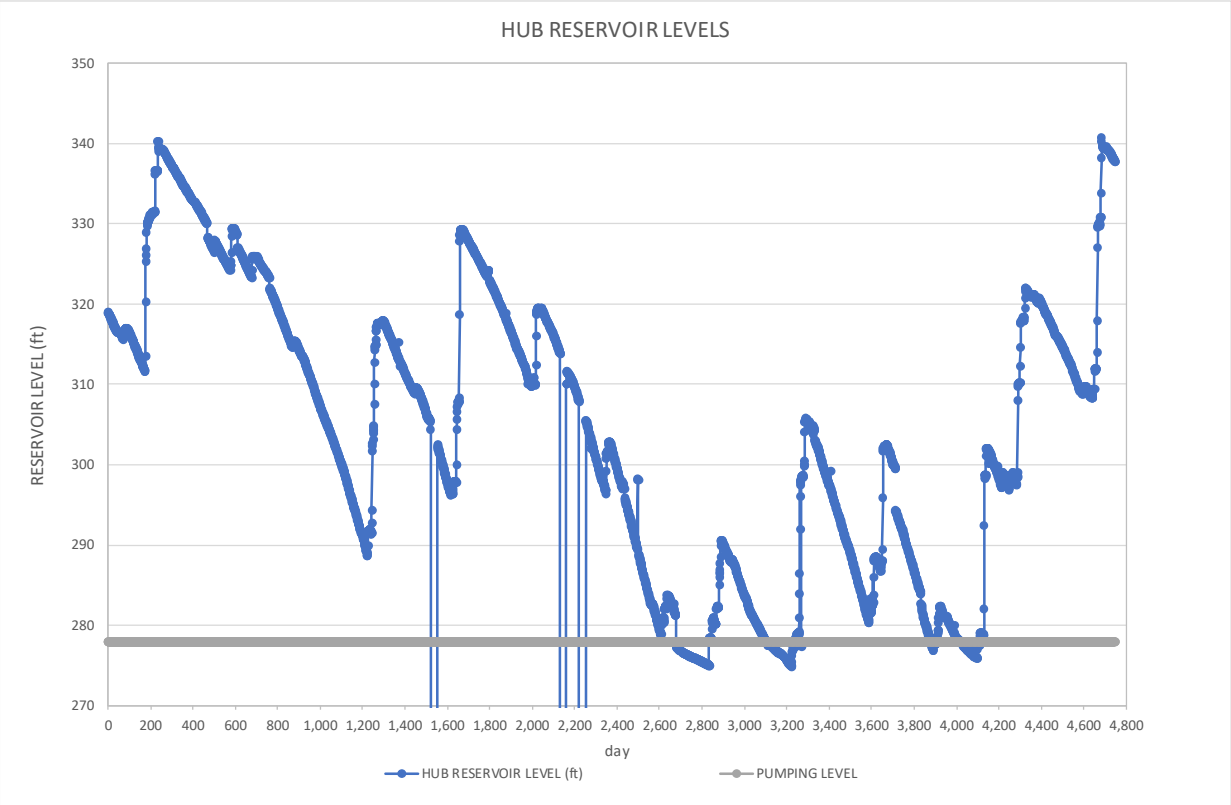


Figure 1. Hub Dam reservoir's water level (ft)

Regarding derived flows, both values equal to zero (they are taken into account as days without derived flow) and flows below 100 MGD (maximum canal capacity) have been considered. Values above have been limited to maximum capacity.

From both daily series and, taking into account the monthly average, a monthly series of data has been constructed.

Regarding the monthly series of data, there are data on reservoir levels, impounded volume and derived flows. The series of levels and flows have been used to complete the months without data of the monthly series generated from daily data.

There are also daily and monthly rainfall data. Both series have been considered complete. The generated series have been represented graphically to show the coherence between them.

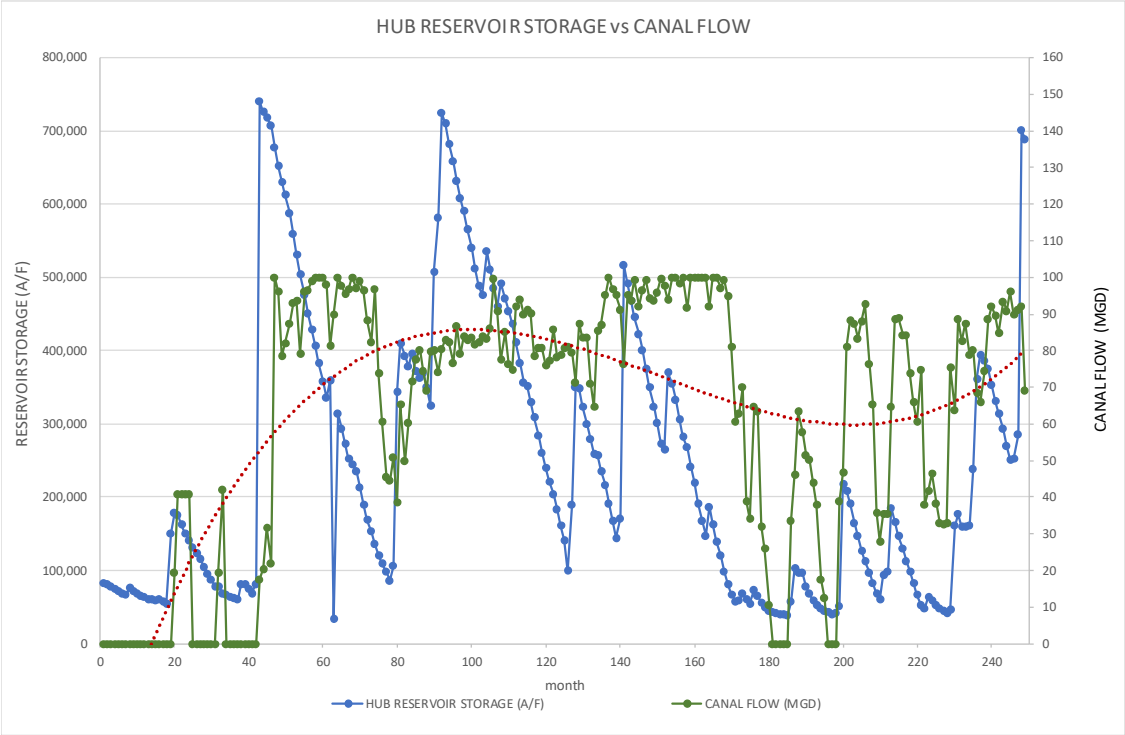


Figure 2. Comparison between Hub Dam's storage (A/F) and water flow at the Karachi KWSB Canal (MGD), per month

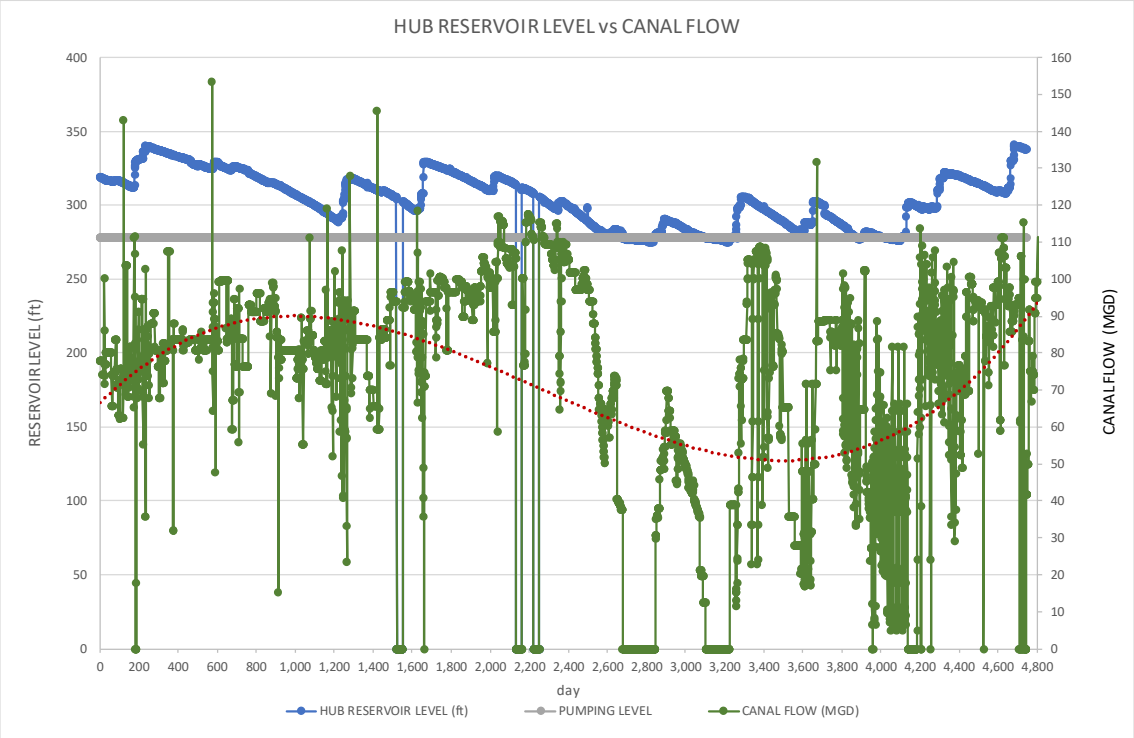


Figure 3. Comparison between Hub Dam's level (ft) and water flow at the Karachi KWSB Canal (MGD), per day

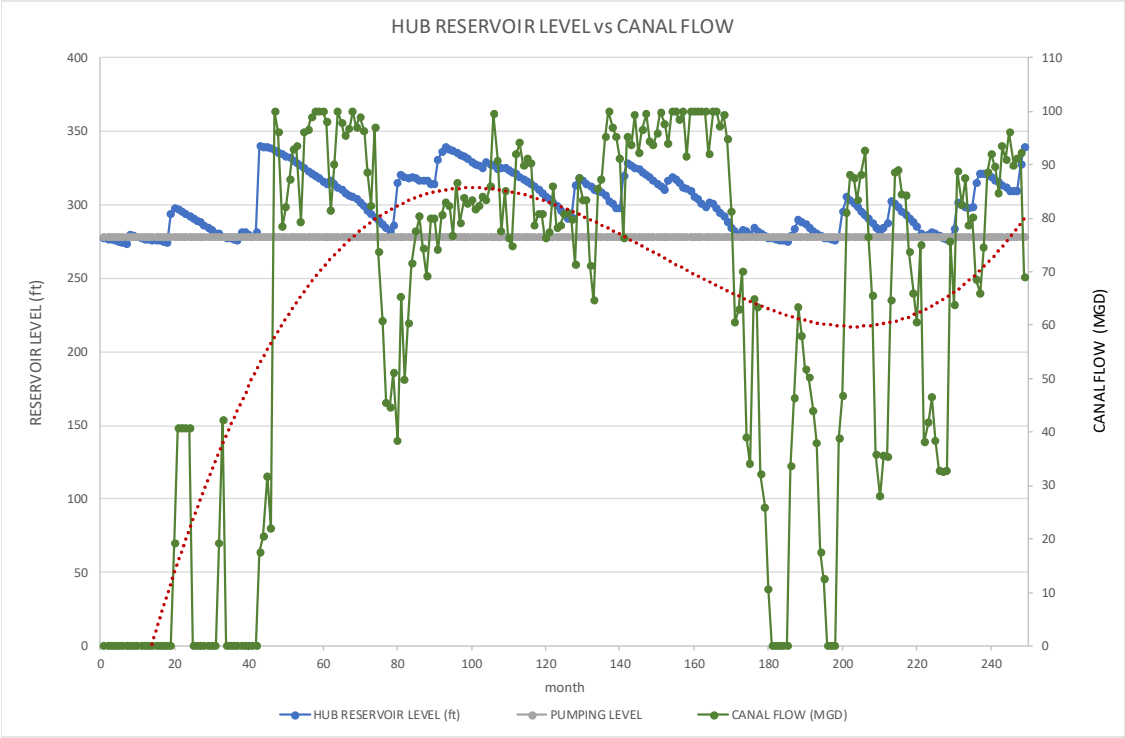


Figure 4. Hub Dam reservoir level (ft) vs KW canal flow (MGD), per month

It can be seen that:

- The series of derived flows decreases when the reservoir empties and increases when it fills. When the reservoir levels are below the 278 ft level, there are no diversions to the Karachi Canal.
- The trend curve of the derived flows follows the patterns of volumes and levels in the reservoir.

Once the coherence of the data series was validated, an analysis of the historical series was carried out to obtain the main statistics: mean, standard deviation, maximum, minimum and median. Once the statistics were obtained, both for the monthly and daily series, the probability distributions of the dammed volume and the flow derived from the Karachi canal have been generated.

A reliability, vulnerability and resilience analysis of the data series has also been carried out.

1.4. ANALYSIS OF KARACHI WATER CANAL OUTFLOWS

The statistical analysis of the daily and monthly data of the outflows from the reservoir to the Karachi water canal has been carried out. The daily series presents 4803 values while the monthly series presents 249 values.

With flow limited to maximum canal capacity (100 MGD) an average flow of 62 MGD is obtained while the median is 78 MGD if the monthly values are analysed.

Furthermore, considering “Daily values”, the mean rises to 70 MGD and the median to 82 MGD, obtaining flows of 100 MGB for 17 months and for 583 days.

With these values, it is observed that the guarantee of deriving flows to the maximum capacity of the canal is approximately 10%, for which the statistical analysis has been carried out considering a maximum capacity of 80 MGD, obtaining a guarantee of 55%.

The following tables present the statistics obtained for the monthly and daily series, taking into account different maximum capacities of the canal.

NUMBER OF MONTHS	DESCRIPTION	KARACHI WATER CANAL OUTFLOWS (MGD)	KARACHI WATER CANAL OUTFLOWS (MGD)
249	MAX.	100.00	80.00
	MIN.	-	-
	AVERAGE	62.21	56.96
	STD DEV	35.39	30.94
	MEDIAN	78.28	78.28
	Months with 100/80 MGD	17	116
	Months with no flow at Karachi Canal	43	43
	Guarantee	10%	55%

Table 1 Statistical results for the Karachi Water Canal at 100 MGD and 80 MGD, per month

NUMBER OF DAYS	DESCRIPTION	KARACHI WATER CANAL OUTFLOWS (MGD)	KARACHI WATER CANAL OUTFLOWS (MGD)
4,803	MAX.	100.00	80.00
	MIN.	-	-
	AVERAGE	70.48	64.05
	STD DEV	30.81	26.14
	MEDIAN	81.80	80.00
	KURTOSIS	0.27	1.03
	Days with 100/80 MGD	583	2,678
	Days with no flow at KWC	466	466

Table 2 Statistical results for the Karachi Water Canal at 100 MGD and 80 MGD, per day

Different probability functions have been adjusted from the daily data series. The one that best approximates is the Gen. Extreme Value of parameters k = -0.96973 s = 32.358 m = 70.067.

The density function is shown in the following figure:

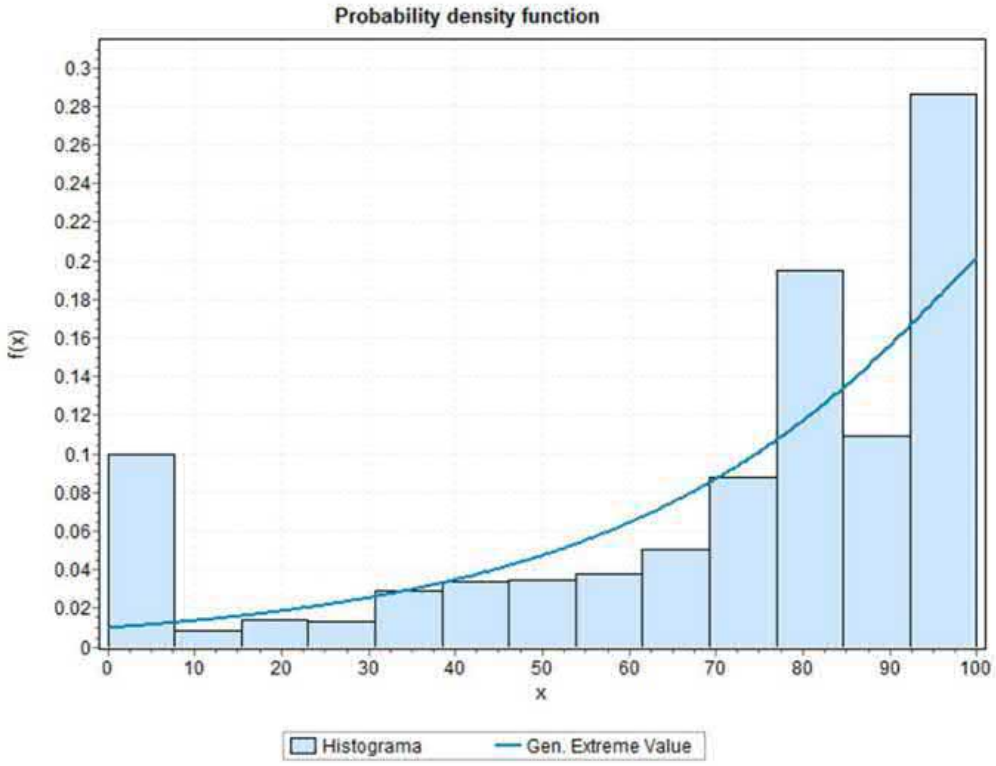


Figure 5. Probability density function

The double probability plot of the fit is also presented:

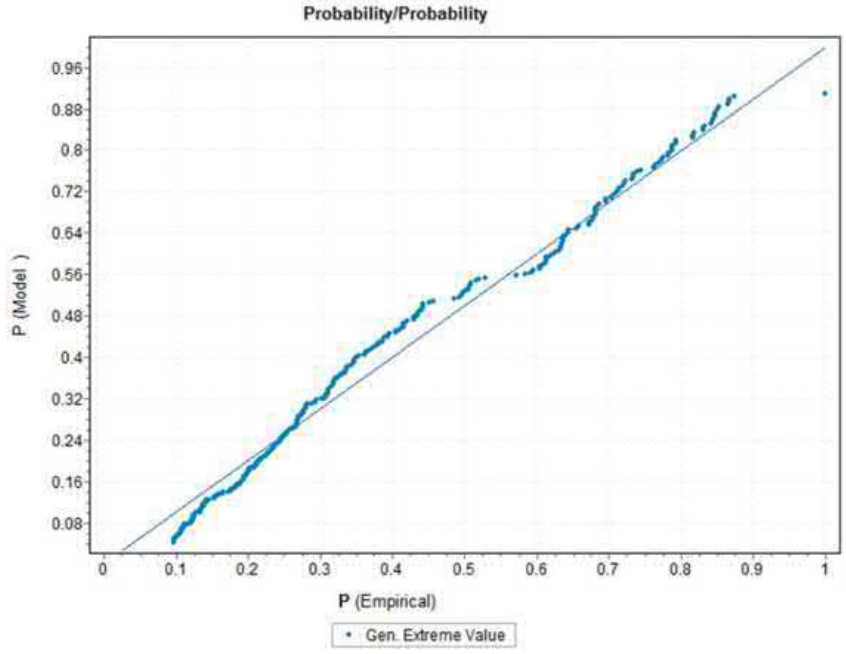


Figure 6. Model/Empirical double probability plot

In addition, an empirical distribution function has been adjusted, the results of which are shown in the following table:

KWC Flow (MGD)	F (x)
5	0.097
10	0.103
15	0.108
20	0.116
25	0.125
30	0.134
35	0.143
40	0.178
45	0.195
50	0.213
55	0.237
60	0.267
65	0.294
70	0.329
75	0.382
80	0.443
85	0.612
90	0.682
95	0.776
100	0.879

Table 3 Empirical distribution function adjustment

Finally, a reliability, resilience and vulnerability analysis associated with the maximum flow rates of 80 MGD and 100 MGD has been carried out.

The **reliability** of any time series can be defined as the number of successful data divided by the total number of data in the time series. **Resilience** can be expressed as the probability that, in one unsatisfactory state, the next will be satisfactory. It is the probability of having a satisfactory value in the period of time t + 1 given an unsatisfactory value in any period of time t. While **vulnerability** is a measure of the magnitude of the differences between the threshold value and the unsatisfactory time series values, it is a probabilistic measure.

Taking into account the theoretical definitions of these concepts, the reliability of the series of flows has been calculated that have been higher than 80 MGD and 100 MGD respectively.

Likewise, the system's resilience has been calculated as the number of times that a flow greater than 80 MGD is achieved after having a flow lower than the same one among the entire data series. It has also been calculated with the limit flow of 100 MGD.

The vulnerability of the system has been obtained against both limit flows (80 MGD and 100 MGD).

DESCRIPTION	KARACHI CANAL 80 MGD	KARACHI CANAL 100 MGD
Reliability:	0.557	0.121
Resilience:	0.064	0.013
Vulnerability	16.42	0.96

Table 4 Karachi Water Canal's characterization

1.5. ANALYSIS OF HUB DAM RESERVOIR WATER RESOURCES

The statistical analysis of the historical volumes impounded, and the levels associated with them in the Hub Dam reservoir has been carried out. The monthly and annual series have been analysed. From a series of 249 monthly data, 33 months were found with a level below 278 ft during which no flow could be derived to the Karachi Canal.

MONTHLY DATA	HUB DAM RESERVOIR WATER STORAGE (A/F)
MAX.	739,891.00
MIN.	33,641.00
AVERAGE	241,928.82
STD DEV.	187,230.90
MEDIAN	177,956.00
Months with reservoir levels < 278 ft	33

Table 5 Hub Dam reservoir's characterization. Storage, per month

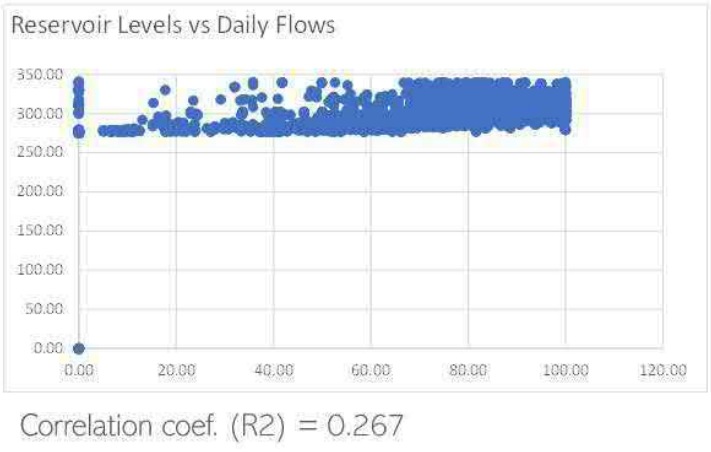


Figure 7. Correlation coef. Hub Dam level vs daily flow

MONTHLY DATA	HUB DAM RESERVOIR LEVELS (ft)
MAX.	340.20
MIN.	273.50

MONTHLY DATA	HUB DAM RESERVOIR LEVELS (ft)
AVERAGE	301.56
STD DEV.	19.24
MEDIAN	300.53
Months with reservoir levels < 278 ft	33

Table 6 Hub Dam reservoir's characterization. Level per month

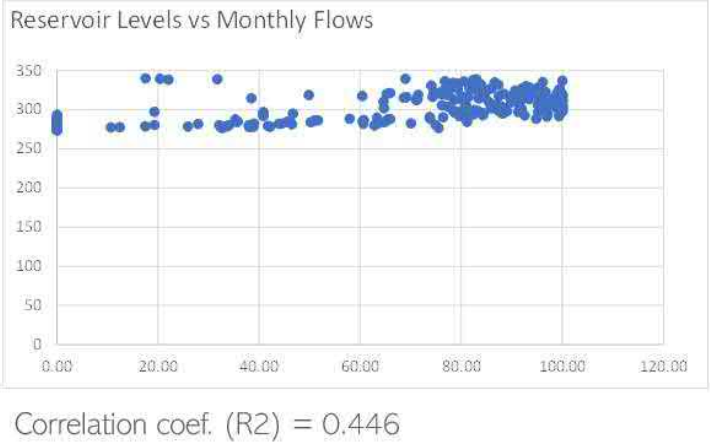


Figure 8. Correlation coef. Hub Dam level vs monthly flow

YEARLY DATA	HUB DAM RESERVOIR LEVELS (ft)
MAX.	328.11
MIN.	253.21
AVERAGE	298.48
STD DEV.	21.40
MEDIAN	297.99
Years with reservoir levels < 278 ft	1

Table 7 Hub Dam reservoir's characterization. Level per month (yearly data)

Different probability functions have been adjusted from the series of monthly data on the volume impounded. The one that best approximates is the Pareto Gen. of parameters k = -0.20298 s = 2.7208E + 5 m = 15760.0.

The density function is shown in the following figure:

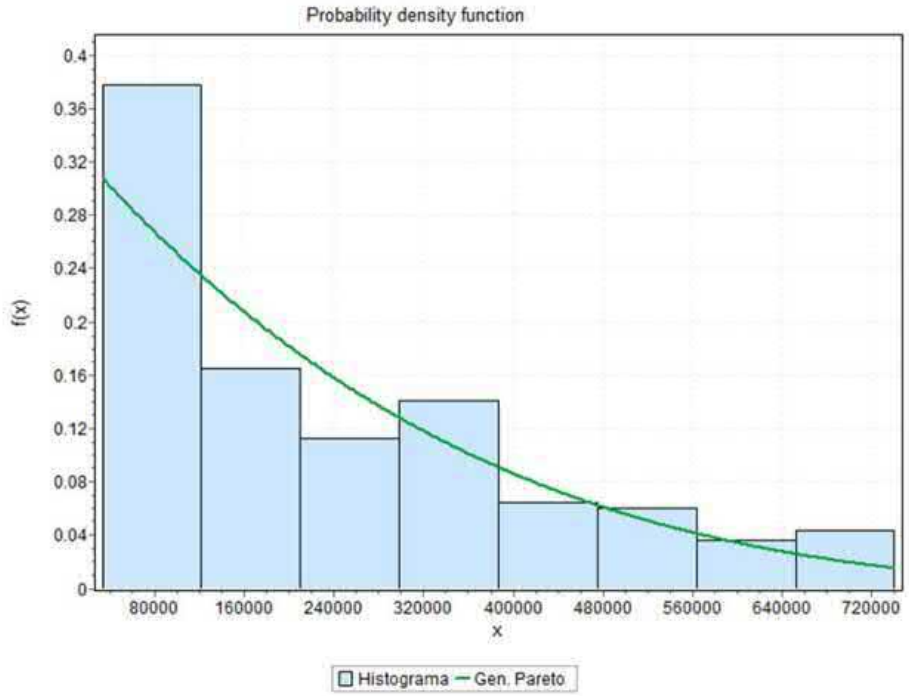


Figure 9. Probability density function

And the double probability function of the fit:

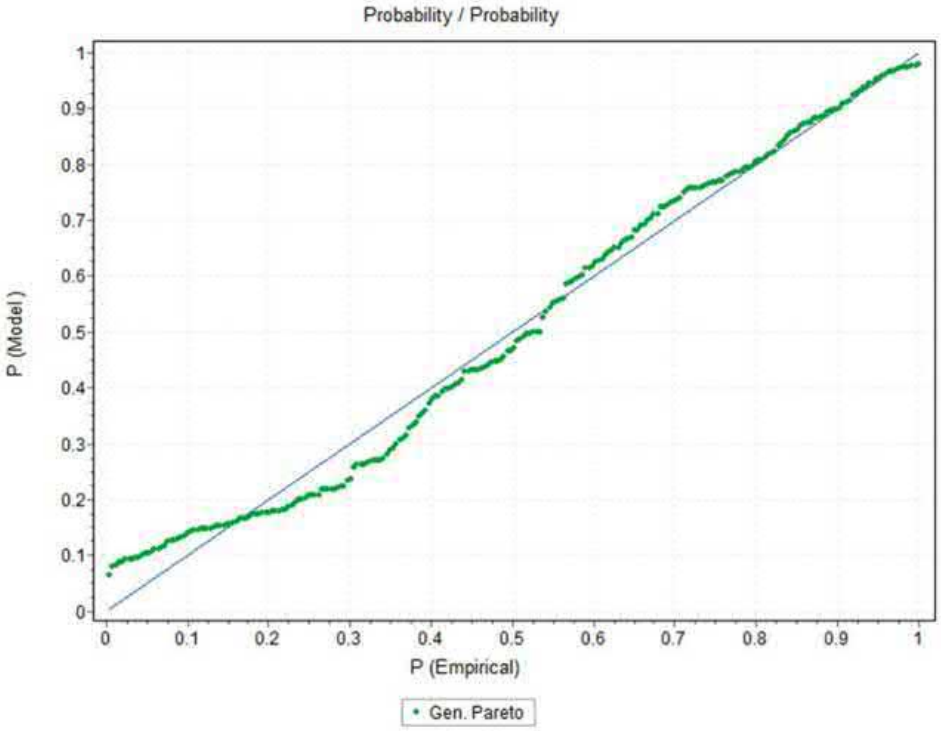


Figure 10. Model/Empirical double probability plot

An analysis of reliability, resilience and vulnerability associated with the daily data of levels measured in the reservoir has been carried out. Two limits have been set: 278 ft, which is the level from which no flow can be derived to the Karachi canal, and 283 ft, which is the level that has been assumed to begin to apply flow restrictions derived from the Karachi canal. Karachi.

DESCRIPTION	HUB DAM 278 ft	HUB DAM 283 ft
Reliability:	0.896	0.795
Resilience:	0.020	0.012
Vulnerability	247.30	105.39

Table 8 Karachi Water Canal's characterization

This analysis has also been carried out for the monthly series of impounded volumes. In this case the limit monthly volume has been 68,900 A / F. This volume is the sum of the volumes associated to elevation 278 ft (from which flow is derived to the Karachi canal) and the volume corresponding to the maximum that can be derived to both canals.

DESCRIPTION	IMPOUNDED VOLUME (68900 A / F)
Reliability:	0.787
Resilience:	0.208
Vulnerability	826,816.04

Table 9 Karachi Water Canal's characterization

Finally, the correlation between rainfall and the volumes and levels of the reservoir has been analysed.

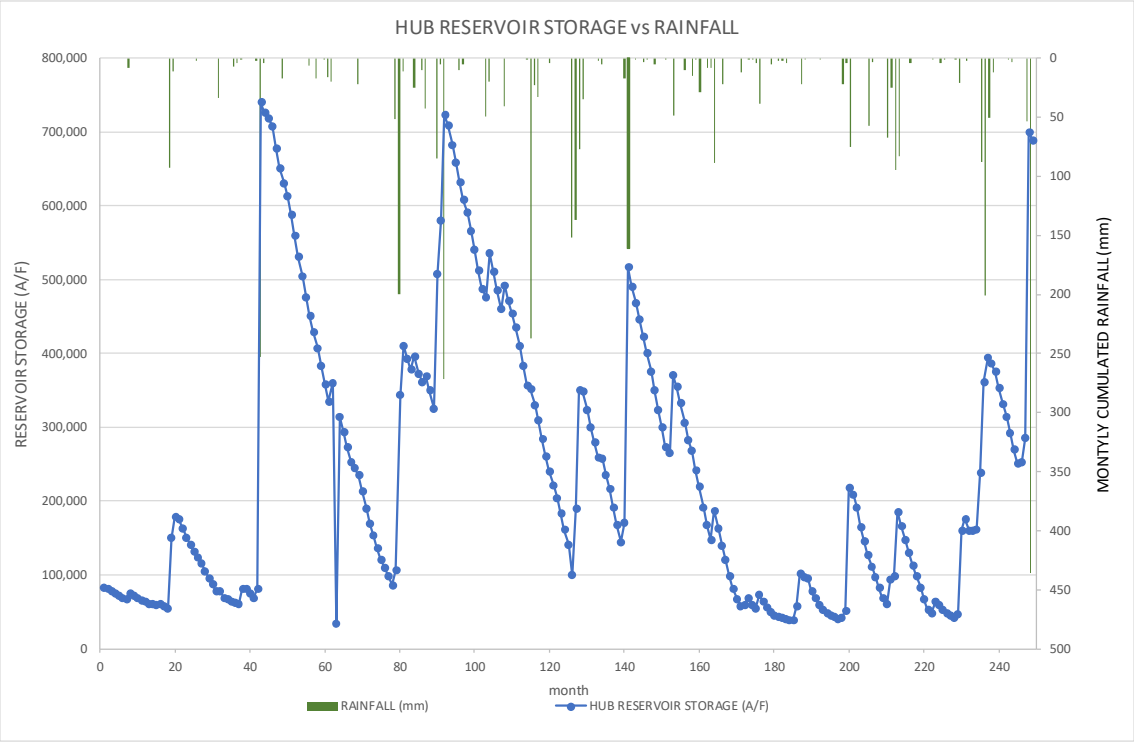


Figure 11. Hub Dam reservoir' storage vs rainfall

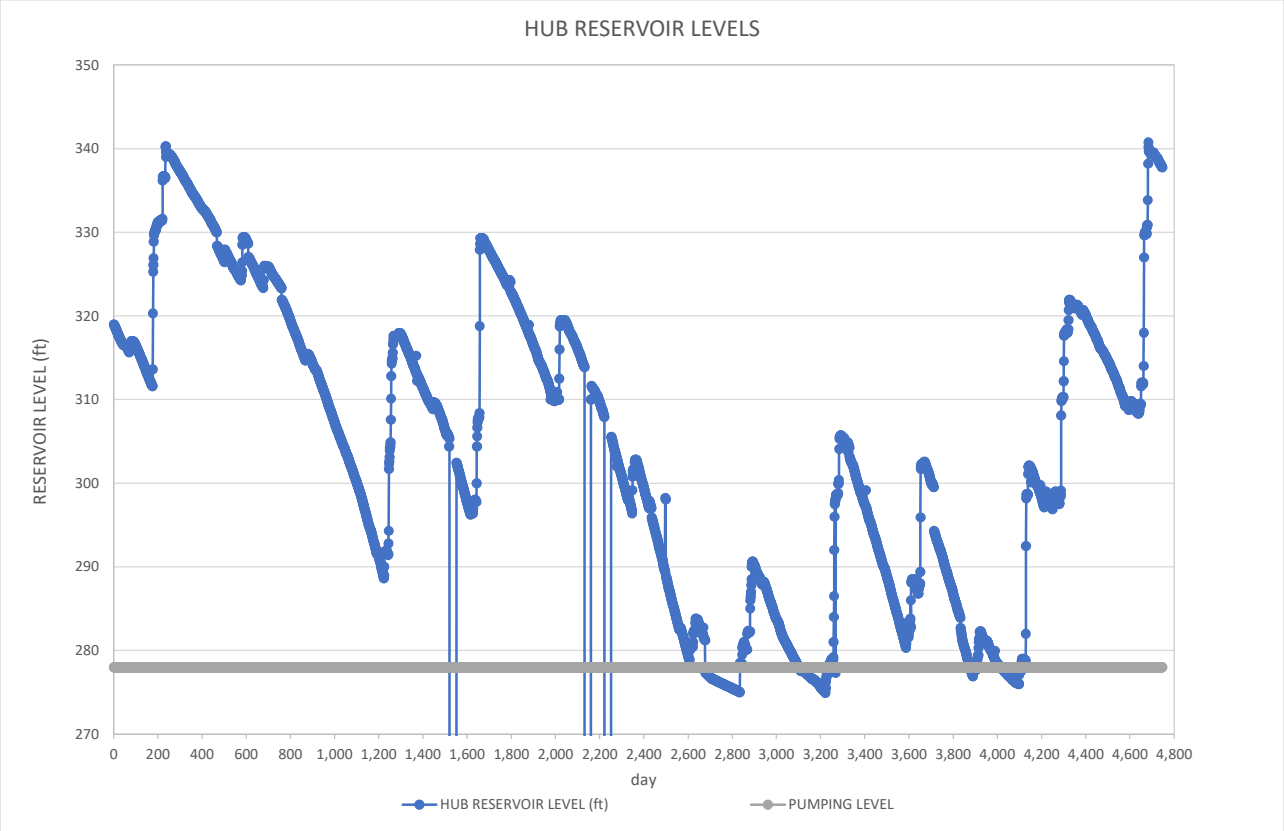


Figure 12. Hub Dam reservoir vs pumping level

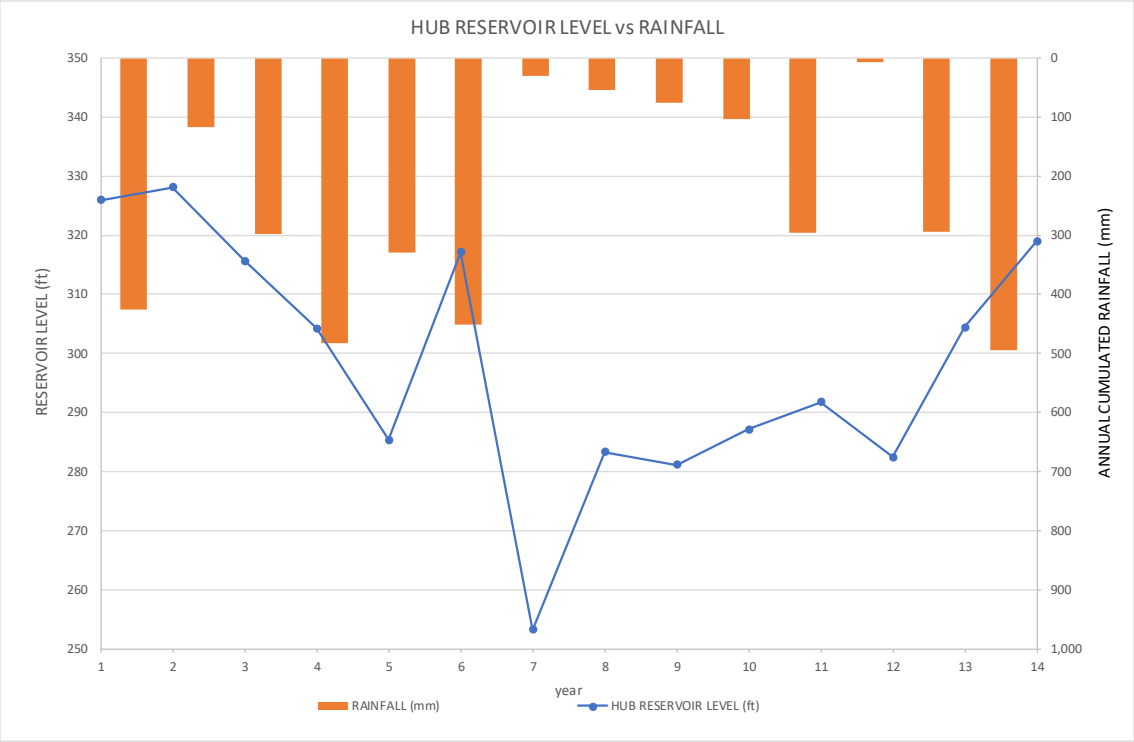


Figure 13. Hub Dam reservoir' s level vs rainfall

It can be observed that episodes of abundant rain allow the levels in the reservoir to recover, while followed periods of drought cause the reservoir to empty and not be able to recover.

1.6. MAIN RESULTS

- The data gathered by WAPDA and KWSB are considered as a reasonable sample to draw sound conclusions with regard to KWC historical flows
- Depending on whether daily of average monthly data is used, the KWC has conveyed a median of 81.8 MGD (4.3 m^3/s) or 78.3 MGD
- The average value is 70.5 MGD (3.7 m^3/s), with a significant std. deviation of 30 to 35 MGD
- 90% of the time, KWC conveyed water
- Reliability of the KWC:
    - For 80 MGD it has been 56%
    - For 100 MGD it has been only 12%
- Resilience of the KWC to recover from flows below a threshold is very small:
    - 6% to recover back to 80 MGD
    - 1% to recover back to 100 MGD
- That means there are significant periods with the KWC out of service (straight months)
- Qualitatively, Hub storage volumes seem to depend on the rainfall
- However, correlation coefficients are not mathematically big

- From the monthly data with a 20-year series, the following data can be drawn:
    - Average monthly reservoir level: 301.56 ft (for the daily data, it is 298.51 ft)
    - Median monthly reservoir level: 300.53 ft (for the daily data, it is 303.40 ft)
    - Standard deviation: 19.24 ft (for the daily data, it is 44.71 ft)
    - Maximum monthly average pool level: 340.20 ft
    - Minimum monthly average pool level: 273.50 ft
- The reliability of the Reservoir is the following (from the daily data):
    - 89.6% for 278 ft
    - 79.5% for 283 ft
- The resilience of the Reservoir is the following (from the daily data):
    - 82.8% to recover from levels below 278 ft
    - 91.3% to recover from levels below 283 ft

1.7. CONCLUSIONS

Based on the historical data, 80 MGD is clearly a design flow that matches better with the actual water conveyed by the KWC

However, the design flow is clearly an economical decision based on tariffs and investment:

- If a free-surface flow is used, the canal should be rehabilitated in the same way, either for 80 or 100 MGD
- If pressure flow is used, a diameter should be chosen to allow both design flows to be conveyed
- Maintenance and operation needs will be different, especially due to the power supply variable costs
- The design flow has a bigger impact on the canal option, due to the erosions and maintenance needs associated with a bigger flow.

HYDRAULIC CALCULATIONS

CONSULTING SERVICES KARACHI WATER CANAL PPP

Contents

HYDRAULIC CALCULTIONS 5

1. BACKGROUND 5
2. DESIGN FLOW 6
3. WATER LEVELS 6
4. PUMPS 6
5. STEADY CALCULATION 7
6. TRANSIENT CALCULATIONS. WATER HAMMER 10
7. AIR VALVES AND WASH OUT VALVES 14
   - 7.1. FILLING PROCESS 14
   - 7.2. EMPTYING OF THE PIPE AND JUSTIFICATION OF THE WASH-OUT DIAMETER 15
   - 7.3. SUMMARY 16

TABLES

Table 1: Results for steady calculations. 9
Table 2: Air flow rate to be eliminated 14
Table 3: Air valve obtained diameter (filling process). 15
Table 4: Wash-out diameters depending on the diameter 16
Table 5: Air valve obtained diameter (emptying process). 16
Table 6: Air valve obtained diameter 16

FIGURES

Figure 1. General layout 5
Figure 2. Characteristic curves of pump at 990 1/min rated speed 6
Figure 3. Scheme used for calculations 9
Figure 4. Non-negative pressures verification 10
Figure 5. Steady and transient flow without protection 11
Figure 6. head situating surge vessels 11
Figure 7. Airvessel before pumps; pressure 12
Figure 8. Airvessel before pumps; air volume 12
Figure 9. Airvessel after pumps; pressure 13
Figure 10. Airvessels after pumps, air volume 13
Figure 11. Air valve diameter calculation (Filling) 15
Figure 12. Air valve diameter calculation (Emptying) 16

HYDRAULIC CALCULTIONS

CONSULTING SERVICES KARACHI WATER CANAL PPP

1. BACKGROUND

A pumping system has been designed, starting at Karachi Water Canal (derived from Wapda Cana). Scheme of designed system begins at a intake chamber, and has a new 9,765 m long GRP pipeline 1,900 mm (74 4/5 inch) inner diameter, a pumping station with 6+1 pumps (includes 500 mm/20" each, check valves at suction), and two rising mains 2,177 m long GRP 1900 mm diameter (only one used).
Throughout the present document, the following items have been justified:

- Normal operation situation for the designed pipelines.
- Overpressures and vacuum due to the transient state generated when the pumps trip
- Features of washout and air-release valves

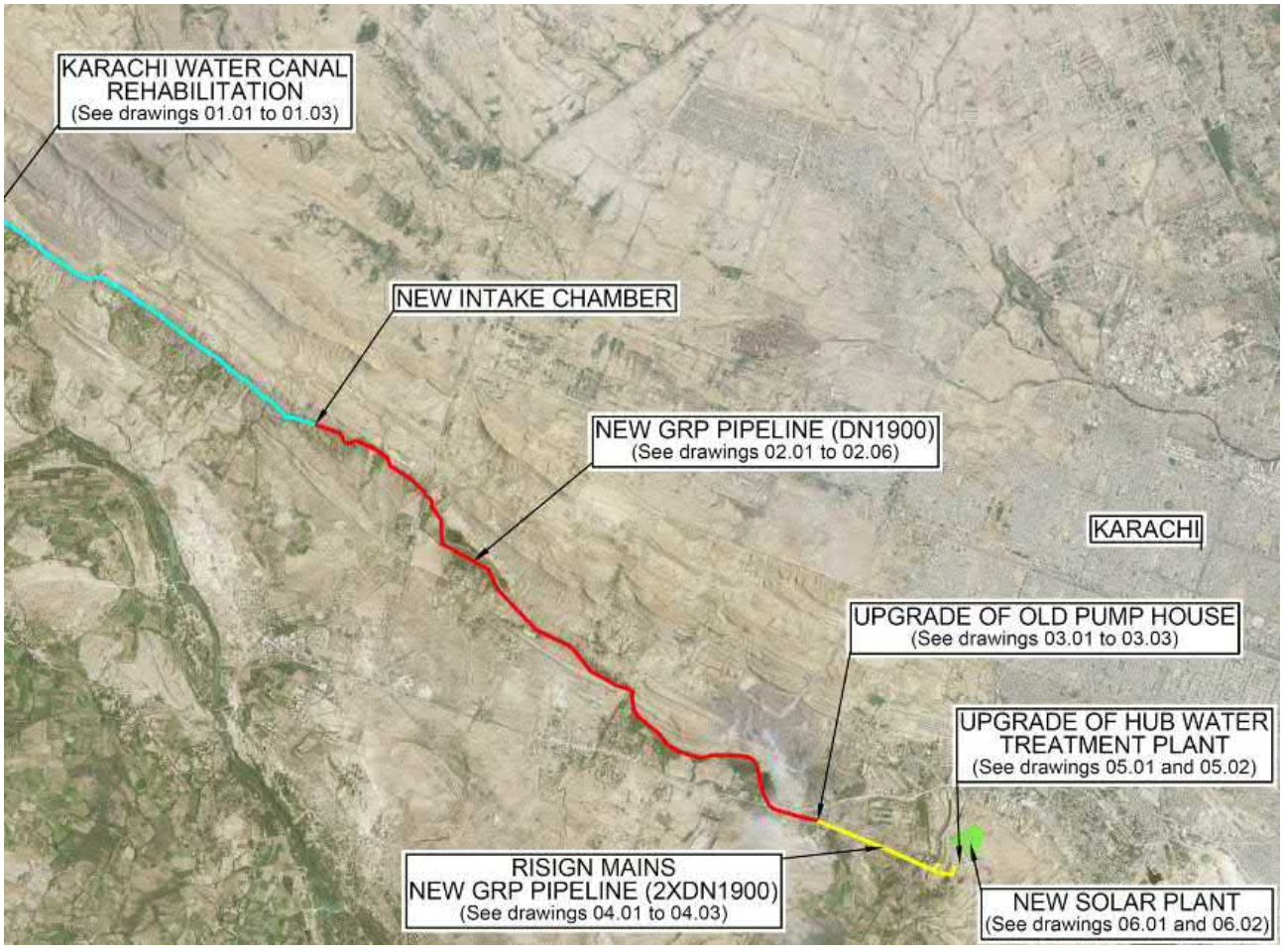


Figure 1. General layout

2. DESIGN FLOW

The design flow is 100 Mgallon/day (454,550 m^3/day).

3. WATER LEVELS

The water level in Karachi canal at intake point is about 79.2 m.o.s.l. and the tank at final line, (on water treatment plant site) is about 113 m.o.s.l. Pumps are located at 59.5 m.o.s.l.

4. PUMPS

A 6+1 pumps scheme has been selected.

Inner diameter at suction is 500 mm and at discharge is 450 mm. (approx. 20" and 18")

Pumps are selected to work near optimus point with 50.98 m. (167.26 feet) head increment, and 3,148 m^3/h flow. Then, six pumps make 18,890 m^3/h; that is 453,360 m^3/day (99.7 Mgallons/day)

Drive motor is 550 kw 6 pole 3000V 50 hz air cooled.

Characteristic curves of pump at 990 1/min rated speed are:

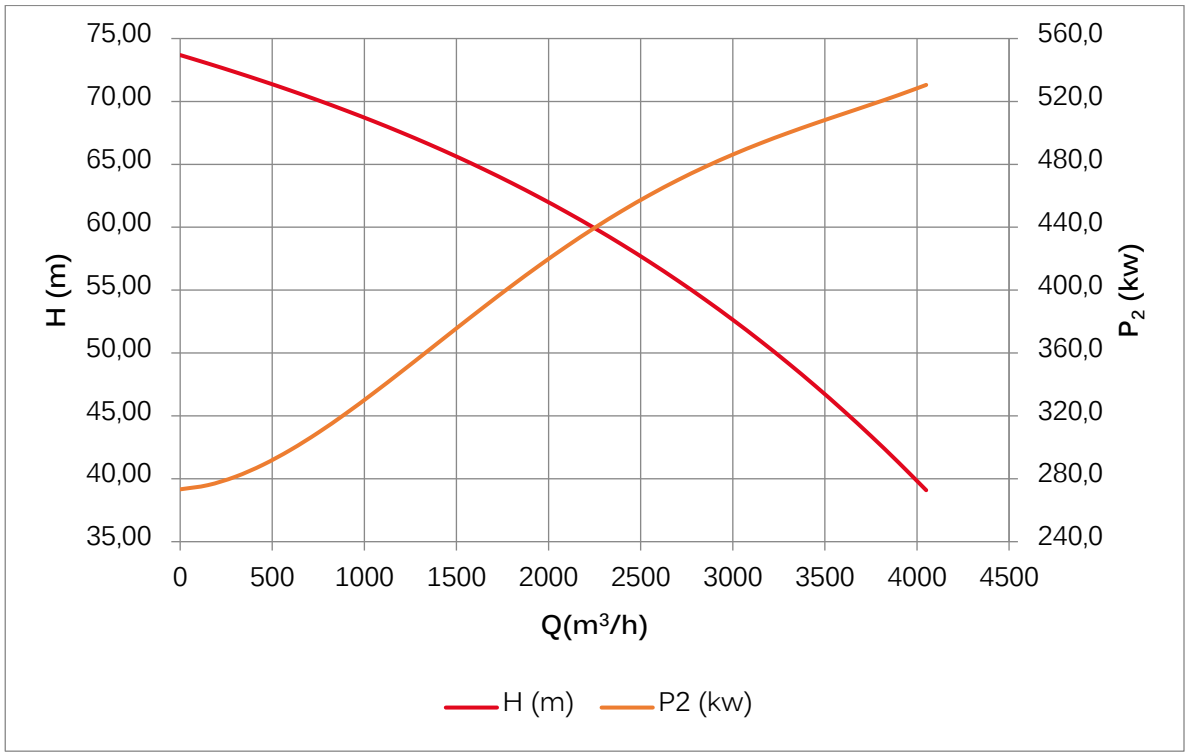


Figure 2. Characteristic curves of pump at 990 1/min rated speed

5. STEADY CALCULATION

The methodology followed started calculating the steady-flow state. Afterwards, the transient state was calculated.

Two facts shall be checked in the steady flow analysis. It shall be proven that the hydraulic head is always above the ground, and that total head is higher than that required in order to reach the Tanks with sufficient pressure.

Bernoulli equation can be stated as follows:

$$H_1 + H_b = H_2 + \Delta H_{1-2}$$

$$h_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = h_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + \Delta H_{1-2}$$

where,

h_i = Height at point "i" (m)

P_i = water pressure at point "i" (N/m^2)

V_i = water velocity at point "i" (m/s)

ΔH_{1-2} = Head loss between points 1 and 2 (m)

γ =water specific weight (9810 N/m^3)

g = gravity acceleration= 9.81 m/s^2

Once the total head line is calculated and taking into account the initial head data, it is necessary to check two more conditions. The first one is that there are no negative pressure points along the pipeline, and the total head at the downstream end of the pipeline is greater than required.

Major head loss is calculated using the Darcy- Weisbach equation.

$$i = \frac{h'_f}{L} = \frac{f.V^2}{2.g.D}$$

where:

h_f'- Major head loss (due to friction) (m)

L - Pipe length (m)

D - Pipe diameter (m)

f - Friction Factor. Using Colebrook's equation,

$$\frac{1}{\sqrt{f}} = -2.\log\left[\frac{k}{3{,}71.D} + \frac{2{,}51}{\mathrm{Re}.\sqrt{f}}\right]$$

where:

k - Roughness height (m). A value of 0.07 mm has been considered

D - Hydraulic Diameter (m)

g - gravity (m/s^2)

Re - Reynolds Number (dimentionless)

$$\mathrm{Re} = \frac{V.D}{\nu}$$

where:

ν - Dynamic viscosity (m^2/s)

V - Velocity (m/s)

Local losses are assumed to increase by 8% friction head loss, so the total head losses are calculated using the following expression:

$$i \quad = 1{,}08 \times \left(\frac{f.V^2}{2.g.D}\right)$$

The upstream point of the main pipeline is intake chamber at Karachi canal. The water level is 79.2 m.

The downstream point is Treatment Station. The maximum water level of this point is of 105,0 m.

Losses calculated are:

9765 m GRP pipeline 1900 mm inner diameter (roughness about 0.07 mm)

Check valve 500 mm diameter (loss coefficient about 1).

2177 m 1900 mm inner diameter GRP (roughness about 0.07 mm)

Different calculations are made with 1 to 6 pump operating at rated speed (990 1/min) and at optimum pump speed (which depends on losses, so, is different for 1 to 6 pumps)

Calculations are made with Wanda 4.5.1208 software.

Scheme used is:

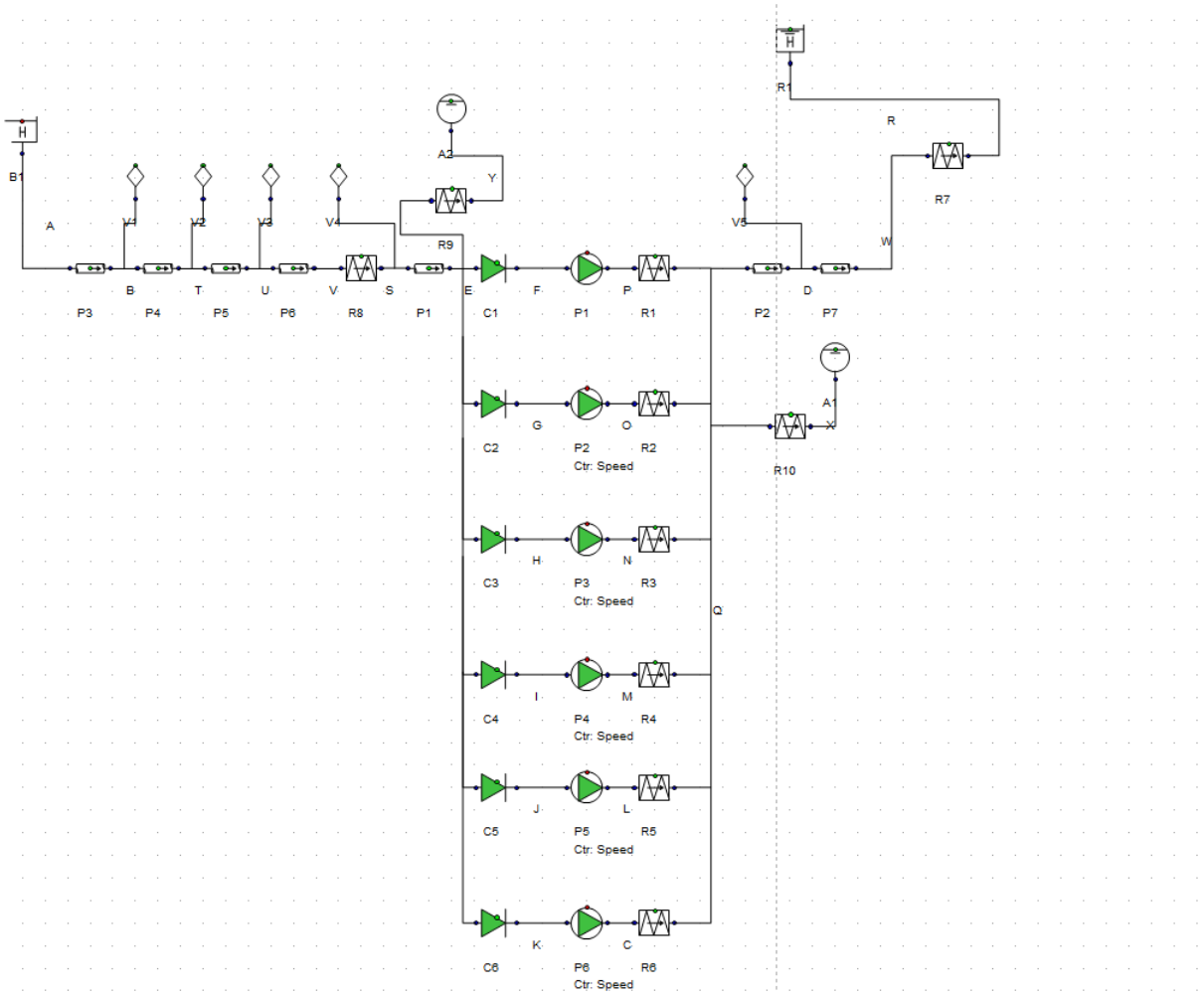


Figure 3. Scheme used for calculations

First four vents on suction pipe and last in impulsion pipe are considered in calculus.

Also punctual losses and check valves are considered.

Results for steady calculations are the following:

Nº Pumps	speed (1/min)	Q (m^3/h)	ΔH (m)	ΔH (pump)	power (kw)	efficiency (%)	C. ratio (kwh/m^3)
1	990	4002	-6.07	39.65	523.8	82.55%	0.1309
2	990	7798	-7.64	41.223	1042.8	84.00%	0.1337
3	990	11241	-9.86	43.438	1550.7	85.81%	0.1380
4	990	14240	-12.38	45.96	2042.0	87.34%	0.1434
5	990	16775	-14.95	48.53	2513.5	88.26%	0.1498
6	990	18888	-17.40	50.976	2962.2	88.57%	0.1568
5	952.9	15515	-12.84	46.42	2216.5	88.54%	0.1429

Table 1: Results for steady calculations.

To verify the non-negative-pressures condition, Wanda 4.5 model shows the following chart (steady flow, six pumps operating 990 rpm):

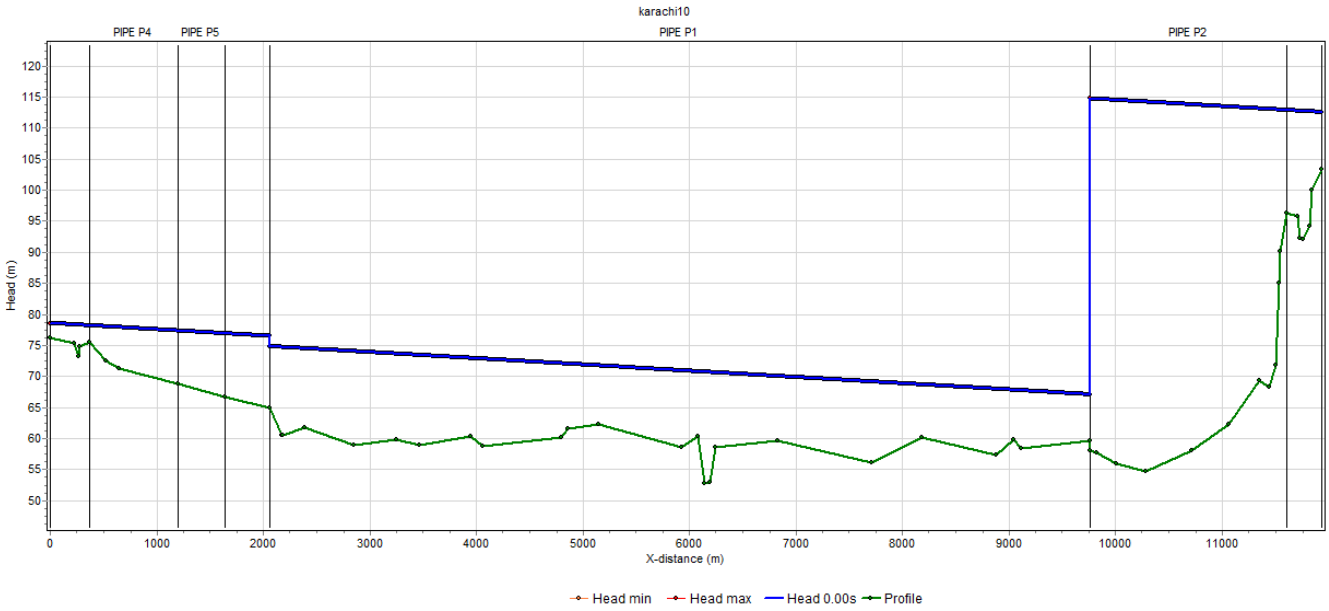


Figure 4. Non-negative pressures verification

The blue line represents the steady flow pressure while the green line determines the ground level. As it can be seen, the pressure line does not intersect the ground level. Hence, this design condition is accomplished.

Increment in head line is due by pumps raising head.

At end point, flow passes from pressure flow to open channel flow.

It's recommended to use variable speed either to pump variable discharge and save energy or to avoid that pumps could be used outside of optimum range.

6. TRANSIENT CALCULATIONS. WATER HAMMER

Water hammer effect shall be due to pump trip. Water hammer must be studied to calculate the maximum overpressure and depression that the pipe and its components must bear.

Materials data:

New pipe:

- Material GRP
- Inner diameter: 1900 mm
- Young Modulus: 1e10 N/m²
- Wave speed: 352 m/s

Proposed pumps:

- Polar moment of inertia of the pump and drive: 54 kgm² (each one)

The following chart shows the head in steady and transient flow (without any kind of protection) between intake chamber and the ISTP Plant at the end of the pipeline.

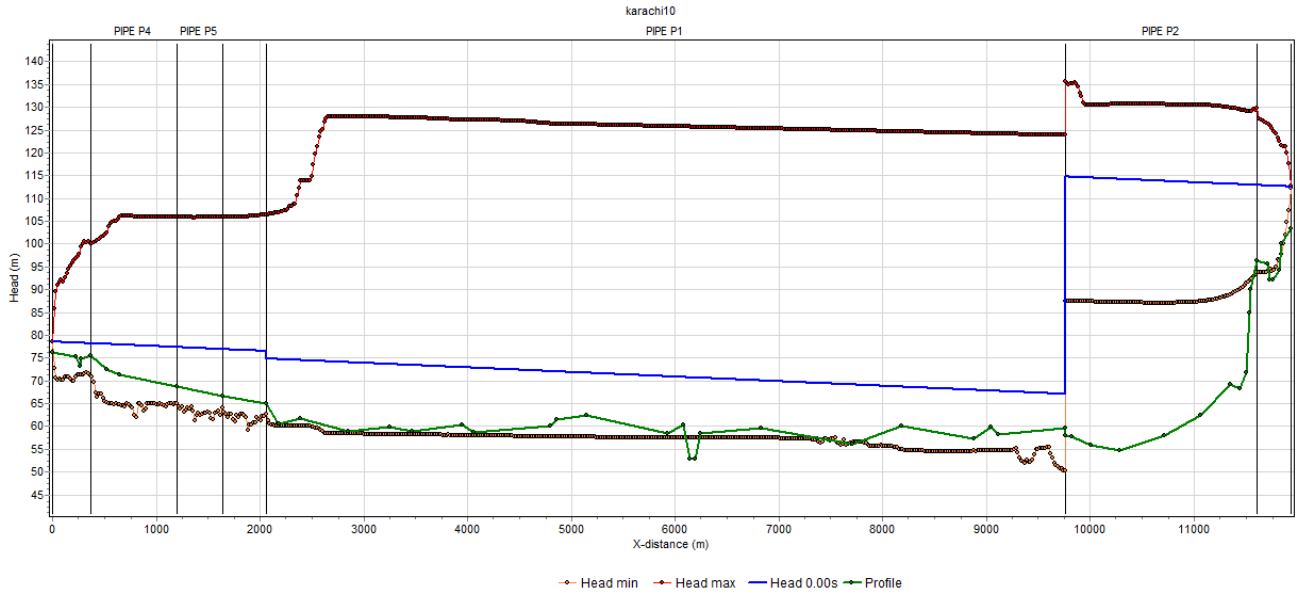


Figure 5. Steady and transient flow without protection

The red line indicates overpressure, and the orange line indicates minimum pressure.

As a conclusion of the graphs represented in the chart, it can be assured that low pressures under atmospheric (near cavitation pressures) will occur at admission pipe and at the end of impulsion pipe.

To avoid this phenomenon, it is proposed **to place surge vessels** located both before and after pump station. The following chart shows the head situating surge vessels.

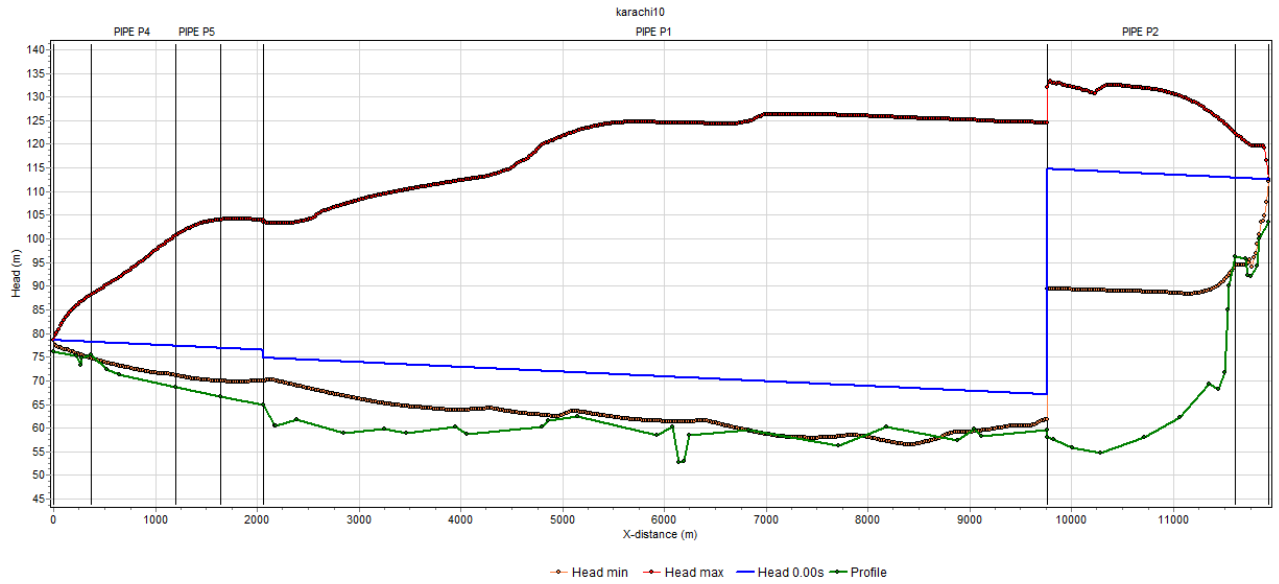


Figure 6. head situating surge vessels

As the chart shows, no cavitation will occur under these circumstances (low pressures about -2 m)

Pressures and air flow volumes at airvessels are shown below:

Airvessel before pumps; pressure:

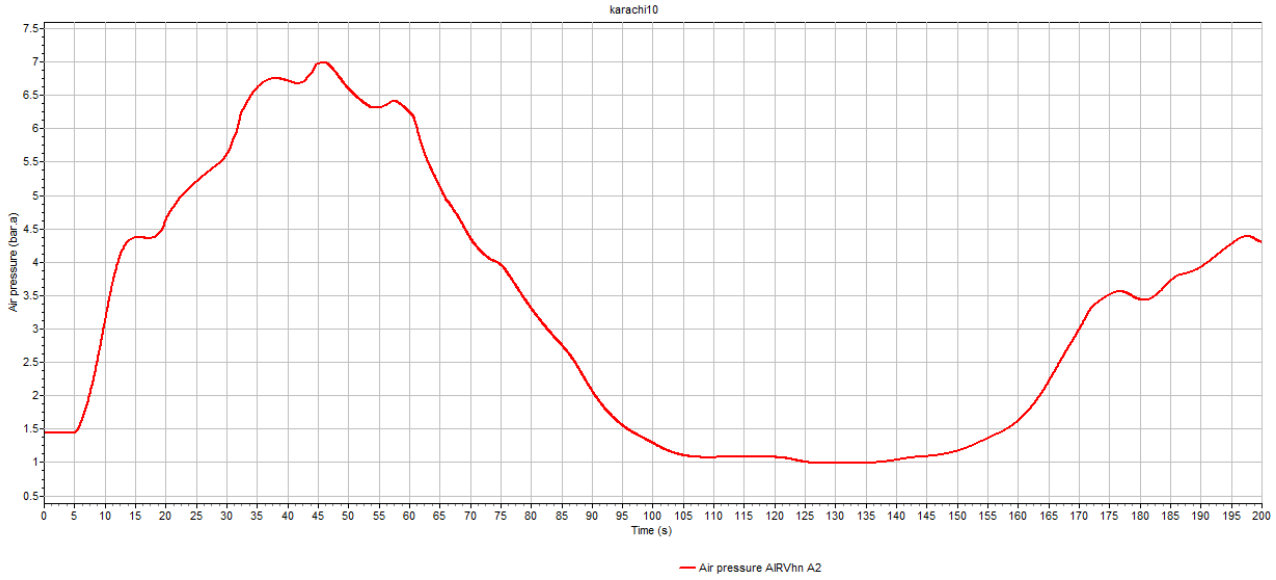


Figure 7. Airvessel before pumps; pressure

Airvessel before pumps; air volume:

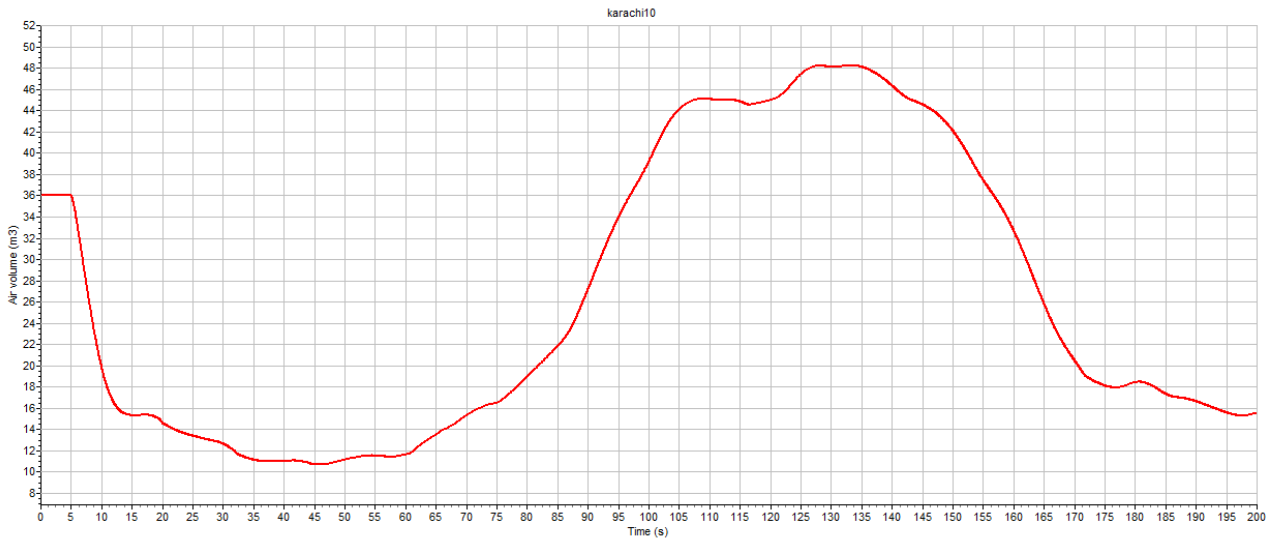


Figure 8. Airvessel before pumps; air volume

Airvessel after pumps; pressure:

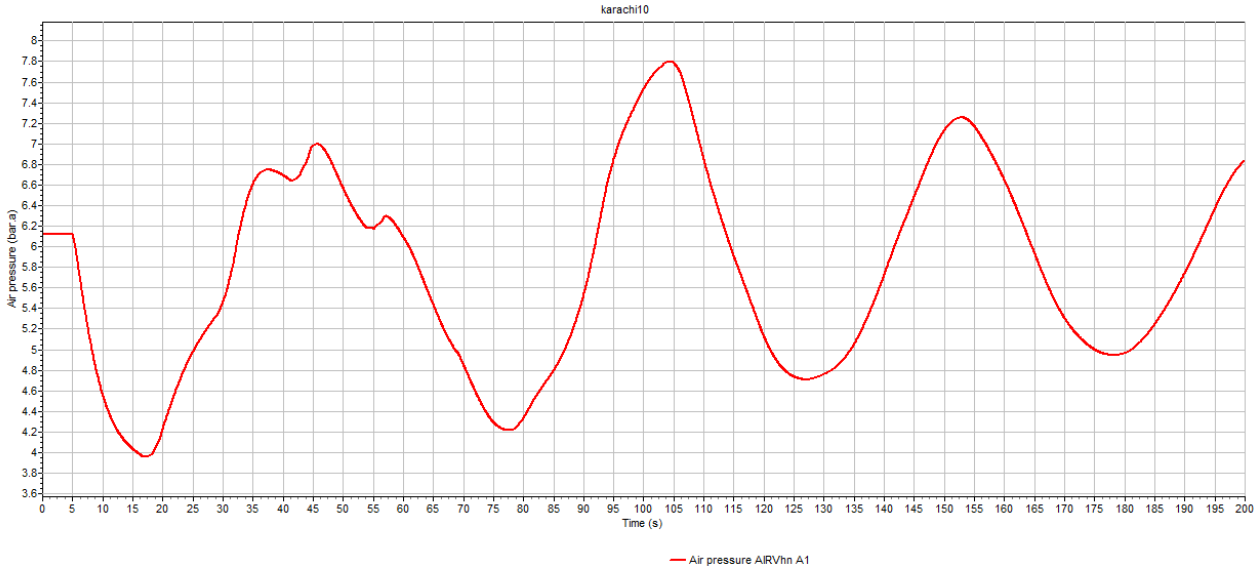


Figure 9. Airvessel after pumps; pressure

Airvessels after pumps, air volume:

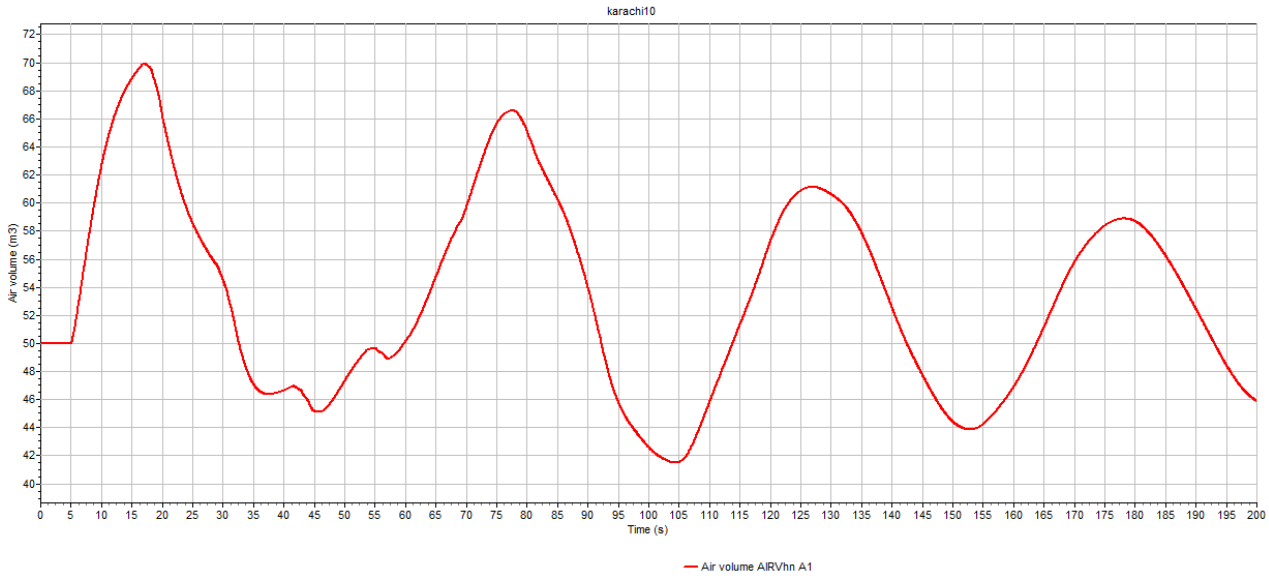


Figure 10. Airvessels after pumps, air volume

Proposed horizontal airvessels:

Airvessel before pumps:

Total Volume: >= 50 m^3

Nominal Pressure: >=10 atm.

Airvessel after pumps:

Total Volume: >= 70 m^3

Nominal Pressure: >=10 atm.

Initial air quantities:

n=PV/RT

When R is gas universal constant. (8.206 10^{-5} m^3·atm/ºK mol), P is air absolute pressure, V is air volume and T is air absolute temperature in ºK. Resultant n is mol of air (that is 1 mol =28 g N_2 if gas is nitrogen)

Initial air volume and pressures at 20º C (293ºK) used in calculus are:

Airvessel 1: P= 1.442 bar (a) V=36 m^3 T = 293ºK

Airvessel 2: P= 6.118 bar (a) V = 50 m^3 T = 293ºK.

Note: calculations with only 1 pump operating are made, with the same air quantities, to ensure that the airvessel is not emptied at this condition.

7. AIR VALVES AND WASH OUT VALVES

Standard AWWA C-512 and M51 have been used for the dimensioning of air valves.

This method is based on the limitation of the differential pressure, both in the filling process (1.5 m.c.a.) and in the emptying process (variable).

7.1. FILLING PROCESS

It is necessary to control the flow of air to be eliminated (FAE), which is equal to the flow of water in the pipe (Q).

Q = FAE

A maximum filling velocity of 0.3 m/s has been considered. The air flow rate to be eliminated is then calculated for the diameter selected:

Diameter (mm)	Inner diameter (mm)	Filling velocity (m/s)	Flow (l/s)	FAE (l/s)
1900	1900	0.3	851	851

Table 2: Air flow rate to be eliminated.

The diameter of the air valve is chosen considering the value of the calculated flow and using the next figure. This is the diameter closest in excess of that defined by the cut-off point of the air flow to be eliminated with the differential pressure (above atmospheric) of 1.5 m.c.a.

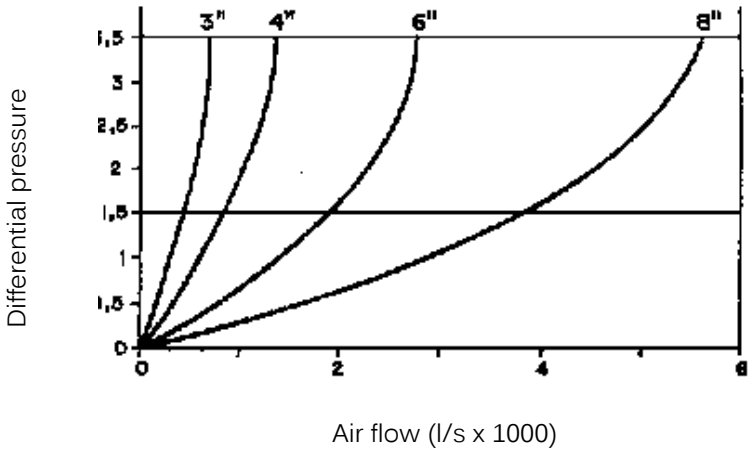


Figure 11. Air valve diameter calculation (Filling)

In this case the following air valve diameter is obtained:

Diameter (mm)	FAE (l/s)	Air valve diameter (mm)
1900	851	4"=100mm

Table 3: Air valve obtained diameter (filling process).

7.2. EMPTYING OF THE PIPE AND JUSTIFICATION OF THE WASH-OUT DIAMETER

In order to avoid the risk of collapse of the pipe due to the relative vacuum produced during the emptying of the pipe, the maximum tolerable differential depression must be established. In the hydraulic calculations carried out, no part of the pipe goes into depression. In any case, the malfunction of an air valve must be taken into account. According to the manufacturers of air valves, it is not expected to exceed a maximum differential pressure of 3.5 m.c.a.

The emptying flow rate is calculated as follows

$$Q_V = Cd \times \sqrt{(2 \times g \times \Delta H)} \times \pi \times (\frac{D}{2})^2$$

where.

Q_v =Emptying flow rate (m^3/s)

Cd = Discharge coefficient. A value of 0.8 has been taken.

ΔH= Maximum pressure of the section under

D = Maximum diameter of the wash-out pipe.

The following wash-out diameter has been considered taking into account the diameter of the main pipe:

Diameter	Wash-out diameter (mm)
1,900	300

Table 4: Wash-out diameters depending on the diameter

The emptying flow rate has been calculated according to the pressure range of the section under consideration. Once the emptying flow rate has been obtained and by entering as following figure as the abscissa and cutting for the 3.5 m.c.a. vacuum line, the required air valve diameters per emptying are obtained

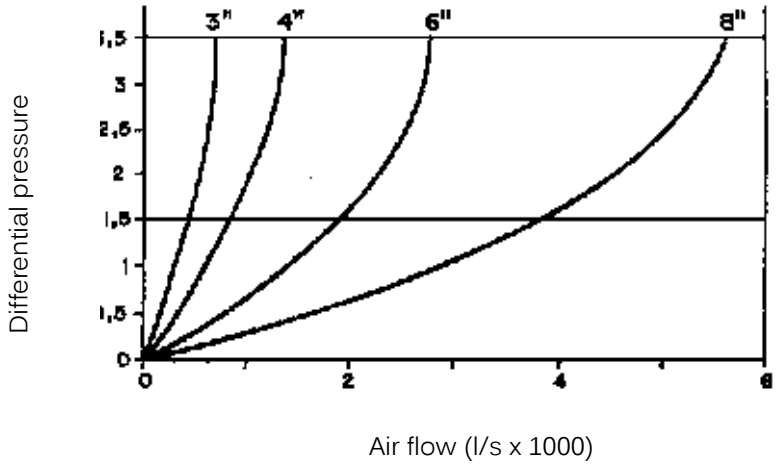


Figure 12. Air valve diameter calculation (Emptying)

Diameter (mm)	Wash-out diameter (mm)	Pressure (m)	Discharge flow (l/s)	Air valve diameter (mm)
1,900	300	46	1,273.5	6"=150mm

Table 5: Air valve obtained diameter (emptying process).

7.3. SUMMARY

Once theoretical emptying and filling diameter of the pipeline have been calculated, the air valve diameter selected is the higher of the two values. The following table summarizes the air valve diameter selected:

Diameter (mm)	Air valve diameter (mm)
1900	6"=150mm

Table 6: Air valve obtained diameter .

Nevertheles of these calculations, waterhammer due to sudden trip on pumps, generates negative pressures on pipeline.

To avoid risk of pipe crushing, 2x150 mm air valve diameter must be placed when minimum low pressures are expected.

WATER QUALITY ANALYSIS TESTS

CONSULTING SERVICES KARACHI WATER CANAL PPP

Annex 3.1. Field survey Report

CONSULTING SERVICES KARACHI WATER CANAL PPP

FIELD SURVEY REPORT

Field visit for the collection of water samples for **Rehabilitation Hub Canal Project** was conducted on 18th September 2020. SGS Pakistan (Pvt) Ltd was assigned for the collection of the water samples in the presence of Halcrow Pakistan (Pvt) Ltd representative. Testing and analysis of required parameters of the water samples will also be conducted in the SGS Pakistan laboratory.

The main canal coming from the Hub dam was distributed into two sub canals namely **'Karachi Canal'** and **'Lasbella Canal'** near head regulator. Initially three water samples were planned to be collected as follows

1) Before head regulator at Main canal (coming from the Hub dam),
2) Inlet of water purification plant in Manghopir – Karachi.
3) Outlet of water purification plant in Manghopir – Karachi.

During the visit total 5 water samples were collected and marked as following

1) Head Regulator (Sample taken before Head regulator)
2) Karachi Canal (Sample taken after Head regulator)
3) Distribution Chamber (Filtration Plant)
4) Withholding Tank (Filtration Plant)
5) Reservoir (Filtration Plant)

At each sampling location, three separate grab samples were collected for microbiological, chemical and metal testing. HNO_3 was added as a preservative for metal sample bottle, at each mentioned location. Below are the observations noted at site.

S.No	Sampling Location	pH	Temperature (°C)
01	Head Regulator	6-7	32.2
02	Karachi Canal	6-7	32.3
03	Distribution Chamber	6-7	34.5
04	With holding Tank	6-7	32.8
05	Reservoir	6-7	32.6

During the field visit it was ensured that samples were collected according to the standard operating procedure and preserved properly to acquire the accurate results during testing. After sample collection from each sampling point, temperature and pH was noted on the spot and then the samples were placed in ice box filled with ice to maintain the temperature inside the icebox and to preserve the samples for further testing in the SGS lab.

PHOTOGRAPHS

Head Regulator location

View of Main Canal

View of main canal before head regulator

Head Regulator

Karachi Canal

Lasbella Canal

Sample Point no. 1 (Before Head Regulator)

Sample collection

Sample Collection

pH monitoring

Temperature monitoring

Adding preservative in to the sample

Halcrow Pakistan representative at location

Sample Point no 2 (Karachi Canal – After Head Regulator)

Sample Collection for microbiological analysis

Sample Collection for chemical analysis

pH monitoring

Adding preservative in the sample

Sample no. 3 (Distribution Chamber - Filtration Plant)

KWESB – Water Treatment Plant

Distribution Chamber

Chlorine mixing in the tank

Sampling Point

Sample Collection

Sample Collection

Sample no.4 (With holding Tank – Filtration Plant)

Sample collection

Sample Collection

Adding preservative in to the sample

pH monitoring

Sample Point no 5 (Resorvoir Tank – Filtration Plant)

View of Reservoir Tank

Reservoir Tank

Sample Collection for chemical analysis

Sample Collection for microbiological analysis

pH monitoring		Adding preservative in to the sample
Sample preservation with ice		Sample preservation with ice

Annex 3.2. First Water Quality Report

CONSULTING SERVICES KARACHI WATER CANAL PPP

ANALYTICAL REPORT

WATER ANALYSIS

MULTIPLE PARAMETER ANALYSIS / 5208614

PREPARED FOR:

HALCROW PAKISTAN

CLIENT DETAILS

Client	Halcrow Pakistan
Address	3rd Floor Business Enclave 77 C, 12th Commercial Street Phase II (Ext) DHA Karachi
Contact	Mr. Azeem Akram
Telephone	
Cell:	0321 5288600.
Email	Azeem.Akram@halcrowpk.com
Project	Analysis of Water
Order Number	5208614
Samples	Water Samples

LABORATORY DETAILS

Manager	Iqbal Ashraf
Laboratory	Chemical & Environmental Laboratory
Address	H-3/3, Sector- 5, Korangi Industrial Area Karachi. 74900.
Telephone	+92-21-35121388-97
Fax	+92-21-35121329
Email	Iqbal_ashraf@sgs.com
SGS Reference	KH20-03323 R0
Sample Received	21-09-2020
Report Number	
Date Reported	02-10-2020

COMMENTS

This report is not valid for any negotiation.
The remaining portion of the sample (s) will be disposed off after one week unless otherwise instructed. (Conditions Apply)
Sample not drawn by SGS Personnel.

SIGNATORIES

Syed Zeeshan Ali
Deputy Manager Laboratory

Iqbal Ashraf
Deputy Manager Laboratory

Sample No.			5208614-01	5208614-02	5208614-03		
Client ID			Distribution Chamber	Head Regulator	Reservoir Tank		
Sample Matrix			Water	Water	Water		
Sample Date / Time			18-09-2020	18-09-2020	18-09-2020	Limits as per WHO	Limits as per SSDWQ
Sample Receipt Date / Tim			18-09-2020	18-09-2020	18-09-2020		
Sampled By			SGS Personnel	SGS Personnel	SGS Personnel		Standard Value For Pakistan.
Parameter	Units	LOR	Result	Result	Result		
pH APHA 4500H+ B 23rd Edition							
*pH at 25 °C	pH unit	00.10	07.00	07.01	06.96	06.50 - 08.50	06.50 - 08.50
Odor APHA 2150 A 23rd Edition							
Odor	-	-	Odorless	Odorless	Odorless	-	-
Taste APHA 2160 A 23rd Edition							
Taste	-	-	Sweet	Sweet	Sweet	-	-
Color APHA 2120 C 23rd Edition							
Color	Pt-Co	05.00	<05.00	<05.00	<05.00	≤15 TCU	≤15 TCU
Turbidity APHA 2130 B 23rd Edition							
Turbidity	NTU	00.20	6.0	9.0	7.5	< 5 NTU	< 5 NTU
Total Dissolved Solid APHA 2540 C 23rd Edition							
*Solids, Total dissolved (TDS)	mg/L	05.00	292.00	200.00	262.00	< 1000.00	< 1000.00
Total, Hardness APHA 2340 A,B 23rd Edition							
Total Hardness	mg/L	00.05	135.73	109.86	130.26	-	<500.00
Fluoride APHA 4500 F C 23rd Edition							
Fluoride by ISE	mg/L	00.05	00.10	00.12	00.12	1.5	≤1.50
Nitrogen, Nitrate (NO_3) APHA 4500 NO3 B 23rd Edition							
Nitrate Nitrogen, NO3 as N	mg/L	0.003	0.330	0.310	0.300	50.00	≤0.50
Nitrogen, Nitrite(NO_2^-) APHA 4500 NO2 B 23rd Edition							
Nitrite Nitrogen, NO2 as N	mg/L	0.003	0.025	0.006	0.004	3.00	≤3.00
Metals APHA 3120 B 23rd Edition							
Aluminum (Al)	mg/L	0.005	0.330	0.250	0.630	0.2	≤0.2
Arsenic (As)	mg/L	0.005	<0.005	<0.005	<0.005	0.01	≤0.05
Boron (B)	mg/L	0.005	0.078	0.130	0.068	0.30	0.30
Barium (Ba)	mg/L	0.005	0.057	0.057	0.077	0.70	0.70
Cadmium (Cd)	mg/L	0.003	<0.003	<0.003	<0.003	0.003	0.01
Chromium (Cr)	mg/L	0.005	0.012	<0.005	0.010	0.05	≤0.05
Copper (Cu)	mg/L	0.005	<0.005	<0.005	<0.005	2.00	2.00
Manganese (Mn)	mg/L	0.005	0.023	0.014	0.014	0.50	≤0.50
Nickel (Ni)	mg/L	0.005	<0.005	<0.005	<0.005	0.02	≤0.02
Lead (Pb)	mg/L	0.005	<0.005	<0.005	0.027	0.01	≤0.05
Antimony (Sb)	mg/L	0.005	<0.005	<0.005	<0.005	0.02	≤0.005
Selenium (Se)	mg/L	0.005	<0.005	<0.005	<0.005	0.01	0.01
Zinc (Zn)	mg/L	0.005	0.008	<0.005	<0.005	3.00	5.00
Mercury APHA 3112 B 23rd Edition							
Mercury (Hg)	mg/L	0.001	<0.001	<0.001	<0.001	0.001	≤0.001
Chloride APHA 4500 CL B 23rd Edition							
Chloride	mg/L	05.00	58.38	27.47	54.95	250.00	<250.00

Sample No.			5208614-01	5208614-02	5208614-03		
Client ID			Distribution Chamber	Head Regulator	Reservoir Tank		
Sample Matrix			Water	Water	Water		
Sample Date / Time			18-09-2020	18-09-2020	18-09-2020	Limits as per WHO	Limits as per SSDWQ
Sample Receipt Date / Tim			18-09-2020	18-09-2020	18-09-2020		
Sampled By			SGS Personnel	SGS Personnel	SGS Personnel		Standard Value For Pakistan.
Parameter	Units	LOR	Result	Result	Result		
Chlorine APHA 4500 G 23rd Edition							
Chlorine (Residual)	mg/L	00.02	<00.02	<00.02	<00.02	-	00.20-00.50
Cyanide APHA 4500 CN E 23rd Edition							
Cyanide (CN^-)	mg/L	00.01	<00.01	<00.01	<00.01	0.07	≤00.05
Total Phenols APHA 5530 B & C 23rd Edition							
Total Phenols	mg/L	0.002	<0.002	<0.002	<0.002	≤0.002	-
Organo Chloro Pesticides [EPA 3510 + USEPA 8081]							
Chloro Pesticides	µg/L	01.00	<01.00	<01.00	<01.00	-	-
Poly Aromatic Hydrocarbon [EPA 3510 + USEPA 3510 & 8100]							
Total PAH	mg/L	00.50	<00.50	<00.50	<00.50	10.00	-
[APHA 2320 B 23rd Edition]							
Total Alkalinity as CaCO3	mg/L	05.00	77.72	74.24	74.24	-	-
[APHA 2310 B 23rd Edition]							
Acidity as CaCO3	mg/L	05.00	<05.00	<05.00	<05.00	-	-
[APHA 5210 D 23rd Edition]							
Biochemical Oxygen Demand (BOD5)	mg/L	02.00	<02.00	<02.00	<02.00	-	-
[Gross Alpha/Beta Counter]							
Alpha	mBq/mL	0.013	<0.013	<0.013	<0.013	0.10	0.10
Beeta	mBq/mL	0.016	<0.016	<0.016	<0.016	1.00	1.00
[Temperature]							
Temperature at the Field	°C	-	32.40	32.00	32.00	-	-
[0005 + APHA 9222 D 23rd Edition]							
Faecal Coliform (E.Coli)	cfu/100mL	01.00	Absent	Absent	Absent	MND/100 ml	MND/100 ml
[0005 + APHA 9222 B 23rd Edition]							
Total Coliforms	cfu/100mL	01.00	16.00	12.00	Absent	MND/100 ml	MND/100 ml
[THM USEPA 8260 B]							
Bromodichloromethane	µg/L	20.00	<20.00	<20.00	<20.00	-	-
Bromoform	µg/L	20.00	<20.00	<20.00	<20.00	-	-
Chloroform	µg/L	20.00	<20.00	<20.00	<20.00	-	-
Dibromochloromethane	µg/L	20.00	<20.00	<20.00	<20.00	-	-

End of Report

FOOTNOTE

IS	Insufficient sample for analysis.
TCC	Total Colony Count
SEQS	Sindh Environmental Quality Standard.
P/A	Present / Absent
MPN	Most Probable Number
TPC	Total Plate Count
HPC	Heterotrophic Plate count
APC	Aerobic Plate Count
TVA	Total Viable Count & Total Becteria
FDA	Food & Drug Administration of USA
BAM	Bacteriological Analytical Manual
LNR	Sample Listed, but not received
NS	No Standard
MND	Must Not Detectable
***	Parameters subcontracted.
*	Minimum Detectable Activity (MDA)
*	This analysis is covered by the scope of accreditation.
	Uncertainty of the test can be provided upon request.
^	Performed by the outside laboratory reporting limit

Sample analyzed as received.

This document is issued, on the client's behalf, by the company under its general conditions of service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The client's attention is drawn to the limitation of indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the company's findings at the time of its intervention only and within the limits of client's instructions, if any. The company's sole responsibility is to its client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

Annex 3.3. Second Water Quality Report

CONSULTING SERVICES KARACHI WATER CANAL PPP

ANALYTICAL REPORT

WATER ANALYSIS

MULTIPLE PARAMETER ANALYSIS / 5208711

PREPARED FOR:

HALCROW PAKISTAN

ANALYTICAL REPORT Report No.KH20-03388

CLIENT DETAILS

Client	Halcrow Pakistan
Address	3rd Floor Business Enclave 77 C, 12th Commercial Street Phase II (Ext) DHA Karachi
Contact	Mr. Azeem Akram
Telephone	
Cell:	0321 5288600.
Email	Azeem.Akram@halcrowpk.com
Project	Analysis of Water
Order Number	5208711
Samples	Water Samples

LABORATORY DETAILS

Manager	Iqbal Ashraf
Laboratory	Chemical & Environmental Laboratory
Address	H-3/3, Sector- 5, Korangi Industrial Area Karachi. 74900.
Telephone	+92-21-35121388-97
Fax	+92-21-35121329
Email	Iqbal_ashraf@sgs.com
SGS Reference	KH20-03388
Sample Received	02-10-2020
Report Number	KH20-03388 R0
Date Reported	16-10-2020

COMMENTS

This report is not valid for any negotiation.
The remaining portion of the sample (s) will be disposed off after one week unless otherwise instructed. (Conditions Apply)
Sample not drawn by SGS Personnel.

SIGNATORIES

Syed Zeeshan Ali
Deputy Manager Laboratory

Iqbal Ashraf
Deputy Manager Laboratory

Sample No.			5208711-01	5208711-02	5208711-03		
Client ID			Before Pumping	Distribution Chamber	Reservoir Tank		
Sample Matrix			Water	Water	Water		
Sample Date / Time			01-10-2020	01-10-2020	01-10-2020	Limits as per WHO	Limits as per SSDWQ
Sample Receipt Date / Tim			01-10-2020	01-10-2020	01-10-2020		
Sampled By			SGS Personnel	SGS Personnel	SGS Personnel		Standard Value For Pakistan.
Parameter	Units	LOR	Result	Result	Result		
pH APHA 4500H+ B 23rd Edition							
*pH at 25 °C	pH unit	00.10	7.45	7.47	7.50	06.50 - 08.50	06.50 - 08.50
Odor APHA 2150 A 23rd Edition							
Odor	-	-	Odorless	Odorless	Odorless	-	-
Taste APHA 2160 A 23rd Edition							
Taste	-	-	Sweet	Sweet	Sweet	-	-
Color APHA 2120 C 23rd Edition							
Color	Pt-Co	05.00	12.00	15.00	12.50	≤15 TCU	≤15 TCU
Turbidity APHA 2130 B 23rd Edition							
Turbidity	NTU	00.20	07.00	05.00	12.00	< 5 NTU	< 5 NTU
Total Dissolved Solid APHA 2540 C 23rd Edition							
*Solids, Total dissolved (TDS)	mg/L	05.00	184.00	196.00	204.00	< 1000.00	< 1000.00
Total, Hardness APHA 2340 A,B 23rd Edition							
Total Hardness	mg/L	00.05	114.18	113.81	115.27	-	<500.00
Fluoride APHA 4500 F C 23rd Edition							
Fluoride by ISE	mg/L	00.05	0.10	0.10	0.12	1.5	≤1.50
Nitrogen, Nitrate (NO_3) APHA 4500 NO3 B 23rd Edition							
Nitrate Nitrogen, NO3 as N	mg/L	0.003	0.14	0.16	0.15	50.00	≤0.50
Nitrogen, Nitrite(NO_2^-) APHA 4500 NO2 B 23rd Edition							
Nitrite Nitrogen, NO2 as N	mg/L	0.003	<0.003	<0.003	<0.003	3.00	≤3.00
Metals APHA 3120 B 23rd Edition							
Cadmium (Cd)	mg/L	0.003	<0.003	<0.003	<0.003	0.003	0.01
Aluminum (Al)	mg/L	0.005	0.43	0.095	0.27	0.2	≤0.2
Antimony (Sb)	mg/L	0.005	<0.005	<0.005	<0.005	0.02	≤0.005
Arsenic (As)	mg/L	0.005	<0.005	<0.005	<0.005	0.01	≤0.05
Barium (Ba)	mg/L	0.005	0.12	0.064	0.084	0.70	0.70
Boron (B)	mg/L	0.005	0.16	0.012	0.098	0.30	0.30
Chromium (Cr)	mg/L	0.005	0.007	<0.005	0.006	0.05	≤0.05
Copper (Cu)	mg/L	0.005	<0.005	<0.005	<0.005	2.00	2.00
Lead (Pb)	mg/L	0.005	0.012	<0.005	<0.005	0.01	≤0.05
Manganese (Mn)	mg/L	0.005	0.015	0.009	0.017	0.50	≤0.50
Selenium (Se)	mg/L	0.005	<0.005	<0.005	<0.005	0.01	0.01
Nickel (Ni)	mg/L	0.005	<0.005	<0.005	<0.005	0.02	≤0.02
Zinc (Zn)	mg/L	0.005	0.021	<0.005	0.007	3.00	5.00
Mercury APHA 3112 B 23rd Edition							
Mercury (Hg)	mg/L	0.001	<0.001	<0.001	<0.001	0.001	≤0.001
Chloride APHA 4500 CL B 23rd Edition							
Chloride	mg/L	05.00	30.61	27.21	29.76	250.00	<250.00

Sample No.			5208711-01	5208711-02	5208711-03		
Client ID			Before Pumping	Distribution Chamber	Reservoir Tank		
Sample Matrix			Water	Water	Water		
Sample Date / Time			01-10-2020	01-10-2020	01-10-2020	Limits as per WHO	Limits as per SSDWQ
Sample Receipt Date / Tim			01-10-2020	01-10-2020	01-10-2020		
Sampled By			SGS Personnel	SGS Personnel	SGS Personnel		Standard Value For Pakistan.
Parameter	Units	LOR	Result	Result	Result		
Chlorine APHA 4500 G 23rd Edition							
Chlorine (Residual)	mg/L	00.02	<00.02	<00.02	<00.02	-	00.20-00.50
Cyanide APHA 4500 CN E 23rd Edition							
Cyanide (CN^-)	mg/L	00.01	<00.01	<00.01	<00.01	0.07	≤00.05
Total Phenols APHA 5530 B & C 23rd Edition							
Total Phenols	mg/L	0.002	<0.002	<0.002	<0.002	≤0.002	-
Organo Chloro Pesticides [EPA 3510 + USEPA 8081]							
Chloro Pesticides	µg/L	01.00	<01.00	<01.00	<01.00	-	-
Poly Aromatic Hydrocarbon [EPA 3510 + USEPA 3510 & 8100]							
Total PAH	mg/L	00.50	<00.50	<00.50	<00.50	10.00	-
[APHA 2320 B 23rd Edition]							
Total Alkalinity as CaCO3	mg/L	05.00	89.83	85.11	81.56	-	-
[APHA 2310 B 23rd Edition]							
Acidity as CaCO3	mg/L	05.00	<05.00	<05.00	<05.00	-	-
[APHA 5210 D 23rd Edition]							
Biochemical Oxygen Demand (BOD5)	mg/L	02.00	<02.00	<02.00	<02.00	-	-
[Gross Alpha/Beta Counter]							
Alpha	mBq/mL	0.013	#	#	#	0.10	0.10
Beeta	mBq/mL	0.016	#	#	#	1.00	1.00
[Temperature]							
Temperature at the Field	°C	-	31.20	31.90	31.60	-	-
[0005 + APHA 9222 D 23rd Edition]							
Faecal Coliform (E.Coli)	cfu/100mL	01.00	9	10	absent	MND/100 ml	MND/100 ml
[0005 + APHA 9222 B 23rd Edition]							
Total Coliforms	cfu/100mL	01.00	15	30	absent	MND/100 ml	MND/100 ml
[THM USEPA 8260 B]							
Bromodichloromethane	µg/L	20.00	<20.00	<20.00	<20.00	-	-
Bromoform	µg/L	20.00	<20.00	<20.00	<20.00	-	-
Chloroform	µg/L	20.00	<20.00	<20.00	21.01	-	-
Dibromochloromethane	µg/L	20.00	<20.00	<20.00	<20.00	-	-

End of Report

FOOTNOTE

IS	Insufficient sample for analysis.
TCC	Total Colony Count
SEQS	Sindh Environmental Quality Standard.
P/A	Present / Absent
MPN	Most Probable Number
TPC	Total Plate Count
HPC	Heterotrophic Plate count
APC	Aerobic Plate Count
TVA	Total Viable Count & Total Becteria
FDA	Food & Drug Administration of USA
BAM	Bacteriological Analytical Manual
LNR	Sample Listed, but not received
NS	No Standard
MND	Must Not Detectable
#	Analysis is in process
***	Parameters subcontracted.
*	Minimum Detectable Activity (MDA)
*	This analysis is covered by the scope of accreditation.
	Uncertainty of the test can be provided upon request.
^	Performed by the outside laboratory reporting limit

Sample analyzed as received.

This document is issued, on the client's behalf, by the company under its general conditions of service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The client's attention is drawn to the limitation of indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the company's findings at the time of its intervention only and within the limits of client's instructions, if any. The company's sole responsibility is to its client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full.

Annex 3.4. K-III Preliminary Water Quality Test

CONSULTING SERVICES KARACHI WATER CANAL PPP

PRELIMINARY REPORT KH21-04104 R0

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	KARACHI WATER & SEWEGE BOARD	Order Number	BOSS. 5011401
		Samples	Water(2)
Address		SGS Reference	KH21-04104
		Received	01/04/2021
		Analysis started	
Contact	Mr. Imtyaz Afridi	Analysis completed	09/04/2021
Telephone		Approved	09/04/2021
Facsimile		Report Number	KH21-04104
Email	imtyazafridi@gmail.com	Date Reported	09/04/2021

COMMENTS

This is an interim report. Final QC checks are yet to be completed.
The uncertainty is expressed as absolute value near to the result; the value is estimated with a covering factor of 2 in an interval of confidence of 95%, in accordance with the procedure SOP123456
The results are reported as absolute value +/- the absolute uncertainty of measurement estimated by the laboratory

SIGNATORIES

This is a preliminary report. The signatories will be applied on the final report.

Sample List

			Temperature	pH in water	Odor in Water	Taste in Water	Color	Turbidity	Total Dissolved Solids	Hardness	Fluoride	Nitrite in Water	Nitrate in Water	Metals in Water by ICPOES	Mercury in Water	Chloride	Residual Chlorine by Iodometric Method	Cyanide in water	Total Phenolics in Water	Organo Chloro Pesticides	Poly Aromatic Hydrocarbon	Acidity
KH21-04104	001	N & K PLANT RESERVIOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	002	k-03 Chemel Hub Pumping	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Sample List

			Alkalinity	BOD5	Fecal Coli Form (E.Coli)	Total coliform	EW_THM
KH21-04104	001	N & K PLANT RESERVIOR	X	X	X	X	X
	002	k-03 Chemel Hub Pumping	X	X	X	X	X

RESULTS

	Sample n°	KH21-04104.001	KH21-04104.002
	Sample Name	N & K PLANT RESERVIOR	k-03 Chemel Hub Pumping
	Sample Matrix	Water	Water
Parameter	**Units**	**RL**	**Result**	**Result**
[Temperature]				
Temperature at the Field	°C	-	28.2	28.2
[APHA 4500 H+ B 23rd Edition]				
pH @ 25 C	pH	0.1	7.41	7.06
[APHA 2150 A 23rd Edition]				
Odor	---	-	odorless	odorless
[APHA 2160 A 23rd Edition]				
Taste	---	-	Sweet	Sweet
[APHA 2120 C 23rd Edition]				
True Color	Pt/Co Colour	5	<5.00	<5.00
[APHA 2130 B 23rd Edition]				
Turbidity	NTU	0.2	<0.2	<0.2
[APHA 2540 C 23rd Edition]				
Total Dissolved Solids	mg/L	5	502.00	504.00
[APHA 2340 A,B 23rd Edition]				
Total Hardness	mg/L	0.05	182.24	190.11
[APHA 4500 F C 23rd Edition]				
Fluoride by ISE	mg/L	0.05	0.25	0.25
[APHA 4500 NO2 B 23rd Edition]				
Nitrite Nitrogen, NO2 as N	mg/L	0.003	<0.003	<0.003
[APHA 4500 NO3 B 23rd Edition]				
Nitrate Nitrogen, NO3 as N	mg/L	0.003	0.31	0.25
[APHA 3120 B 23rd Edition]				
Aluminium, Al	mg/L	0.005	0.13	TBA
Antimony, Sb	mg/L	0.005	0.005	TBA
Arsenic, As	mg/L	0.005	<0.005	TBA
Barium, Ba	mg/L	0.005	0.029	TBA
Boron, B	mg/L	0.005	0.14	TBA
Cadmium, Cd	mg/L	0.003	<0.003	TBA
Total Chromium(Cr+3 + Cr+6)	mg/L	0.005	0.016	TBA
Copper, Cu	mg/L	0.005	<0.005	TBA
Lead, Pb	mg/L	0.005	<0.005	TBA
Manganese, Mn	mg/L	0.005	0.016	TBA
Nickel, Ni	mg/L	0.005	<0.005	TBA
Selenium, Se	mg/L	0.005	<0.005	TBA
Zinc, Zn	mg/L	0.005	0.030	TBA
[APHA 3112 B 23rd Edition]				
Mercury, Hg	mg/L	0.001	<0.001	TBA
[APHA 4500 CL B 23rd Edition]				
Chloride	mg/L	5	102.44	101.56
[APHA 4500 CL B 23rd Edition]				
Residual Chlorine	mg/L	1	<1.00	<1.00

RESULTS

	Sample n°	KH21-04104.001	KH21-04104.002
	Sample Name	N & K PLANT RESERVIOR	k-03 Chemel Hub Pumping
	Sample Matrix	Water	Water
Parameter	**Units**	**RL**	**Result**	**Result**
[APHA 4500 CN E 23rd Edition]				
Cyanide	mg/L	0.01	<0.01	<0.01
[APHA 5530 B & C 23rd Edition]				
Total Phenols	mg/L	0.002	<0.002	<0.002
Organo Chloro Pesticides [EPA 3510 + USEPA 8081]				
Chloro Pesticides	µg/L	1	<1.00	<1.00
Poly Aromatic Hydrocarbon [EPA 3510 + USEPA 3510 & 8100]				
Total PAH	mg/L	0.5	<0.50	<0.50
[APHA 2310 B 23rd Edition]				
Acidity as CaCO3	mg/L	5	<5.00	<5.00
[APHA 2320 B 23rd Edition]				
Total Alkalinity as CaCO3	mg/L	5	121.79	125.64
[APHA 5210 D 23rd Edition]				
Biochemical Oxygen Demand (BOD5)	mg/L	2	<2.00	TBA
[0005 + APHA 9222 D 23rd Edition]				
Faecal Coliform (E.Coli)	cfu/100mL	1	TBA	TBA
[0005 + APHA 9222 B 23rd Edition]				
Total Coliforms	cfu/100mL	1	TBA	TBA
[THM USEPA 8260 B]				
Bromodichloromethane	µg/L	20	<20.00	<20.00
Bromoform	µg/L	20	<20.00	<20.00
Chloroform	µg/L	20	79.80	40.44
Dibromochloromethane	µg/L	20	<20.00	<20.00

FOOTNOTES

^	Performed by external SGS laboratory.	IS	Insufficient sample for analysis.
^^	Performed by outside laboratory.	LNR	Sample listed, but not received.
RL	Reporting Limit	NA	The sample was not analysed for this analyte
↑	Raised Limit of Reporting	NVL	Result to be validated
↓	Lowered Limit of Reporting	TBA	Parameter not yet analysed

Samples analysed as received.

Solid samples expressed on a dry weight basis.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: http://www.au.sgs.com/sgs-mp-au-env-qu-022-qa-qc-plan-en-09.pdf

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full.

--- End of the analytical report ---

GEOTECHNICAL SURVEY

CONSULTING SERVICES KARACHI WATER CANAL PPP

HALCROW PAKISTAN (PVT) LTD

REHABILITATION OF KARACHI WATER CANAL

GEOLOGICAL MAPPING REPORT

January 2021

SURVEY TECH (PVT) LTD

ENGINEERS, CONTRACTORS, GEOLOGIST & PROFESSIONAL SURVEYORS

H-129,Block-II,Sector C-I, Township, Lahore-Pakistan. +92-42-35465005, Fax: 042- 35465005

E-mail: surveytech2@gmail.com URL: www.surveytechpak.com

TABLE OF CONTENTS

1. INTRODUCTION 1

1.1 BACKGROUND 1

1.2 PURPOSE AND SCOPE 1

1.3 LOCATION AND ACCESSIBILITY 3

1.4 CLIMATE AND GEOMORPHOLOGY 3

2. REGIONAL GEOLOGY OF THE AREA 4

2.1 GENERAL GEOLOGY 4

2.2 REGIONAL STRATIGRAPHY 6

2.3 STRUCTURAL FEATURES OF KARACHI REGION AND SURROUNDING 6

2.4 SEISMOLOGY OF KARACHI REGION 6

2.4.1 Active Faults 7

2.4.2 Regional Folding and Faulting 8

2.4.3 Faults in Karachi 9

3. GEOLOGICAL MAPPING OF THE PROJECT AREA 11

3.1 GENERAL 11

3.2 GEOLOGICAL STRUCTURE AND TECTONIC SETTING OF THE PROJECT AREA 11

3.3 SRATIGRAPHY OF THE PROJECT AREA 11

3.4 ORANGI MEMBER OF NARI FORMATION 12

3.5 PIR MANGHO MEMBER OF NARI FORMATION 13

3.6 HUB MEMBER OF NARI FORMATION 15

3.7 GENERAL DESCRIPTION OF MATERIALS AT PROJECT AREA 16

3.7.1 Alluvium 16

3.7.2 Gravely soil 16

3.7.3 Pied Mounts 16

3.7.4 Shale 17

3.8 DESCRIPTION OF MATERIAL FROM MANGHOPIR PUMPING STATION TO KATTIPAHARI 17

4. CONCLUSIONS AND RECOMMENDATIONS 20

5. REFERENCES 21

ANNEXURES

ANNEX-A: **GEOLOGICAL MAPPING SHEETS**

ANNEX-B: **GEOLOGICAL CROSS SECTIONS**

ANNEX-C: **TEST PIT DATA SHEETS**

ANNEX-D: **PROJECT PHOTOGRAPHS**

REHABILITATION OF KARACHI WATER CANAL

1. INTRODUCTION

1.1 BACKGROUND

M/S Survey Tech (Pvt.) Limited proposed and decide to prepare a geological report for rehabilitation of 22 km approximately Karachi canal located in north Karachi Originate from Hub Dam to the north and KW&SB Pumping station at the south. In this regards geological survey was carried out to determine the geology and geological structure along the route of the Karachi water canal.

The area is easily accessible from Hub dam road to the pumping station along the canal route. In this regard, M/S Survey Tech (Pvt.) Limited sent a team to the project area to gather the information/data on 14 December, 2020. Layout Plan of Karachi Canal is shown in **Figure-1.1**.

1.2 PURPOSE AND SCOPE

The geological map is highly interpretive, scientific process that can produce a range of map products for many different uses, including assessing ground water quality, predicting earthquakes and land slide hazards, land use managements and land use planning. The geological mapper strives to understand the composition and structure of the material at the earth surface and depth on the view of the above factors, a plane was made to prepare the geological map of the Karachi canal at 1: 1000 scale to delineate the overall geology and the geological structure encountered at the 70 meters corridor from the center of the canal route position 70m left &70m right approximately etc. In this regards 56 numbers. topographical sheets at 1:1000 were used for geological mapping and structural evaluation keeping in view the importance of the project. Fifty six number of structural geological cross section were also made to predict the subsurface geology of the project area. The basic purpose of the visit was to prepare a geological map of the project area at 1:1000 scales and to obtain the engineering geological information of the site.

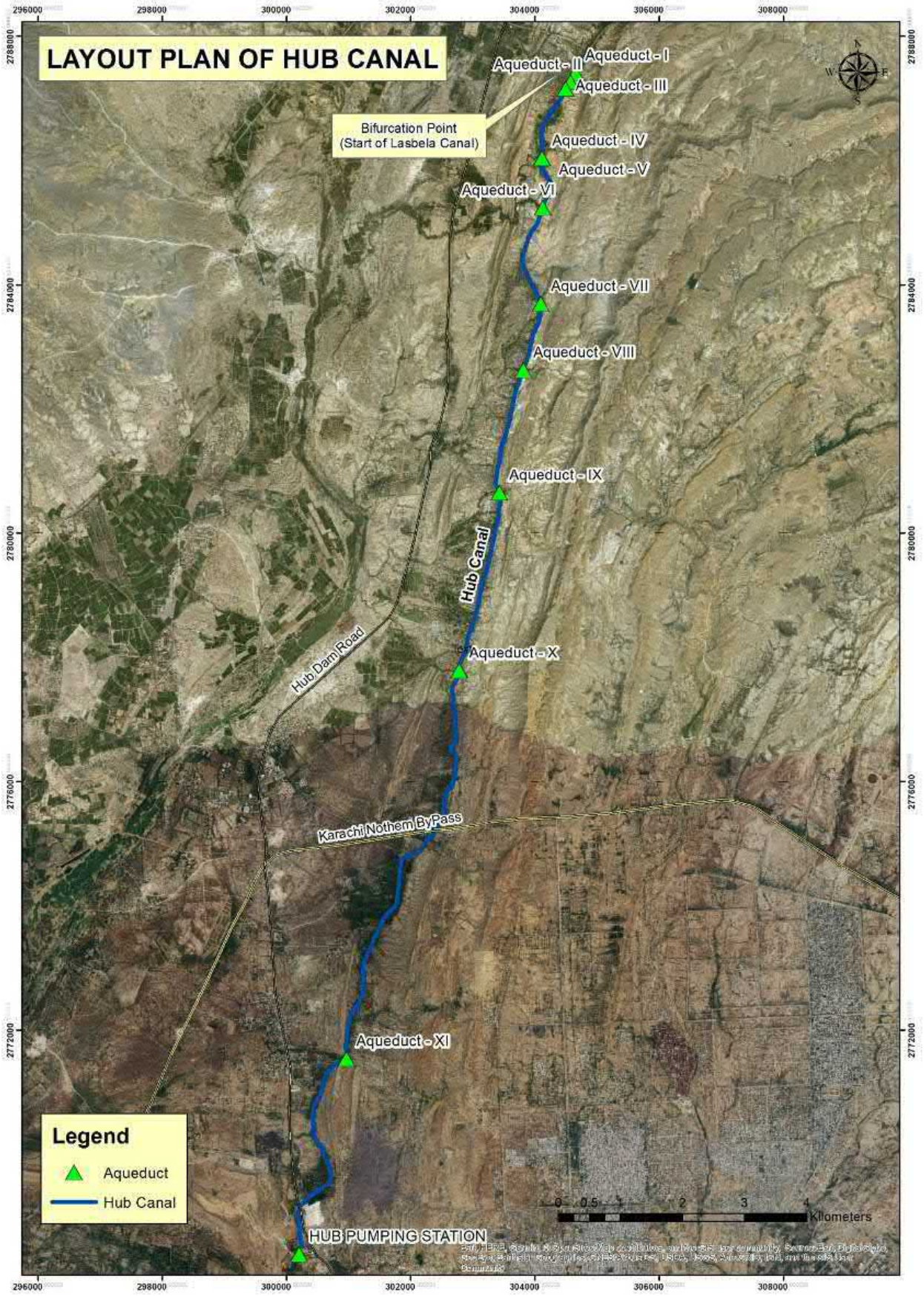


Fig-1.1: Layout Plan of Karachi Water Canal

1.3 LOCATION AND ACCESSIBILITY

The area under investigation starts from the bifurcation point of Lasbella canal in the north to katti-pahari in the south in between the latitude 25.0196 and 25.193, and longitude 67.0633 and 67.0203.

The area under investigation is extended from Mangho-pir town to near Hub Dam site located in Northwestern part of Karachi with Hub River on the west and Gadap town in the east. The area can easily be accessed from Karachi to Hub Dam road via metaled and non metaled track. The area has arid climate with low precipitation levels. Winter in the area is dry while summer is hot and humid.

1.4 CLIMATE AND GEOMORPHOLOGY

Climatically the Karachi and surrounding areas are located in the arid coastal zone of Pakistan having an average annual rainfall of about 25 cm. The climate is mild, in summer maximum temperature generally goes upto 40 degree and in winter the minimum temperature touches around 10 degree c. Humidity remain high and ranges from 60 % in winter to 80 % in summer. During the summer month, i.e March to October the wind blows from south and southwest. The monsoon reaches in early July and lasts till September generally with overcast of clouds. Monsoon rains provide maximum precipitation to Karachi. In the winter winds are mild and blows from west during the day and from northeast during the nights and early hours of the day. Climate conditions are favorable for groundwater accumulation and retention in a basin mainly because of high humidity.

Karachi is located in the south Sindh, on the coast of the Arabian Sea. It covers an area of approximately 3,600 km2, comprised largely of flat or rolling plains, with hills on the western and northern boundaries of the urban sprawl. The city represents quite a variety of habitats such as the sea coast, island, sand dunes, swamps, semi arid regions, cultivated fields, dry steam beds, sandy plains, hillocks. Classified accordingly to physiographic features, Karachi City District can be divided into three broad categories Hilly Region (Mountain Highland), Alluvial Plain (Piedmont Plain) and Coastal Area (Valley Floor).

2. REGIONAL GEOLOGY OF THE AREA

2.1 GENERAL GEOLOGY

Accordingly to Bender and Raza (1995), the Geological Structural Setup of Karachi Region belongs (Southern Indian Basin which is result of the rifting during Triassic, oblique Collision of the Indo-Pakistan Plate with Afghan blocks during the Late-Cretaceous and Palaeogene, and by post collision deformation during Neogene and Quaternary periods. Tectonically, the counter clockwise movement of India plate during Eocene time, after its collision with Eurasian plate, has resulted in the formation of Karachi Embayment. It has remained as a trough in the recent geological time. It was followed by structural deformation in the late Pleistocene to middle Pleistocene related to the Himalayan Orogeny.

This arc forms of southernmost part of the Kirthan Mountain and southwestern margin of Lower Indus Basin. It is bounded by Ornach-Nal Fault in the west and Hyderabad High in the East. The southern part of the embayment is submerged in the sea and still receiving sediments from different sources. It is comprised of a series of parallel to sub parallel short, narrow, serrate, accurate (convex to east) enechelon ridge and wide, dome-shaped anticlinal hills. It forms nearly 200 km long and 50 km wide zone between Karachi and Sehwan. The Bhit range, Bhadra range, Lakhi hills and Lakhra hills are some of its more prominent components. The altitude of the Hills varies from 250 m in the south to about 1,100 m in the north. The Naing, Baram and Malir River are the main steams draining this region. Regional Geological Map of Karachi is shown in **Fig-2.1**.

The trough is characterized by thick early Cretaceous sediments and also marks the last stages of marine sedimentation. The located deposition represents and unique feature where no hiatus in sedimentation occurs. Sembar and Goru (Cretaceous) of several meters thickness, overlain Parh Mughal Kot and Pub formation. The Paleocene sequences are marked by Rani Kot Formation. The Eocene is represented by Ghazij Shale and carbonates of Kirthar and Laki formation. The Oligocene is represented by the Nari formation which is underlain by Gaj formation of Miocene age. The submerged part of embayment is still receiving sediments from sources of proto Indus drainage system (Shoaib and Rafi, 2004).

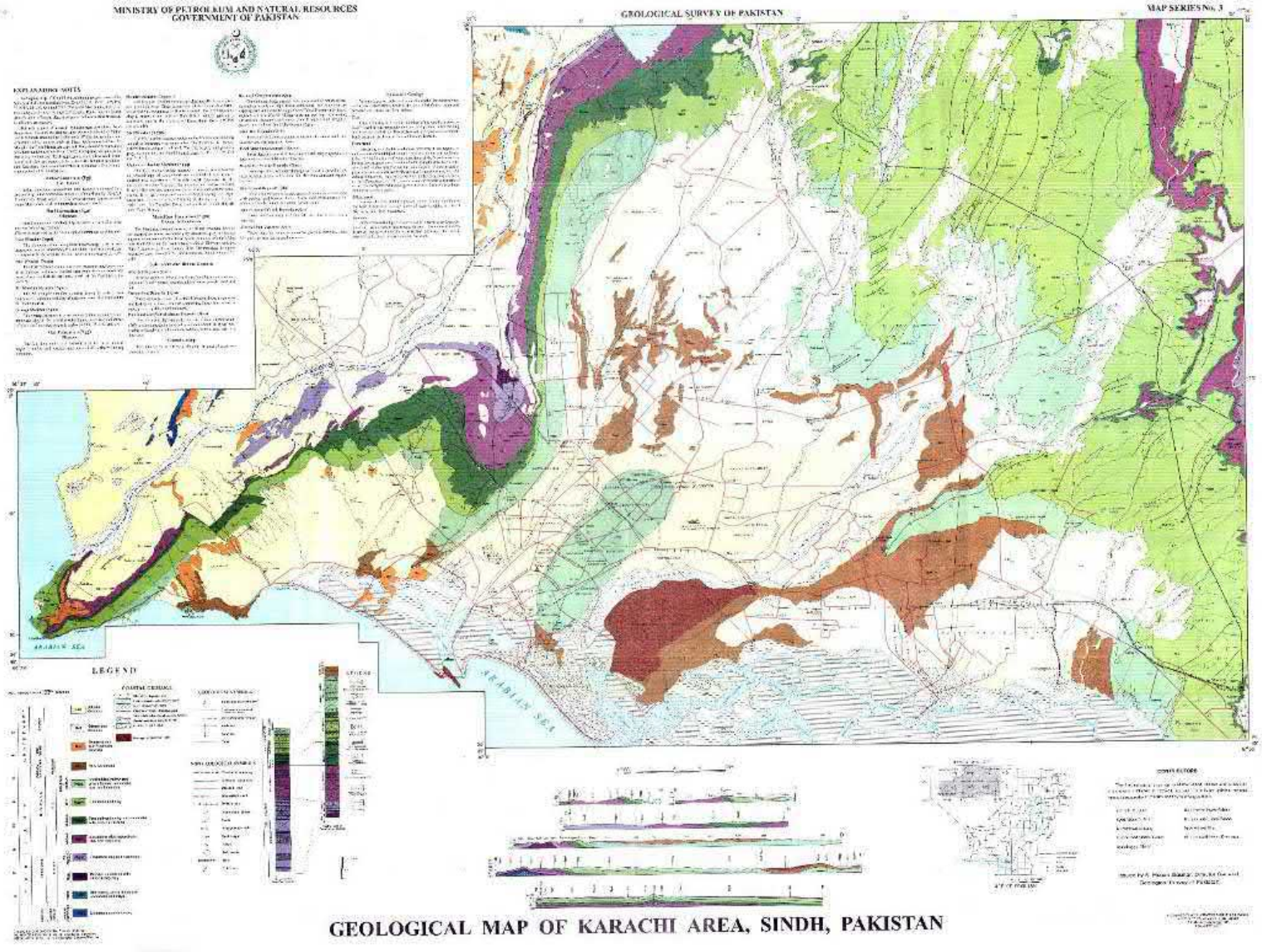


Fig-2.1: Regional Geological Map of Karachi Area

2.2 REGIONAL STRATIGRAPHY

The main rocks exposed in Karachi are given in **Table 2.1** as described hereunder.

Table 2.1: Rock Exposed in Karachi Region & Surrounding

Quaternary	Recent: Alluvial deposits, steam bed deposits Sub Recent Piedmont and sub piedmont deposits.
Pliocene	Manchar Gray Limestone.
Pliestocene	Gulistan-e-Johar Inter bedded and grey Siltstone, Sandstone Clay and Limestone
Miocene	Gaj Formation Mole: Limestone and Clay Mundro: Predominantly Clay and Sandstone with minor Limestone
Oligocene	Nari Formation Orangi Member: Sandstone with subordinate Clay and Limestone. Pir Mangho Member : Limestone, Clay and Sandstone Hab Member : Massive Sandstone, limestone with minor Sandy Clay Tobo Member : Alternating Sandstone and Clay
Eocene	Laki Formation.

2.3 STRUCTURAL FEATURES OF KARACHI REGION AND SURROUNDING

In the western part of the Karachi, a series of Transverse faults have displayed the rocks. The relative movement of individual block in relation to adjoining block has been towards North West (As shown in figure). The degree of lateral displacement decreases from west to east. The traces of the following faults have been delineated (Hassan and Anisuddin, 1979; Mirza et al, 1984 and Kazmi and jan 1997).

2.4 SEISMOLOGY OF KARACHI REGION

The city of Karachi, Pakistan, sits close to a plate boundary and within reach of earthquakes on numerous tectonically active structures surrounding the city. Geologically, Karachi is located on the southern margin of the geological trough which lies in the southern extension of the Kirthar range. The trough is delineated by severely deformed mountain ranges namely the Mor Range Pab Range and Belaophiolite mélange zone to the west, Kirthar Range to the north and the east, and by the Indus

delta and the Arabian Sea creeks to the south. The trough may be subdivided into three principal regions i) Northern relative uplifted region, ii) Southern submerged region and iii) Western monocline.. Seismic Map of Pakistan is shown as **Figure-2.2**.

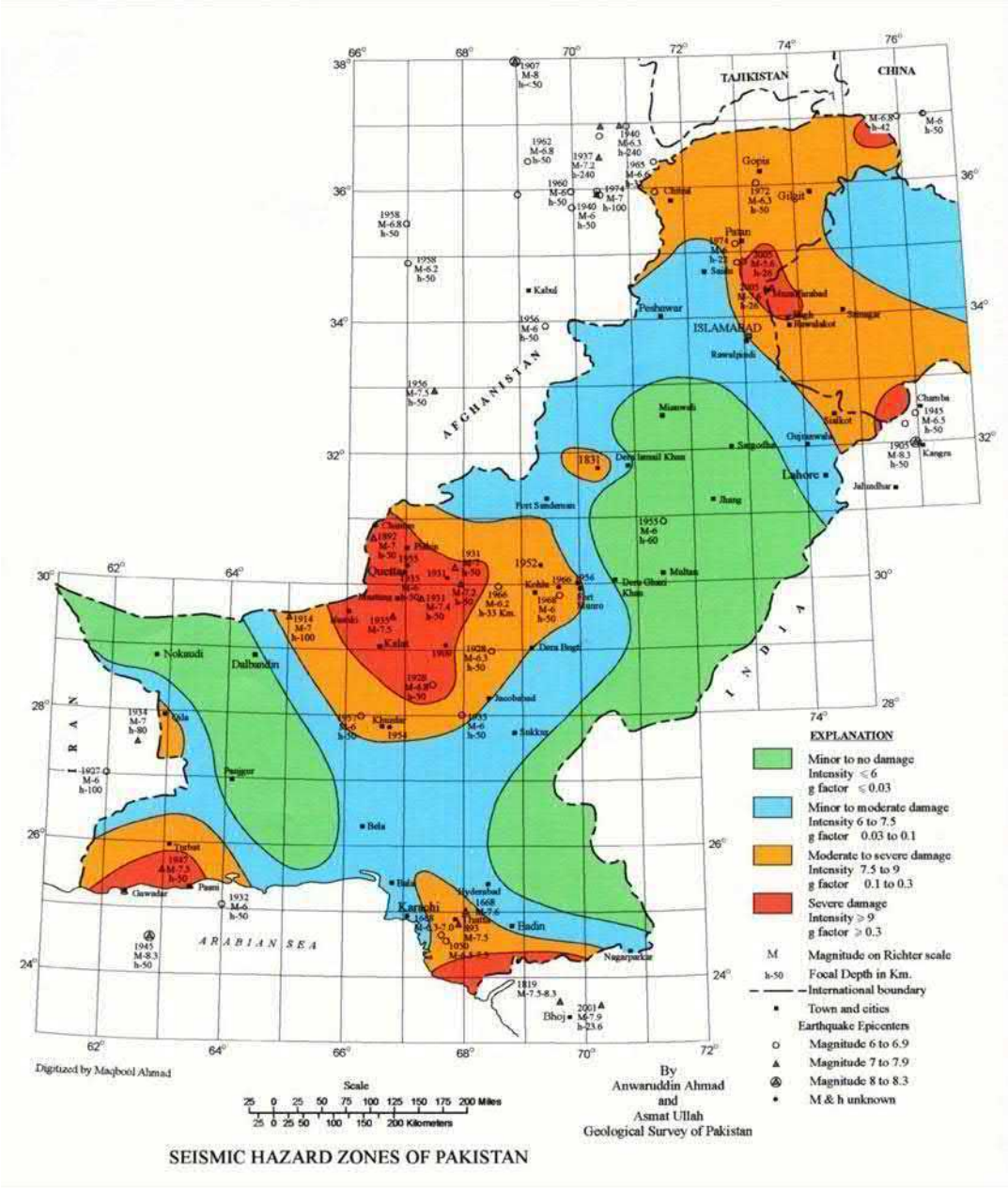


Fig-2.2.: Seismic Hazard Zone of Pakistan

2.4.1 Active Faults

Karachi is situated close to the junction of three tectonic plates (Indo-Pakistan, Arabian and Eurasian Plates). The earth hazard in the Indus Delta and estuaries of the Passive continental margin is mainly from the intra-plate active faults, principally the Rann-of-Kutch Karachi Fault (also Known as Karachi-Jati-Allah Bund fault), the Pab-Null Fault and their respective strands. The Rann-of-Kutch Fault passes close to the Eastern

Industrial Zone of the Port Qasim. Karachi coast has three other segments namely the Jhimpir fault, the Pab faults, and the Surjani fault. These are the intra-plate active faults the pose major earthquake hazard in the Indus delta and the estuaries of the Passive continental margin. The orientation of the Rann of Kutch fault is roughly east-west; it is 225 km in length and is responsible for the production of earthquakes of considerably high magnitude of up to 7.6 M on Richter scale and of IX to X intensity on the Modified Merchali (MM) scale. The Pab fault on the other hand is 135 KM in length and is oriented north-south. On the basis of the study of the seismic potential of the active faults viz. Rann of Kutch and Pab faults over their entire length, along with analysis of historical and instrumental records of the Pakistan coastal zone the risk factor for this region is estimated to be 7.7 to 8.2 M for the former and 7.2 to 7.8 M for the later.

According to the United States Geological Survey (USGS) the Karachi. Makran coast in the Arabian Sea is seismically quite active. A high seismic activity of Karachi-Makran offshore is indicated by a large number of seismic shocks of 4 to 5 on Richter scale. Generally the areas which are prone to frequent small intensity earthquakes also suffer from major earthquakes (>7) periodically. This period may vary from 50 to 150 years. A list of earthquakes with inland epicenters, since 1668 to date which affected the Indus Deltaic Creeks.

2.4.2 Regional Folding and Faulting

Structurally Karachi Trough forms an asymmetric structure. The western flank forms a narrow gentle monocline while the eastern flank is much wider and steeper.

From Karachi as centre in both east and west direction, older formations are exposed ranging from Mio-Pliocene to Paleocene and Eocene. Within this regional setup many narrow folded structures were developed. These can be grouped into system of parallel Anticlinal zone. Within the limit of Karachi area, three major Anticlines separated by Alluviated Synclinal tracks. The Major Anticlinal units are separated by Synclinal troughs.

In the west the east the first major Anticline is Cap Montz Anticline Followed by Pir Mangho Anticline, This Anticline is followed by Liyari Syncline and further to the east and north east comes the Drigh Road Anticline followed by Malir Synclinal trough.

All above folded structure are plunging and asymmetric whereas eastern limbs are steeper than western ones. It follows general SSW-NNE trend with south western plunge.

The Anticlines are dissected by erosion whereas, the Synclinal trough are mostly aggraded by recent fluvial deposits and are thus obscured. The structural trend in Karachi trough area particularly in Mangho Pir the surrounding is in conformity with the major structural trend in Kirther and Pab Ranges.

The rocks exposed in Karachi were subjected to lateral compression. The prevalent direction of the compression force seems to be ENE. The Mango pir area, where the best Anticlinal structure is exposed, the trend of Anticlinal axis is SSW-NNE. The Anticline is plunges to south. It has 100 to 150 dip on western flank but the eastern steep flank has an average dip of 300 or more and at places the dip is as high as 600. In the displays a general corresponds in its trend with the Anticline.

The other important structure situated in this area is the Drigh Road Anticline. This shows low dips which ranges between 2-50 at the most. At places the rocks became horizontal. The Anticline seems to be double plunging with a sag in the central part. It forms an elongated Dome. This encloses only the exposure of Gaj Formation.

2.4.3 Faults in Karachi

i) Sona Fault

The Sona fault is located northwest of Hawks Bay along Sona Pass. The trace is straight, trends N 420 W and exposed for 3800 m. It is left lateral fault with western side moving north for 2200 m.

ii) Lal Bakhar Fault:

The Lal Bakhar Fault is located north-northwest of Hawksbay in Lal Bakhar Pass along the upstream of Kochani Nala. It is right lateral fault. The relative movement is of the order of about 1680 m.

iii) Golamani Fault:

The Golamani fault is located north the Hawks Bay in Golamani Pass. The trace is exposed for 6400 m. It is concave towards west in the southern segment and concave towards east in northern segment. It is left lateral fault and relative lateral displacement is of order of 1200 m.

iv) Abdullah Fault:

The fault is located north of Hawks Bay near Goth Abdullah. The trace of fault is exposed for 7200 m. It is concave towards southwest in the southern segment. It is left lateral fault and the relative movement of beds is order of about 1000 m

v) Khosti Fault:

The Khosti fault is located in the west of Hub Chowki Road near Goth Haji Khosti. The fault trace is exposed for 8400 m. It is concave towards northeast in the central part. It is a left lateral fault. The relative displacement of beds in about 1800m.

vi) Nek Mohammad Fault

It is located northwest of Lalji village near Goth Nek Mohammad. This appears to be hinge fault.

vii) Matan Fault:

The Methan fault is along the course of methanala. It is right lateral fault. Nearly all of the above faults may have eastward—concealed extensions under the recent sediments.

viii) Laki Limestone:

Along the Kirthar Range Front, there are N-S trending active faults. They are dip-slip are bedding-plane faults. North of Karachi and west of Lakhra, the north-south Surjani Fault cuts across the Quaternary deposits. West of Jhimpir, the southern end of this fault is intersected by the northwest trending Jhimpir Fault. The interaction of these two faults is characterized by at least four teleseimic events of shallow focal depth and magnitude 3-6. The maximum magnitude of the earthquake associated with the Surjani Fault is of the order of M~6.1.

ix) Jhimpir Fault

Jhimpir Faults is N-W trending. A number of epicenters are located on this fault. The fault has produced an earthquake of M~5.6 on Richter scale.

x) Pab Fault:

NNW-SSE trending and located in the eastern part of Pab Range. The maximum magnitude of the earthquake associated with this fault is of the order M~7.0 on Richter scale. The Pab fault has disorder vertically the quaternary alluvial fans.

3. GEOLOGICAL MAPPING OF THE PROJECT AREA

3.1 GENERAL

The geological mapping was carried out to determine the geological units falls along the Karachi route canal of the project site. The total length of the route corridor is 22 kms in length and the width is 70 meters at both sides from canal route alignment at left and right respectively, to prepare the geological map at the required scale. The topographical sheets were prepared at 1: 1000 scale and the whole area split into 56 nos. sheets for detailed geological mapping. At the first stage the geology along the canal alignment and surrounding area 70 meters on both side from center of the canal approximately were marked, critical zones like faulted zones were also marked on the bases of field observation and strata that encountered in the project area. Similarly 56 number of structural geological cross section were prepared to describe the subsurface strata that may encountered during excavation.

3.2 GEOLOGICAL STRUCTURE AND TECTONIC SETTING OF THE PROJECT AREA

The area under investigation is located in the northwestern part of Karachi with north south trending Hub fault on its west Kirthar mountains on the north Gadap town syncline in the east and seismically active coastal of Karachi in the south. The project area falls in the eastern limb Hub anticline with Hub member in the core of anticline followed by Hub member Pir Mango member and Orangi member of Nari formation.

3.3 STRATIGRAPHY OF THE PROJECT AREA

The clastic Nari formation of Oligocene age is mainly exposed in the mapped area. It has four members as described in **Table-3.1**. Orangi member is the youngest member of the Nari formation. Out of its four member three members that are Hub member, Pir Mango member and Orangi member are exposed in the northern and eastern portion of the mapped area. Western and southern portion is partly covered with alluvium. The oldest Tobo member of Nari formation is not exposed in the mapped area.

Table 3.1. Stratigraphic Sequence of Northwestern Parts of Karachi

ERA	AGE	FORMATION	MEMBER	DESCRIPTION
TERTIARY	Pliocene	Manchar		Gray Sandstone
	Miocene	Gaj	Ghulistan-e-Johar	Interbedded siltstone sandstone clays and limestone.
			Mol	Limestone and clay
			Mundro	Dominantly clay with sandstone and limestone
	Oligocene	Nari	Orangi	Sandstone with subordinate clay, shale and limestone
			Pir Mangho	Limestone clay and sandstone
			Hub	Massive sandstone with limestone and minor sandy clays
			Tobo	Sandy limestone sandstone and clay

Detail description of exposed rock units in the project is as under:

3.4 ORANGI MEMBER OF NARI FORMATION

Orangi member is mainly composed of multi colour massive sandstone and clays with subordinate limestone and coarse grained lenses of glass sand at places. The colour of sandstone varies from cherry reddish, brownish and grayish. Basal part is medium bedded and compacted as shown in **Figure-3.1**.

Fig-3.1: Exposure of Orange Member of Nari Formation at Site

3.5 PIR MANGHO MEMBER OF NARI FORMATION

This member is mainly composed of brown to rusty brown sandstone and limestone and clays of different hues. In the mapped area it is thickening upward and is nearly horizontal or dipping 3-6 degree. The upper part of the member is multi colour massive medium to coarse grained and friable in nature which at some places is gritty. In the mapped area it forms gentle slopes with low dips and even nearly horizontal at places. It is highly borrowed, caved, and poorly sorted. Texturally is medium to coarse grained Field photographs of Pir Mangho Member of Nari Formation are shown in **Figure-3.2, Figure-3.3** and **Figure-3.4.**

Fig-3.2: Pir Mango Member of Nari Formation Exposed in the Area

Fig-3.3: Exposure of Pir Mangho Member at Site

Fig-3.4 Faulted Contact between Pir Mango &Orange Member of Nari Formation

3.6 HUB MEMBER OF NARI FORMATION

This member is dominantly composed of greenish to brownish colour massive cross bedded sandstone with whitish to pinkish colour limestone. The limestone is fossiliferous in the mapped area it is exposed in the southern and western part of mapped area. Field photographs of Hub Member of Nari Formation are shown in **Figure-3.5, Figure-3.6** and **Figure-3.7.**

Fig-3.5: Exposure of Hub Member of Nari Formation at Site

Fig-3.6: Fossiliferous Limestone in the Hub Member of Nari Formation

Fig-3.7: Faulted Zone in the Hub Member of Nari Formation

3.7 GENERAL DESCRIPTION OF MATERIALS AT PROJECT AREA

The following geological materials have been identified during the geological mapping of the project area.

3.7.1 Alluvium

Generally the area is covered by alluvium having varied thickness at places along the canal alignment and surroundings. The alluvium is also divided into two types which are as follow

I. **Qal 1**. It is light brown to brown, fine to medium grained clayey silty sand
II. **Qal** it is light gray to gray. Light Brown to yellowish brown, grayish black in colour, it is composed of medium grained silty sand and also densely rooted.

3.7.2 Gravely soil

It is grayish to dark gray, brownish gray, brownish black in color. It is composed of mix lithology includes clay, silt, sand, pebbles, cobbles and boulders of older formations.

3.7.3 Pied Mounts

It is light gray to gray, light brown to yellowish brown in color presents at both side of the canal alignment. It is composed of mix material like clays, slit sand and fragments pieces derived from adjacent exposed strata.

3.7.4 Shale

It light gray to dark gray and brownish in colour along with thin beds of sandstone and mudstone. It is soft to medium hard at places.

3.8 DESCRIPTION OF MATERIAL FROM MANGHOPIR PUMPING STATION TO KATTIPAHARI

At **2767081 N 300218 E** the material is composed of boulders, pebbles, cobbles and gravels of hard fossiliferous limestone and poorly sorted sandstone. Sandstone is light brownish to grayish in color and is highly borrowed. Boulders of sandstone with diameter 3 to 4 ft are common in the material. Limestone is fossileferous and coconidal at places and is very hard. At some places sandstone is lateritic. At **300248 E** and **2767257 N** the material is composed of parallel laminated, multicolor and soft mudstone. At **300252 E** and **2767296 N** the material is composed of silty clay along with pebbles and gravel of sandstone and limestone. At **300252 E** and **2767363 N** the material is dominantly clayey forming hard nodules at dry place. At **300237 N** and **2767690 E** material is sandy with boulders with diameter 2 to 2.5 ft. At places it contains conglomerates and abundant cobbles and pebbles of sandstone. At **300258 E** and **2767845 N** material is composed of light brown to dark brown sand with abundant pebbles, cobles, gravel and boulders of sandstone. At **300266 E** and **2768041 N** material is mainly composed silty sand fine to medium grain devoid of gravel and pebble as in RD 21+ 000. Some of field photographs of materials from pumping station to Katti Pahari are shown as under:

4. CONCLUSIONS AND RECOMMENDATIONS

The geological information along the canal route alignment and surrounding areas can be concluded as.

- The geological units of the site area shows that the strata is mainly consists of alluvium deposits Sandstone, Mudstone, Limestone and shales.
- The terrain along the alignment is generally flat and plain at the right side of the canal a few exposures of sandstone and limestone are presents and marked in geological sheets while the maximum rock exposures of sandstone lies at left side that are also marked with description in geological sheets.
- The alluvium deposits are generally loose and approximately up to 3 meters thick and at places it is medium dense to dense and stiff to hard in case of containing rock & boulders if encountered.
- The general dip of strata is gentle to medium in NE direction while the strike is generally in NS direction.
- Normal and Strike Slip types of faults are exist in the mapped area and the direction of the faults planes are 60 to 70 degree NE.
- The limestone & sandstone exposures runs parallel along the canal alignment and being cuts by faults lines at places.
- Generally slopes are stable due to gentle dip trends at site.
- From pumping station to Khatti Phari the material composed of mix lithology includes alluvium sandstone, conglomerates and limestone and boulders of angular to sub- angular in shape.
- Structurally the project area falls in Eastern limb of the Hub anticline and in west of Gadap town syncline.
- Seismically it lies between the Hub & Orangi faults which lies in south and west of project area.
- The faults exist along the canal alignment may activated in future due to any regional tectonic activity, so it should be keep in considerations.
- Globally Changing climatic conditions and in rainy season, the flood may damage to the structure due to erosion of sandy material at the right bank of the canal.
- Hard strata may encounter during excavation even in the alluvium.
- Repose angle of the materials at site must be considered during excavation.

5. REFERENCES

1. Hunting Survey Corporation (1960)

2. S.M.I.(1979) Stratigraphy of Pakistan

3. Farshori M.z.(1972) Geology of Sindh

4. Clyde, W.C., Khan, I.H., and Gingerich, P.D., 2003, Stratigraphic response and mammalian dispersal during initial India-Asia collision; Evidence from the Ghazij Formation, Balochistan, Pakistan: Geology, v. 31, No. 12, p. 1097–1100.

5. Kazmi, A. H., and Rana, R. A, 1982. Tectonic map of Pakistan. Geological Survey of Pakistan, Quetta, Pakistan.

6. Hafeez, H., 2007. The potential of Tsunami generation along Karachi and Makran coast of Pakistan. Pakistan Jour. Meteorology, 4 (7), 25-41.

7. Bilham, R., Lodi, S., Hough, S., Bukhary, S., Khan, A. M., and Rafeeqi, S. F. A., 2007. Seismic Hazard in Karachi, Pakistan: Uncertain Past, Uncertain Future. Seism.Res. Lett.

8. Kazmi, A. H., 1979. Active Fault system in Pakistan. In Geodynamics of Pakistan (Eds. Farah & De Jong).Geological Survey of Pakistan, Quetta, Pakistan.

9. Mahar, G. A., 2009. Geomorphic degradation of Indus delta and its demographic impact. Unpublished Ph. D thesis submitted to University of Karachi.

10. Chung W-Y and Gao H 1995 Source parameters of the Anjar earthquake of July 21, 1956, India, and its seismotectonic implications for the Kutch rift basin; *Tectonophys.* 242, 281–295.

11. Johnston A C and Kanter L R 1990 Earthquakes in stable continental crust; *Scientific American* 262 69–75.

12. Quittmeyer R C and Jacob K H 1979. Historical and modern seismicity of Pakistan, Afghanistan, North-western India and South-eastern Iran; *Bull.Seismol. Soc. Am.* 69, 773–823.

13. Flam, L., 1999. The prehistoric Indus river system and the Indus civilization in Sindh. Man and Environment, 24(2), pp.35-69.

14. Kazmi, A. H.,1984. Geology of the Indus delta. In B. U., Haque and J. D., Milliman (eds): Marine geology and oceanography of Arabian sea and coastal Pakistan. Van Nostr and Reindhold, New York, pp.71-84.

15. Wells, J. T., and Coleman, J. M.,1984. Deltaic morphology and sedimentology, with special reference to Indus delta. In B. U., Haque and J. D., Milliman (eds): Marine geology and oceanography of Arabian sea and coastal Pakistan. Van Nostr and Reindhold, New York, pp. 85-100.

16. Powell, C. McA., 1979. A speculative tectonic history of Pakistan and surroundings: Some constraints from the Indian Ocean. In: Farah, A. & DeJong, K. A. (eds.) Geodynanmics of Pakistan. Geol. Surv. Pak., Quetta, pp.1-451.

17. Chaudhry, M.N., Ghazanfar, M., and Ahsan, N., 1994. Rates of Sedimentation of Kawagarh Formation at Giah and Timing of Uplift at K-T Boundary. Pak. Jour. Geol. Vol. 2 & 3, No. 1, pp. 29-32.

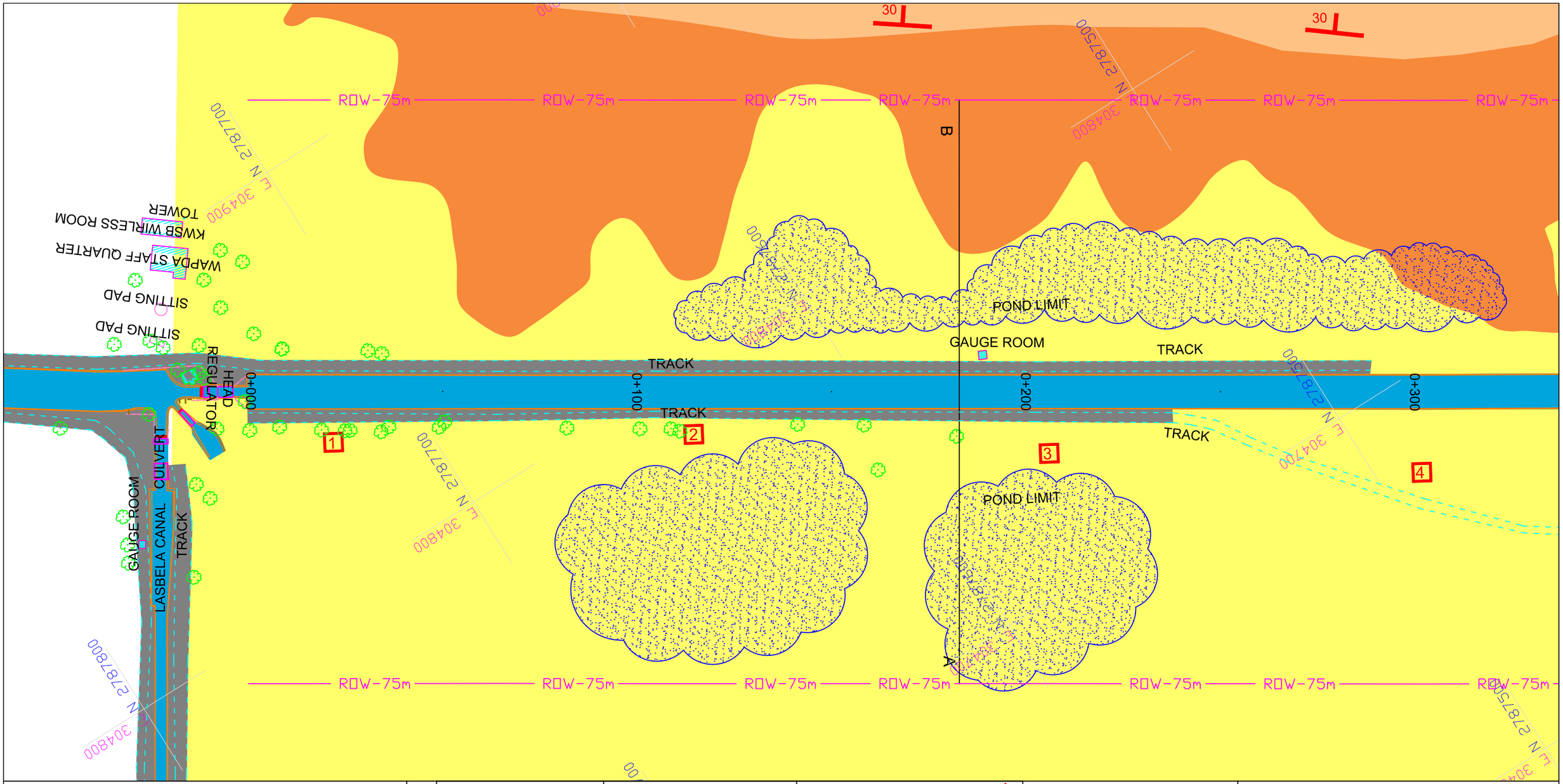
18. Valdiya, K.S., 2002. Emergence and evolution of Himalaya: reconstructing history in the light of recent studies. SAGE Publications. Progress in Physical Geography, 26, No. 3, pp. 360-399.

19. Zaigham, N. A.,1994. Impact of tectonics on the courses of Indus river and associated geomorphic features in Pakistan. Kashmir Journal of Geology, 11-12, pp.121-126.

20. Lawrence, R.D., Khan, S.H., DeJong, K.A., Farah, A., and Yeats, R.S., 1981, Thrust and strike-slip fault interaction along the Chaman transform zone, Pakistan, *in* McClay, K., and Price, N., eds., Thrust and Nappe Tectonics: Geological Society of London Special Publication 9, p. 363–368.

ANNEXURES

ANNEXURE-A
GEOLOGICAL MAPPING SHEETS



HUB CANAL PROJECT

MAP TITTLE:-

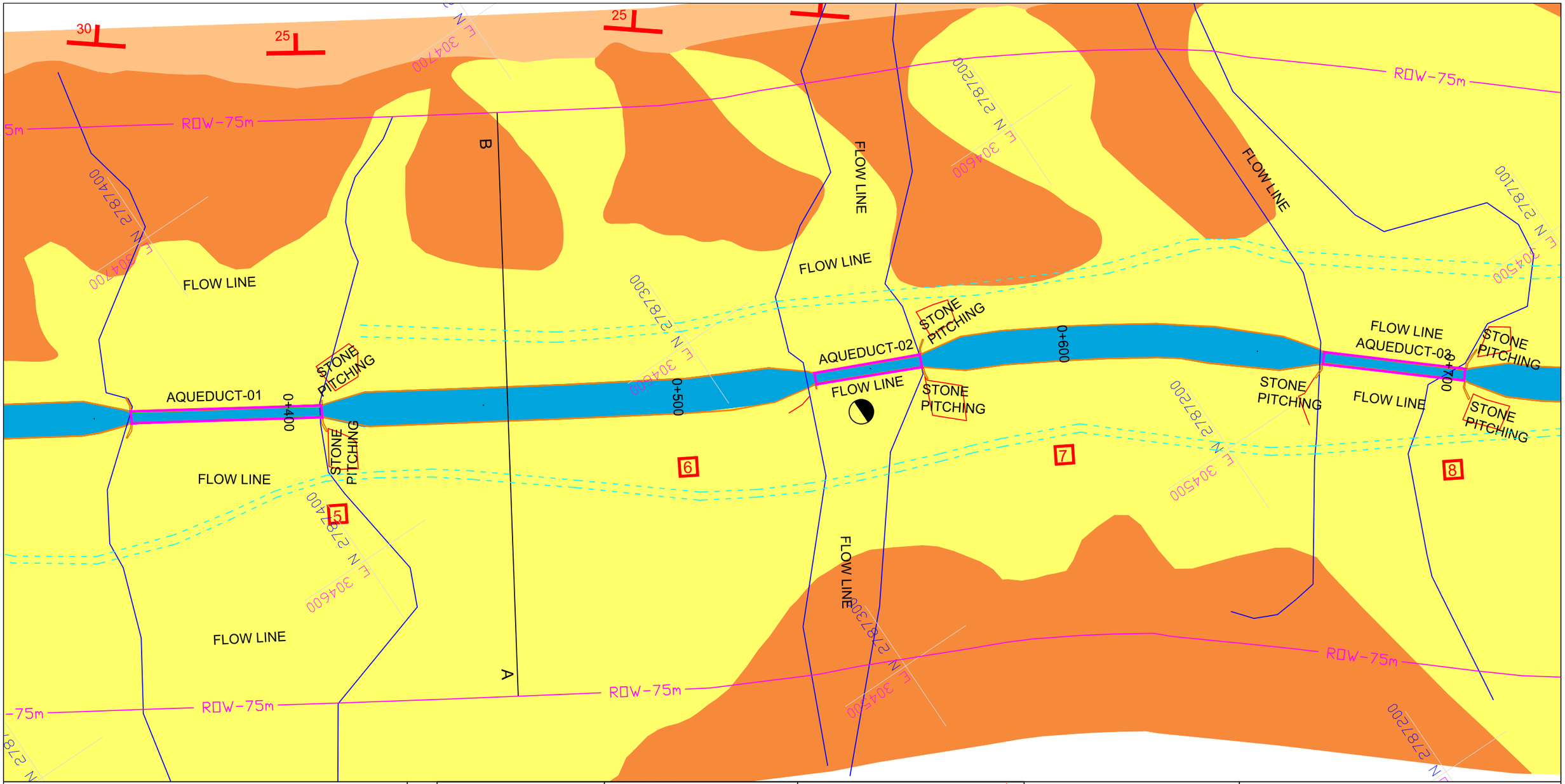
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 01
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

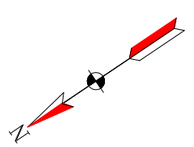
HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

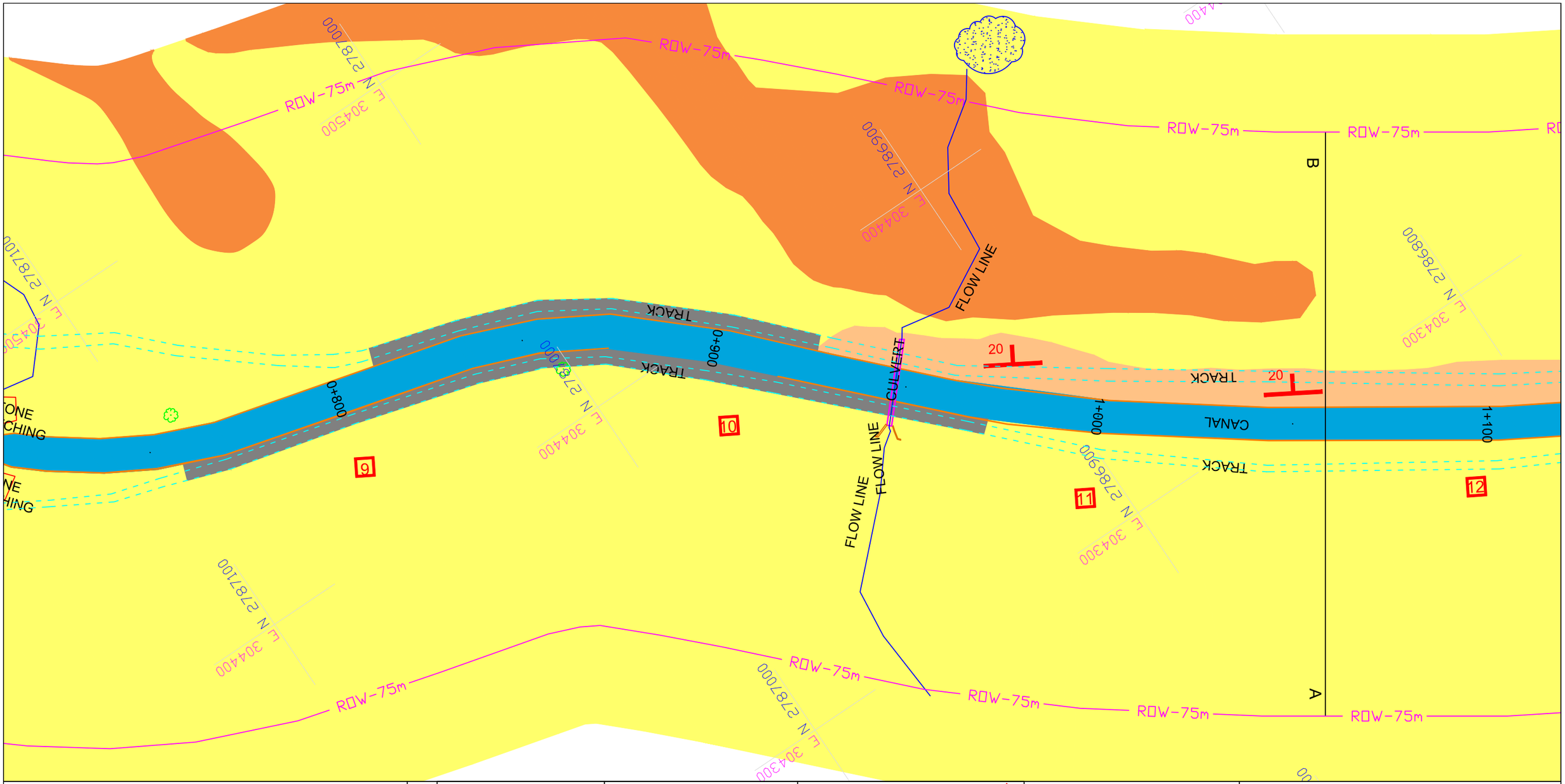
PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-



SCALE:- 1:1000

SHEET NO:- 02



HUB CANAL PROJECT

MAP TITTLE:-

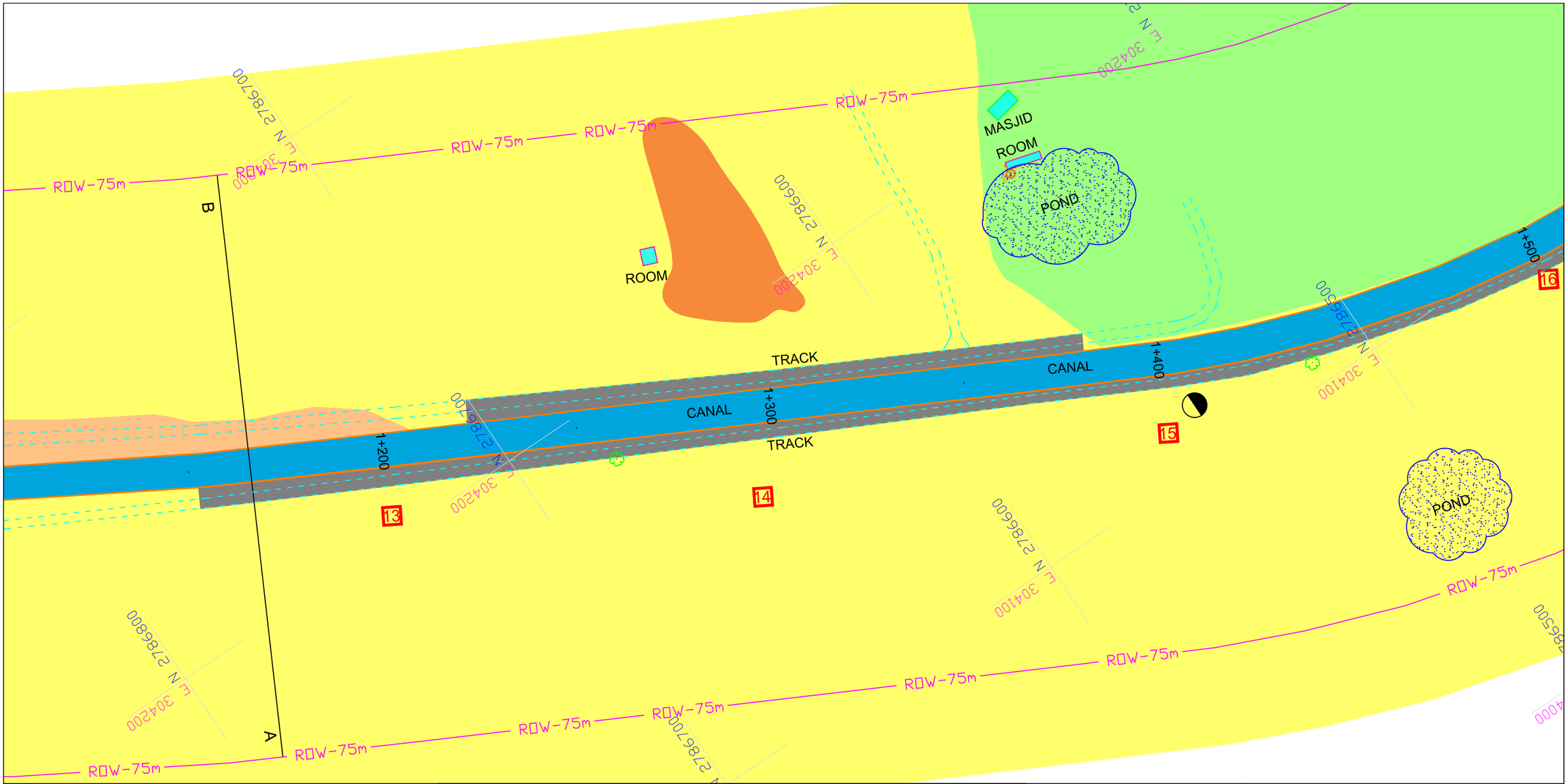
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 03
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

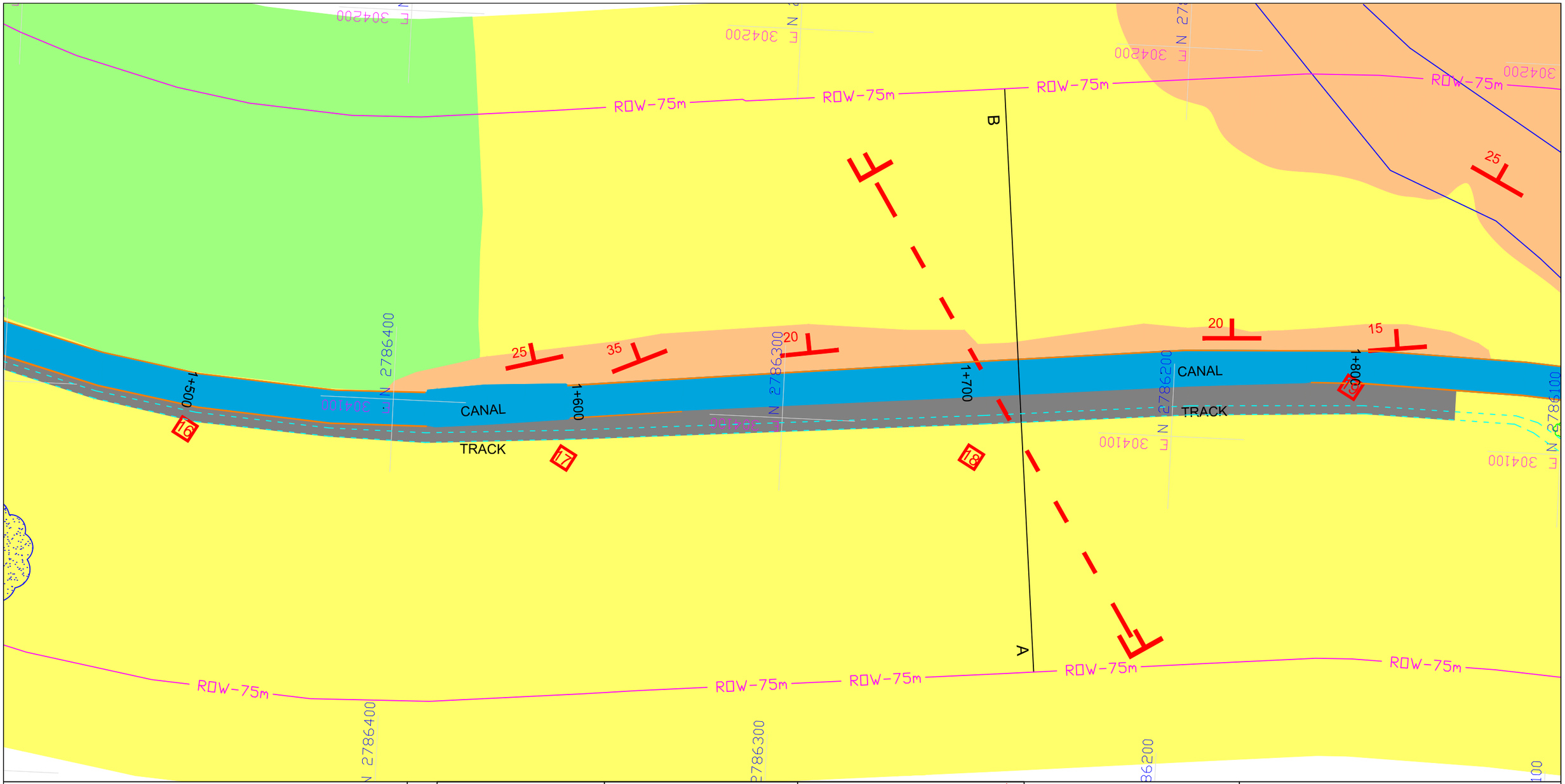
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 04
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

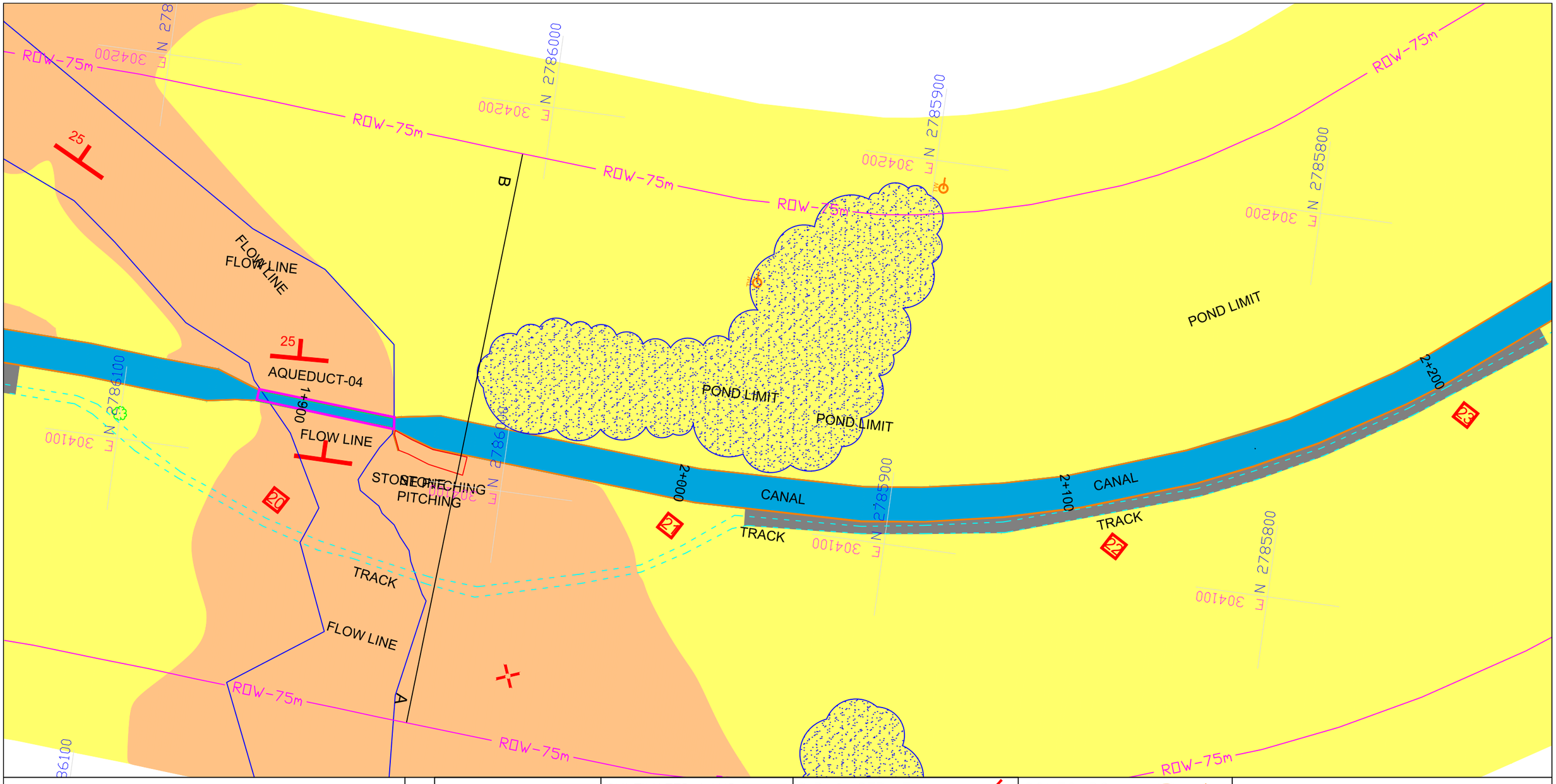
N

SCALE:-

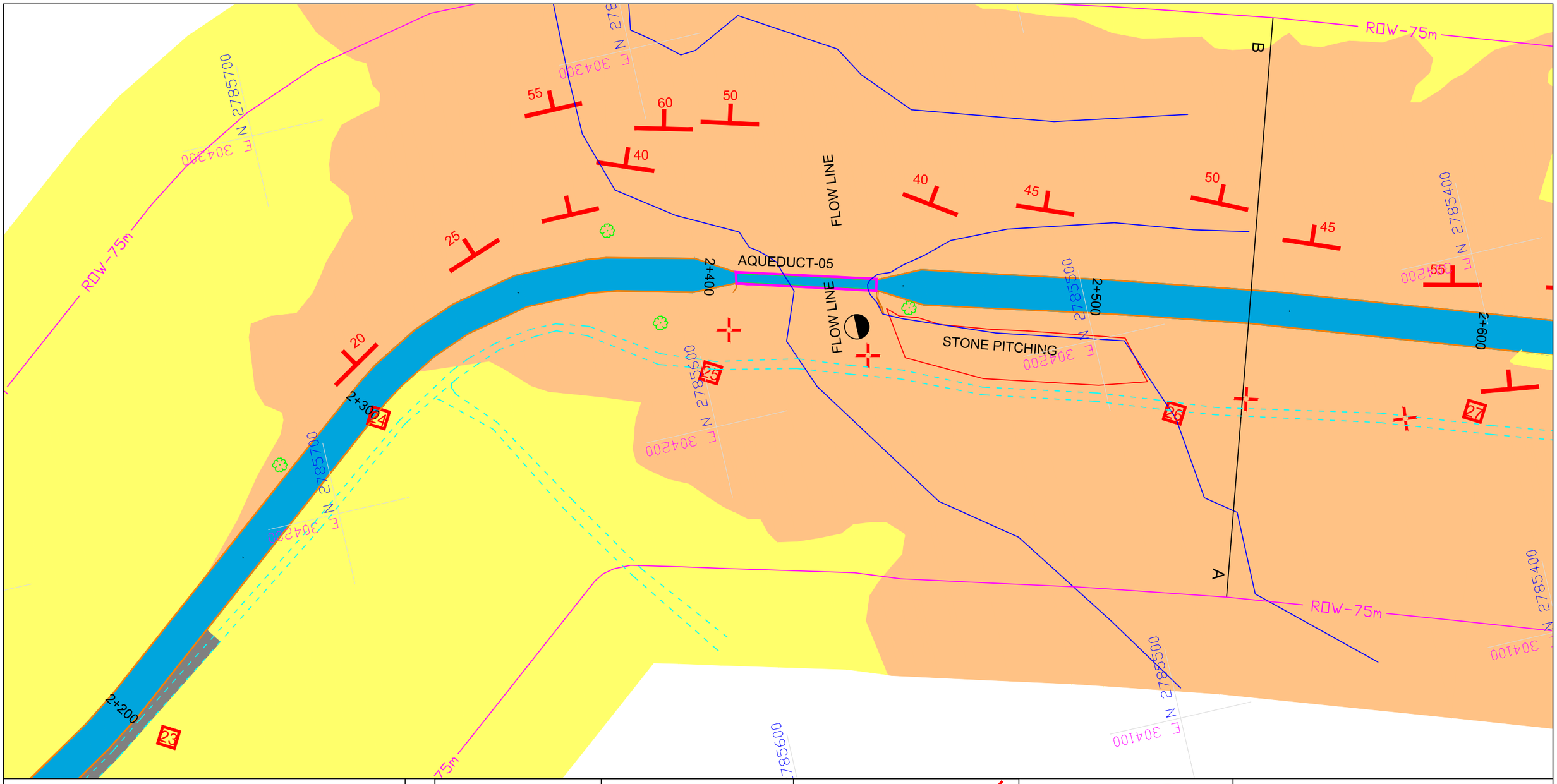
1:1000

SHEET NO:-

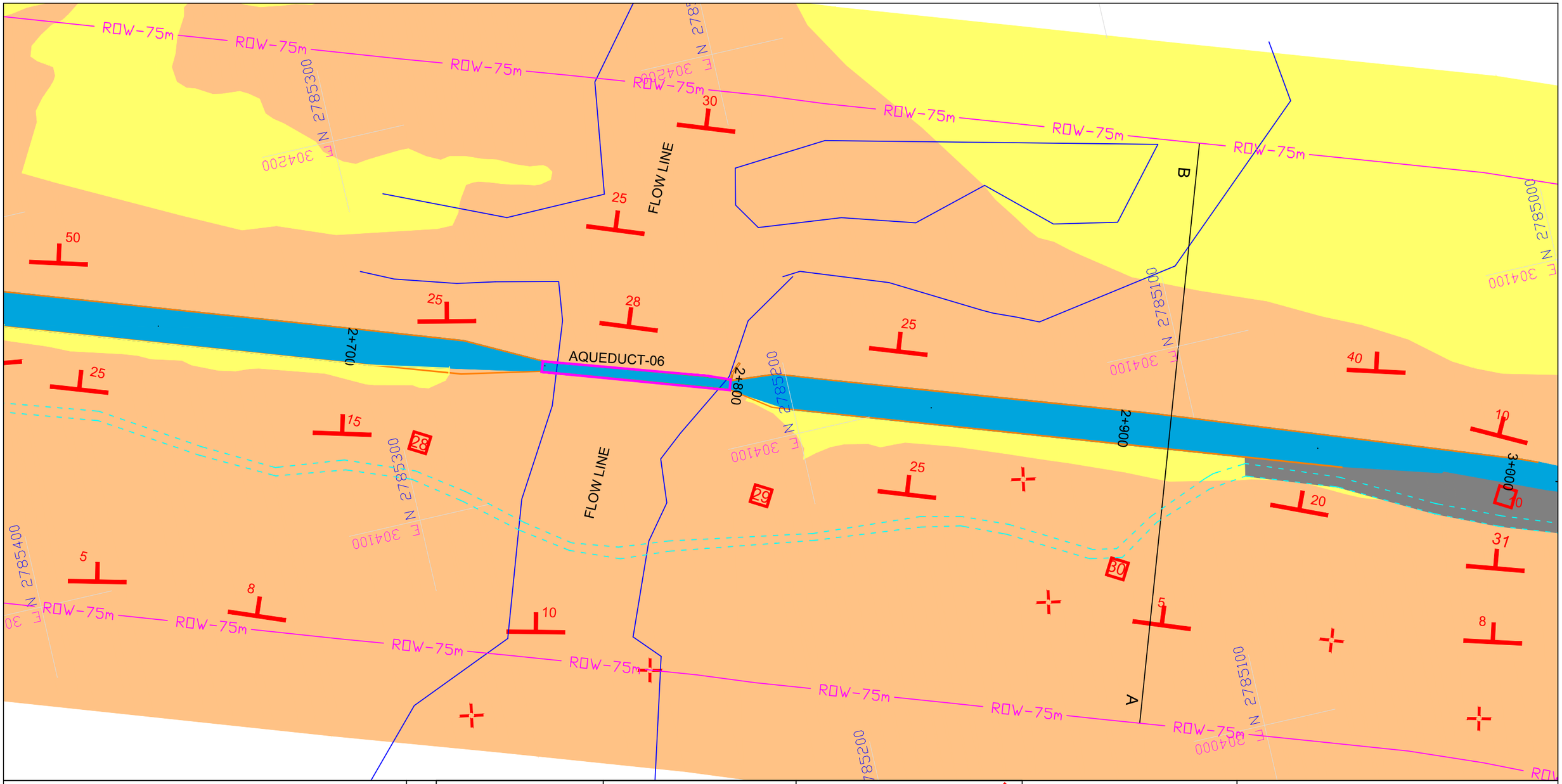
05



HUB CANAL PROJECT	LEGENDS:-				NORTH ARROW:-
MAP TITTLE:- GEOLOGICAL MAPING		PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
		CLAY STONE	LIMESTONE	FAULT F	WATER TANK
		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE
		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE
HALCROW PAKSITAN		TEST PIT	CANAL	BORE HOLE	
		MASJID	CULVERT/BRIDGES	ROAD	
SURVEY TECH (PVT) LTD		TRACK	HOUSE/BUILDING	HAND PUMP HP	SCALE:- 1:1000
		POND	ELECTRIC POLE	TELEPHONE POLE T	SHEET NO:- 06



HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
MAP TITTLE:-		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
GEOLOGICAL MAPING		CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
HALCROW PAKSITAN		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
SURVEY TECH (PVT) LTD		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
		TEST PIT	CANAL	BORE HOLE			
		MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 07
		TRACK	HOUSE/BUILDING	HAND PUMP HP			
		POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

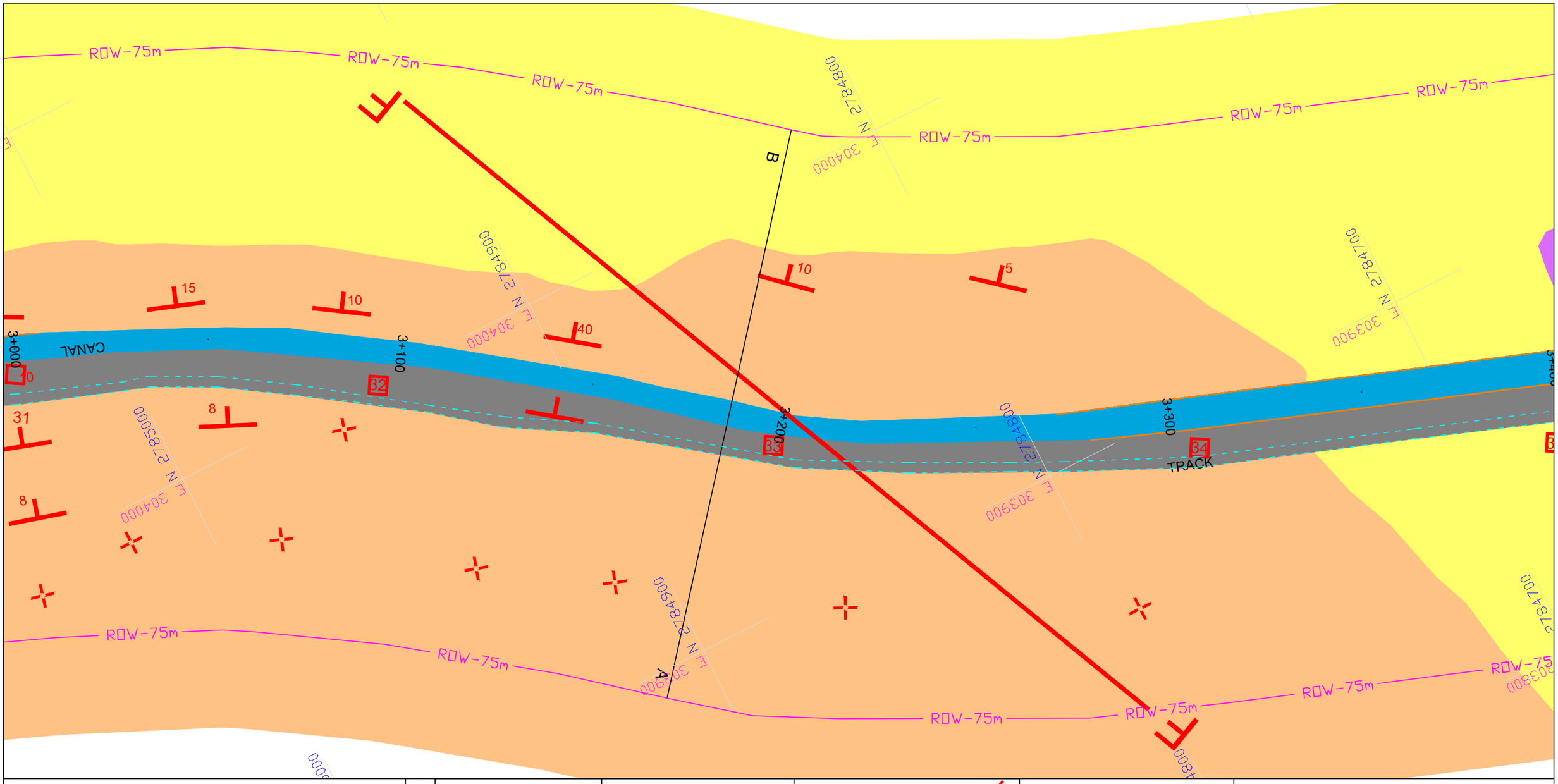
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 08
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			

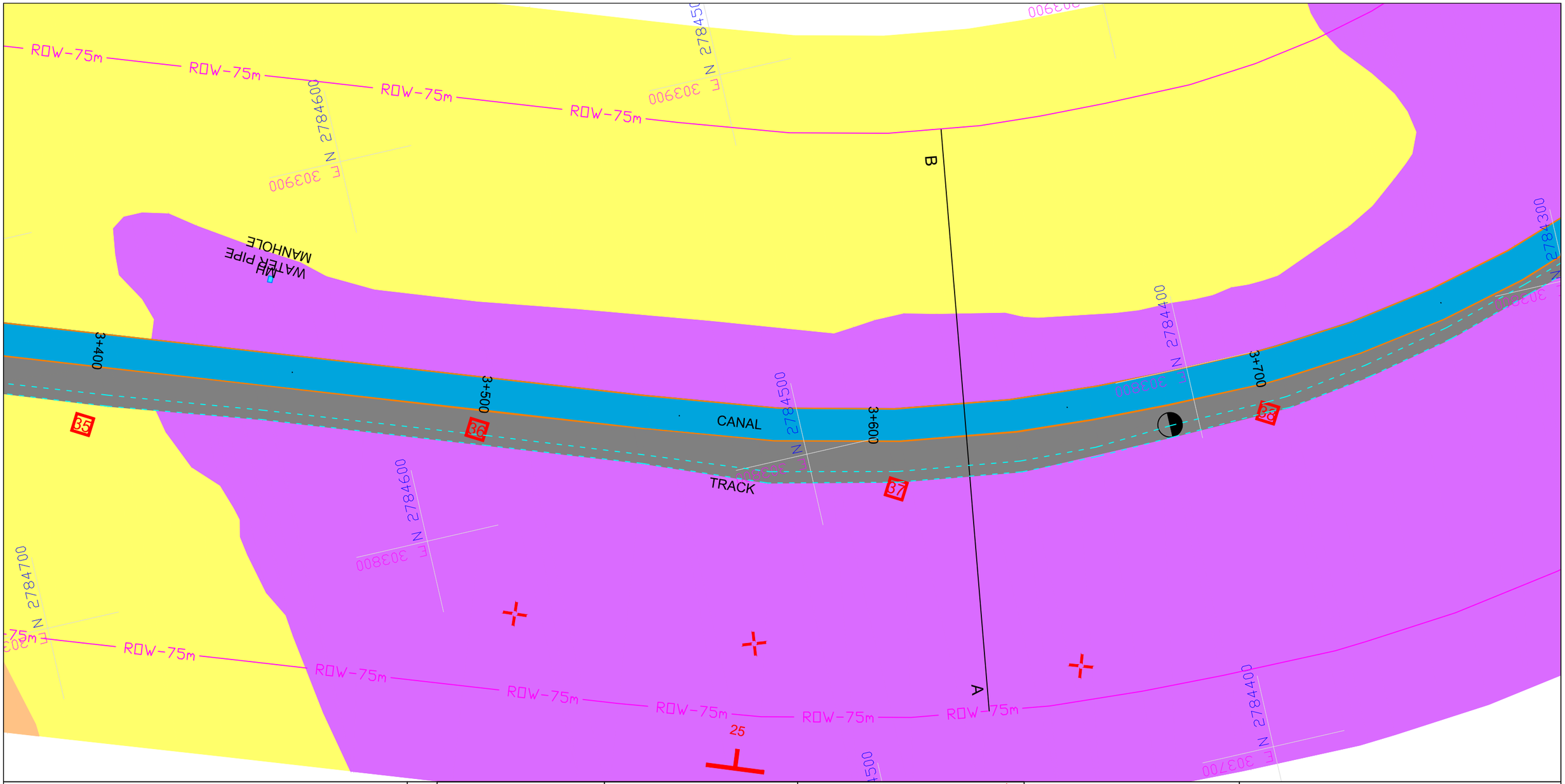


HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
		CLAY STONE	LIMESTONE	FAULT F	WATER TANK
		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE
		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE
HALCROW PAKSITAN		TEST PIT	CANAL	BORE HOLE	
		MASJID	CULVERT/BRIDGES	ROAD	
SURVEY TECH (PVT) LTD		TRACK	HOUSE/BUILDING	HAND PUMP HP	
		POND	ELECTRIC POLE	TELEPHONE POLE T	

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 09

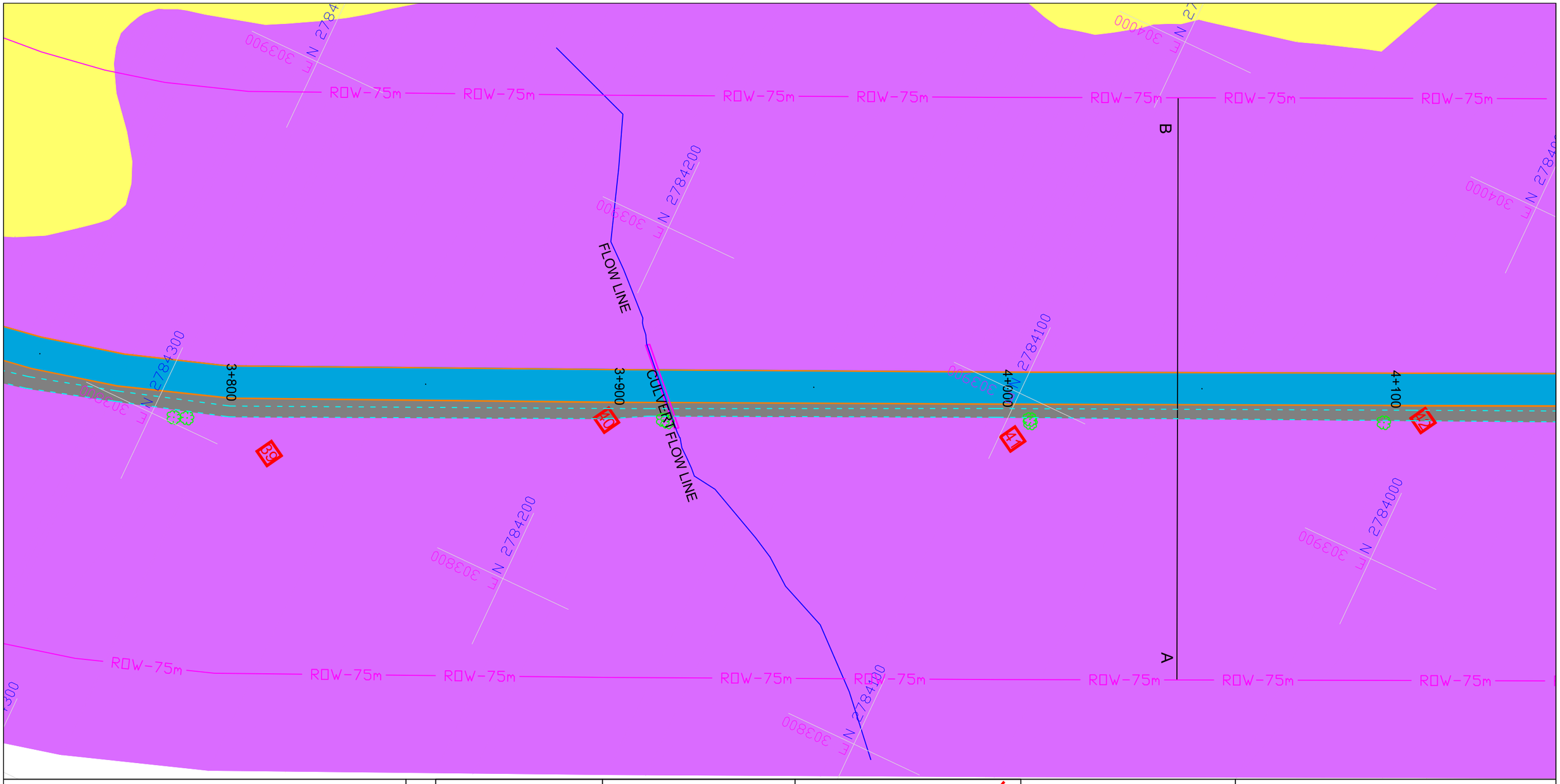


HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
		CLAY STONE	LIMESTONE	FAULT F	WATER TANK
		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE
		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE
HALCROW PAKSITAN		TEST PIT	CANAL	BORE HOLE	
		MASJID	CULVERT/BRIDGES	ROAD	
SURVEY TECH (PVT) LTD		TRACK	HOUSE/BUILDING	HAND PUMP HP	
		POND	ELECTRIC POLE	TELEPHONE POLE T	

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 10



HUB CANAL PROJECT

MAP TITTLE:-

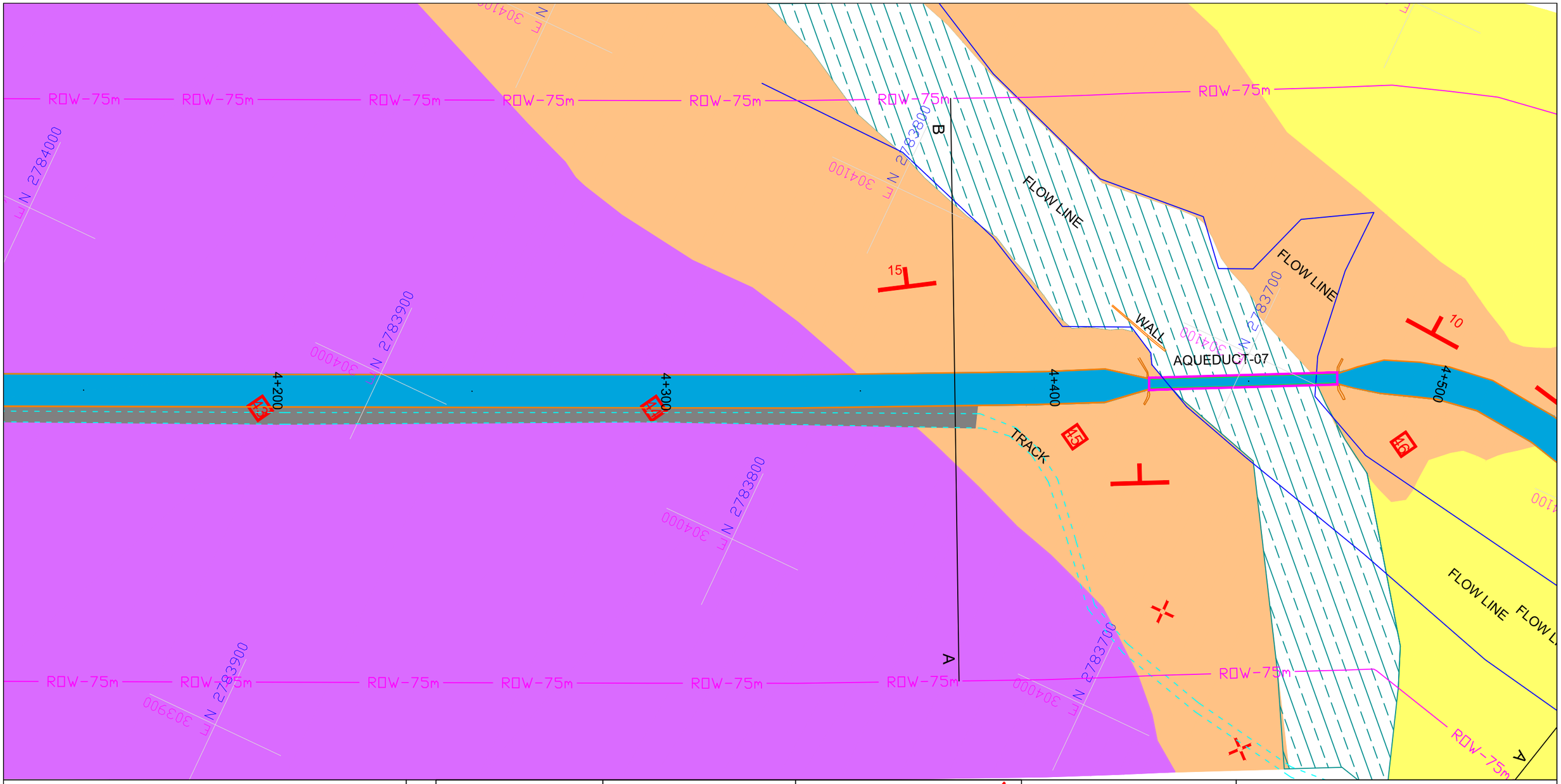
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 11
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

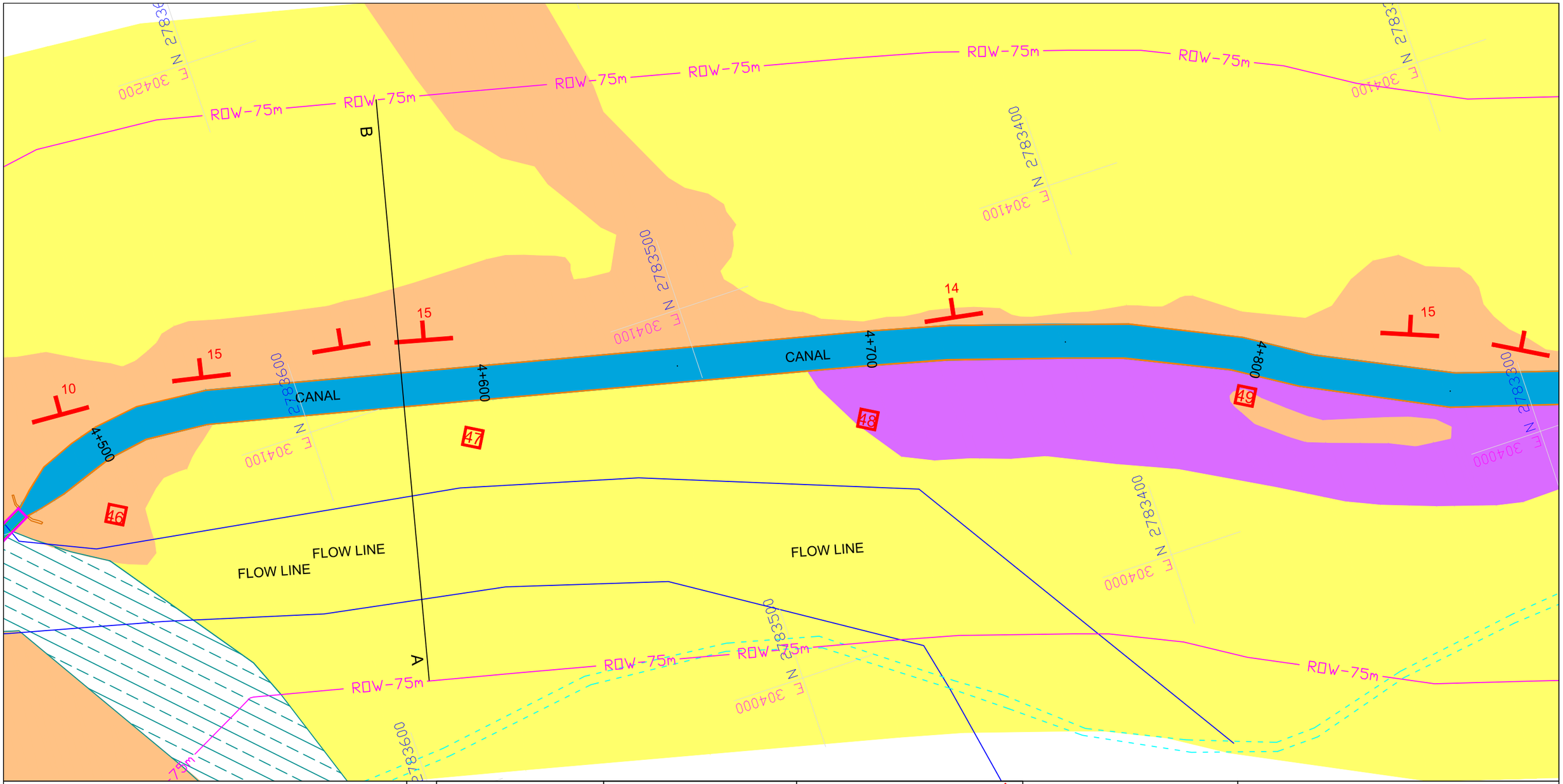
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 12
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 13

HUB CANAL PROJECT

MAP TITTLE:-

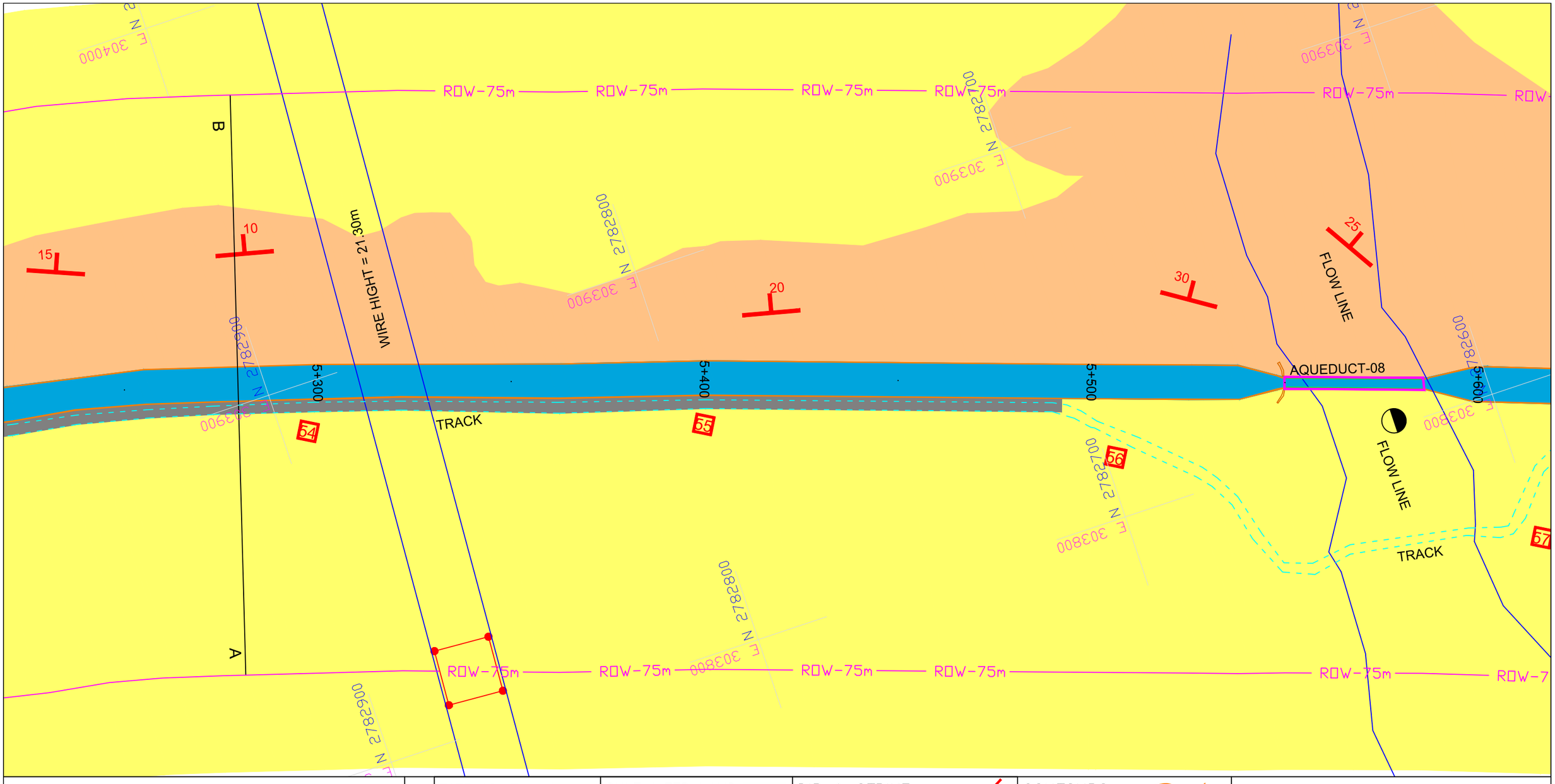
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 14
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

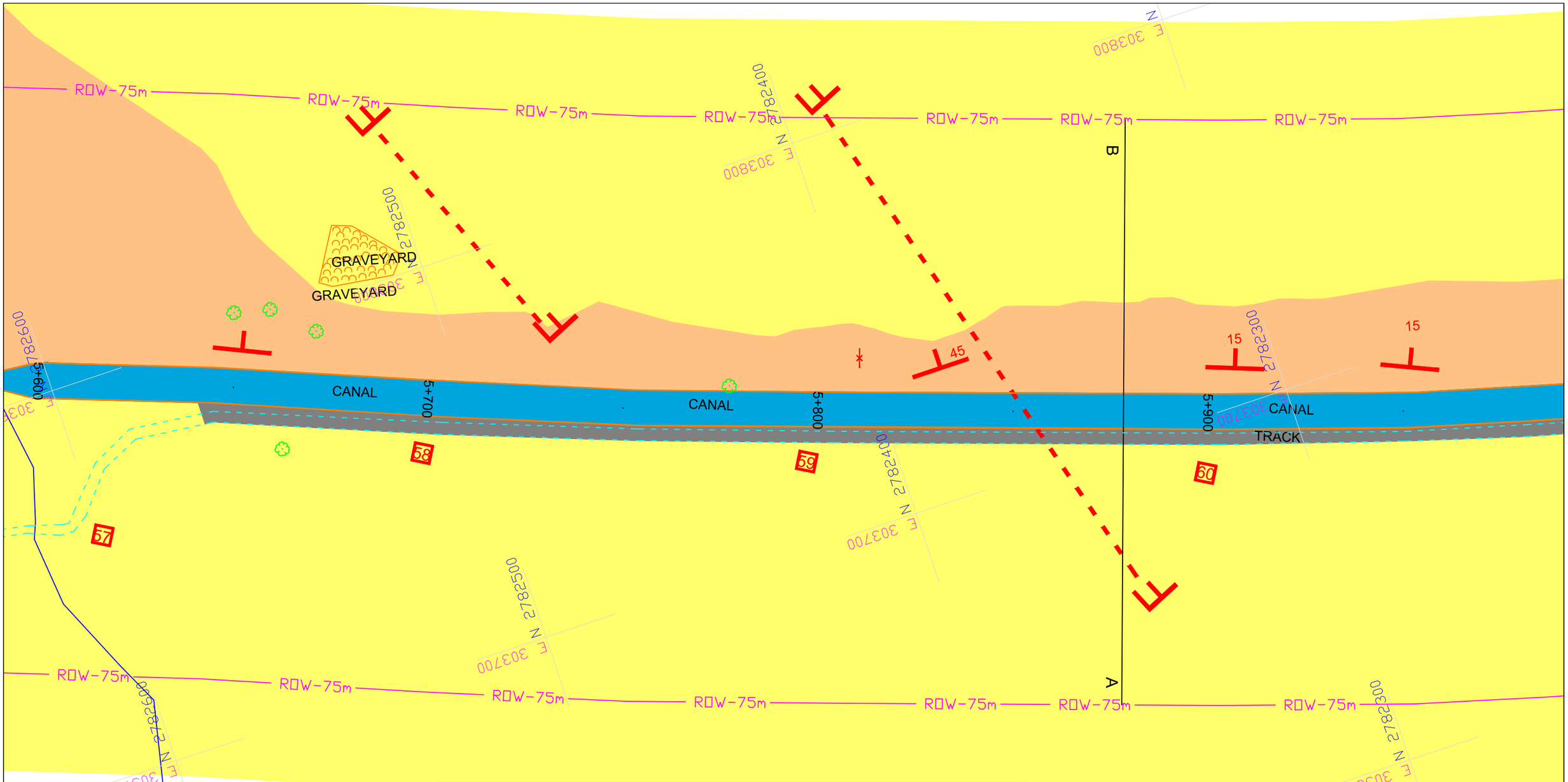
LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 15



HUB CANAL PROJECT

MAP TITTLE:-

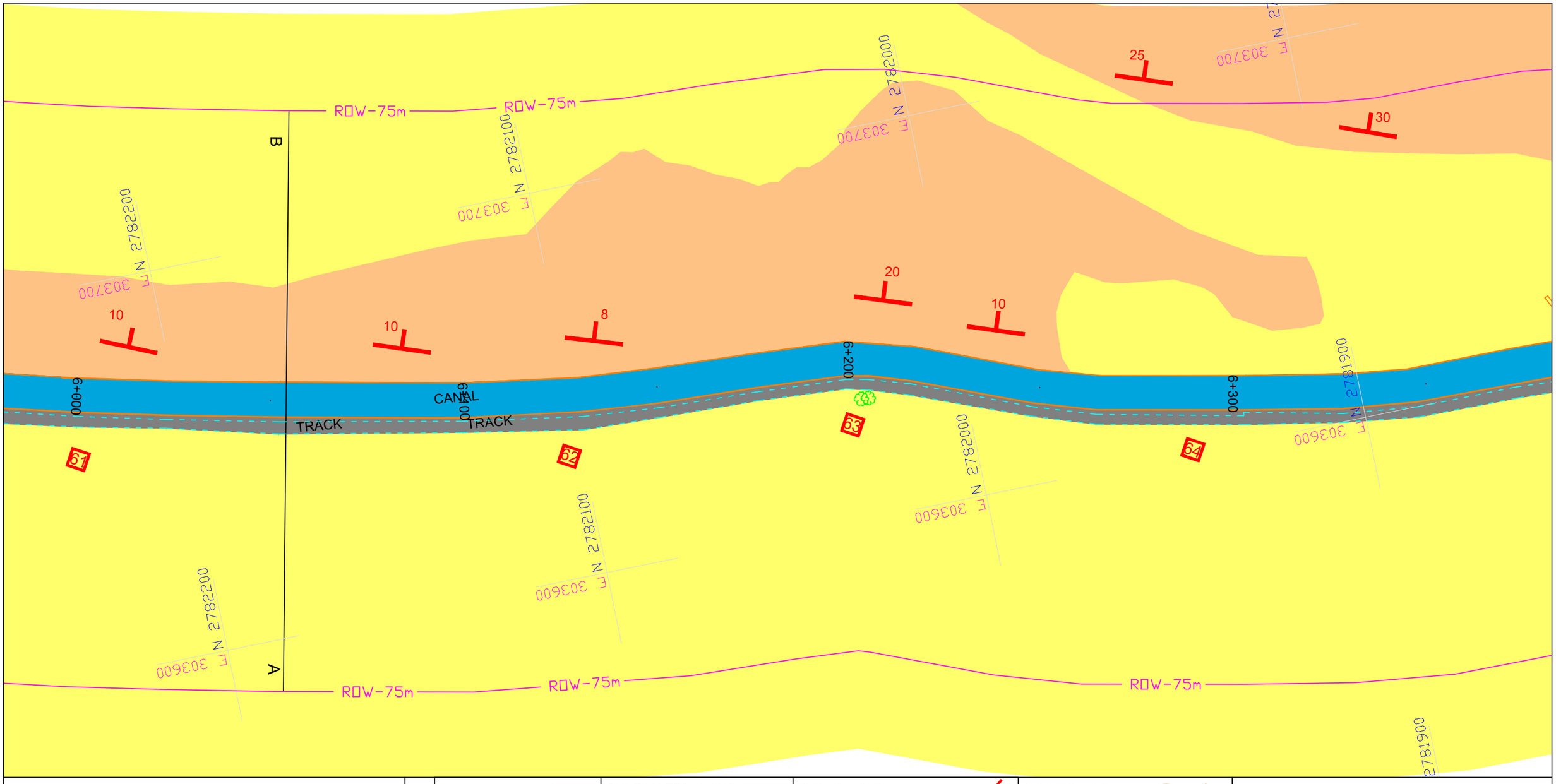
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 16
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

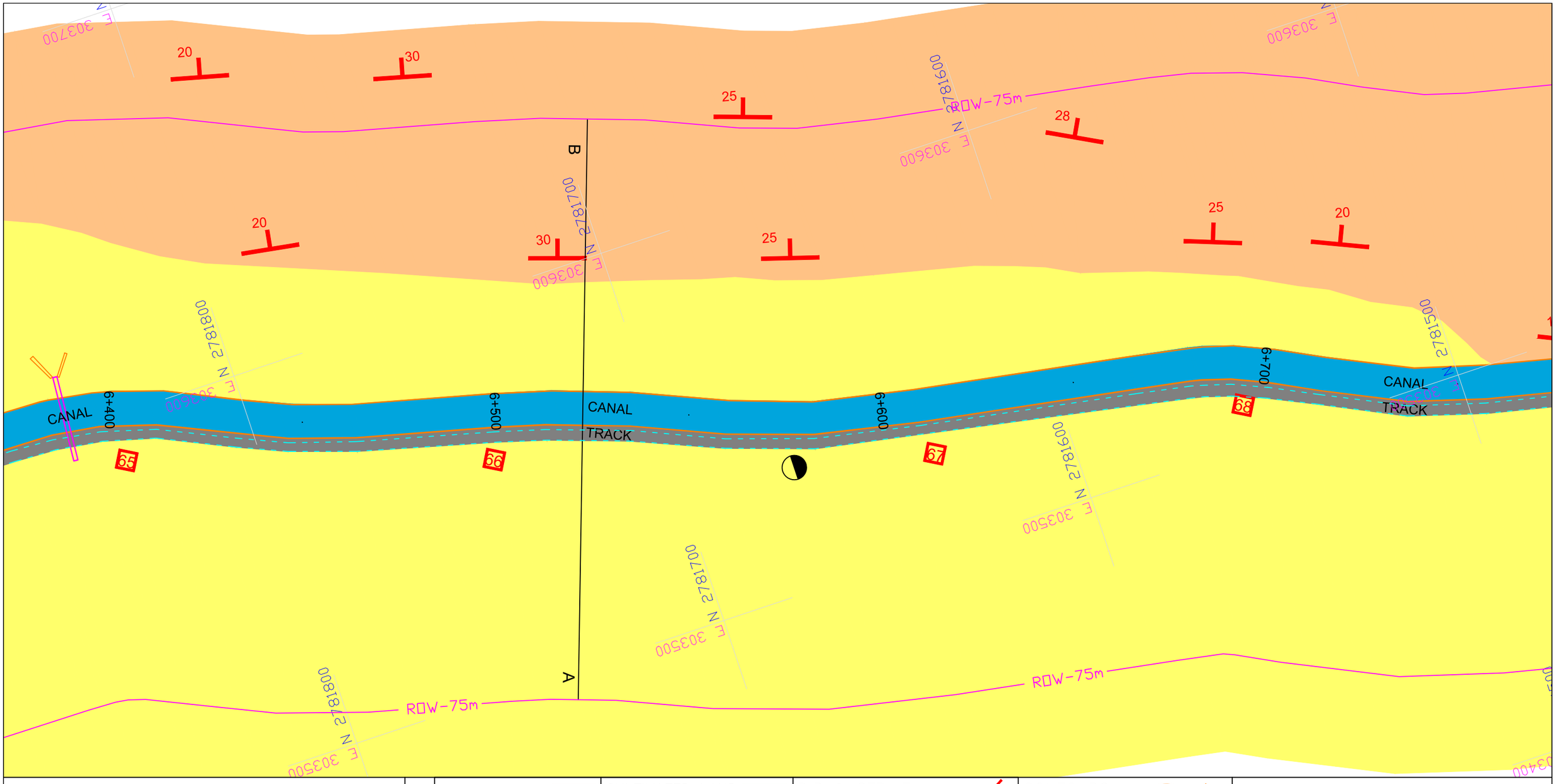
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 17
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

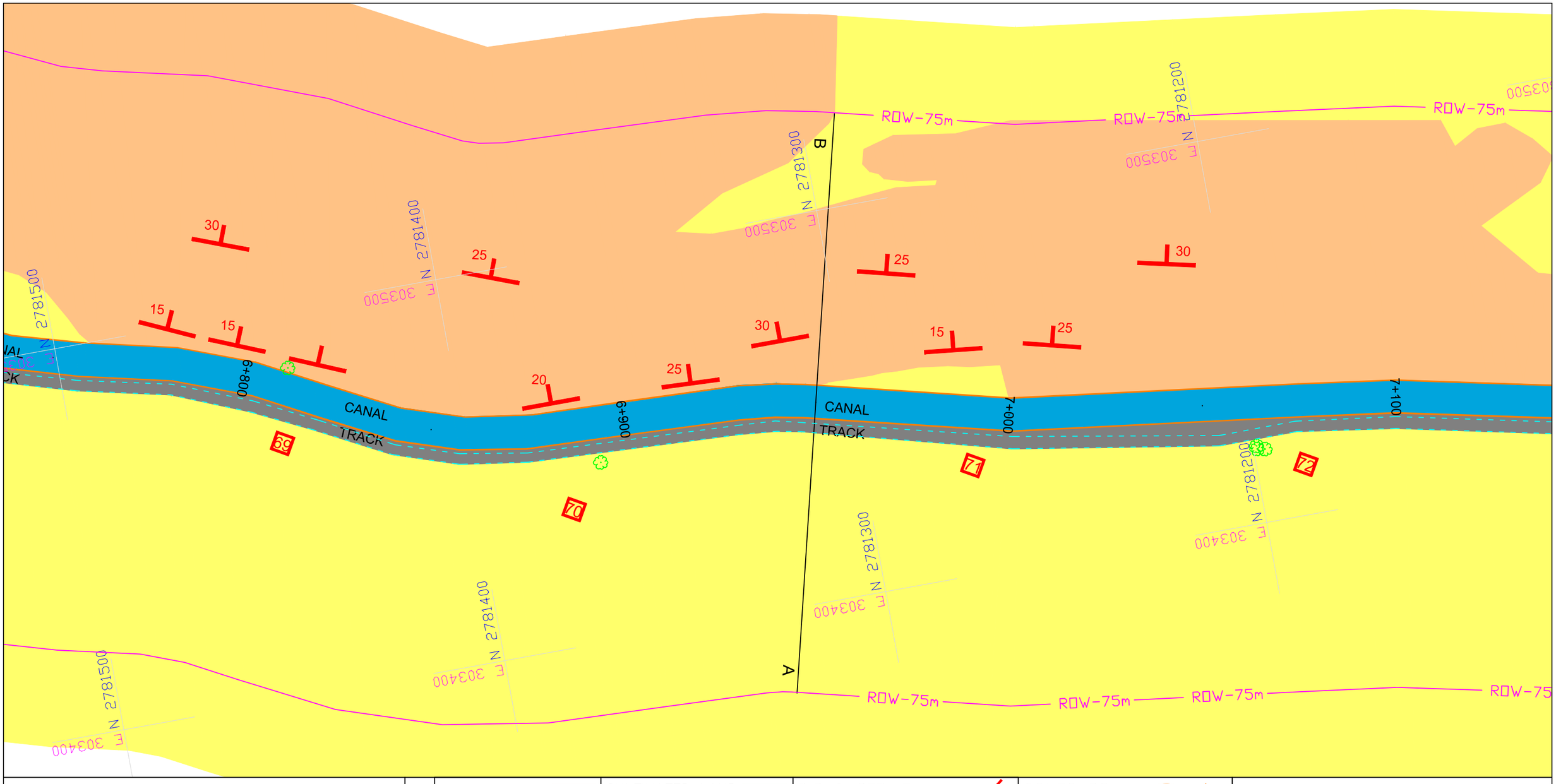
LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
CLAY STONE	LIMESTONE	FAULT — F	WATER TANK
SHALE	MUD STONE	FAULT INFERRED - - - - F	FLOW LINE
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE
TEST PIT	CANAL	BORE HOLE	
MASJID	CULVERT/BRIDGES	ROAD	
TRACK	HOUSE/BUILDING	HAND PUMP HP	
POND	ELECTRIC POLE	TELEPHONE POLE T	

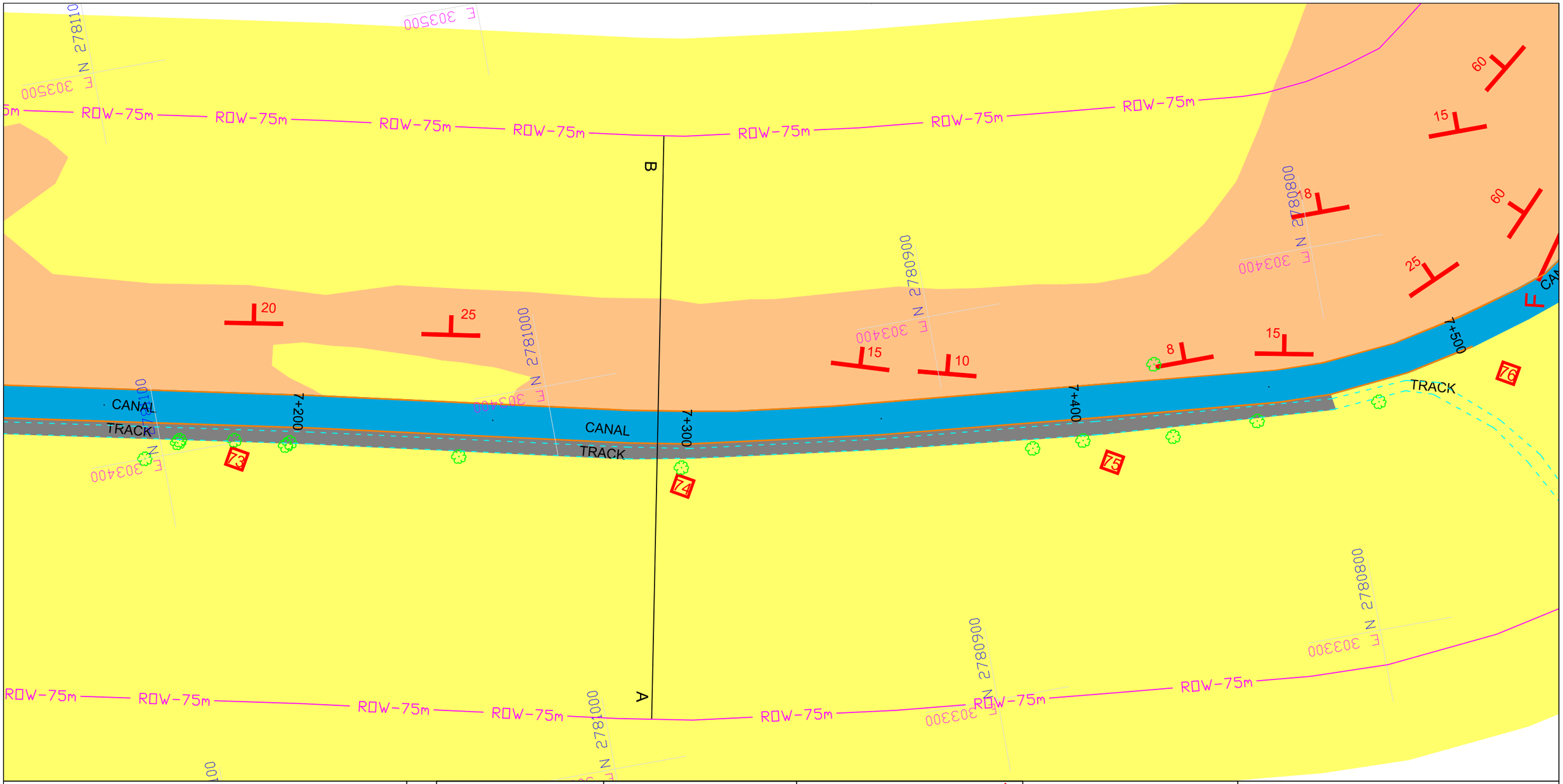
NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 18



HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
MAP TITTLE:-		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
GEOLOGICAL MAPING		CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
HALCROW PAKSITAN		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
SURVEY TECH (PVT) LTD		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
		TEST PIT	CANAL	BORE HOLE		SCALE:- 1:1000	SHEET NO:- 19
		MASJID	CULVERT/BRIDGES	ROAD			
		TRACK	HOUSE/BUILDING	HAND PUMP HP			
		POND	ELECTRIC POLE	TELEPHONE POLE T			

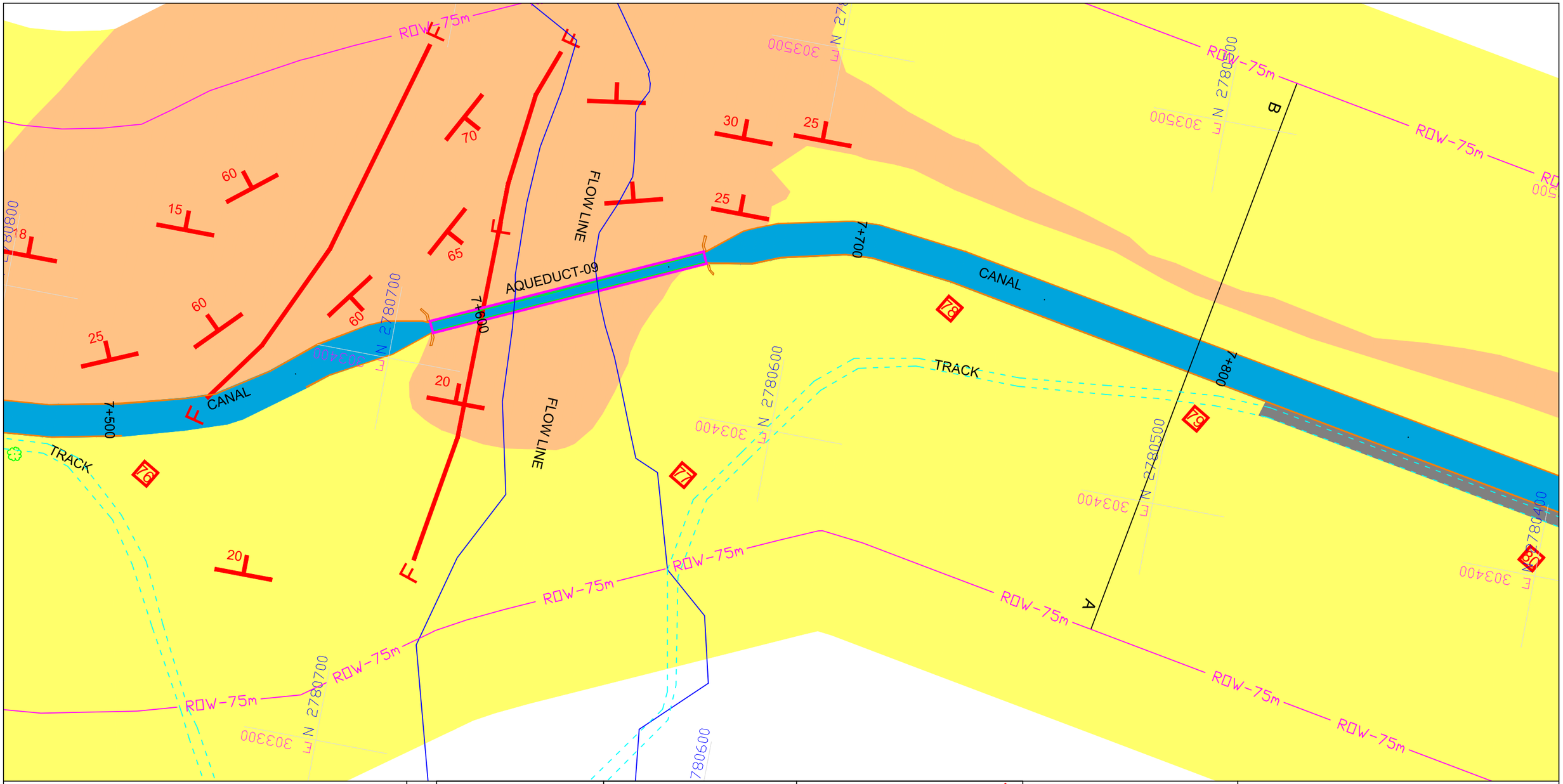


HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
MAP TITTLE:-		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
GEOLOGICAL MAPING		CLAY STONE	LIMESTONE	FAULT F	WATER TANK
HALCROW PAKSITAN		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE
SURVEY TECH (PVT) LTD		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE
		TEST PIT	CANAL	BORE HOLE	
		MASJID	CULVERT/BRIDGES	ROAD	
		TRACK	HOUSE/BUILDING	HAND PUMP HP	
		POND	ELECTRIC POLE	TELEPHONE POLE T	

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 20

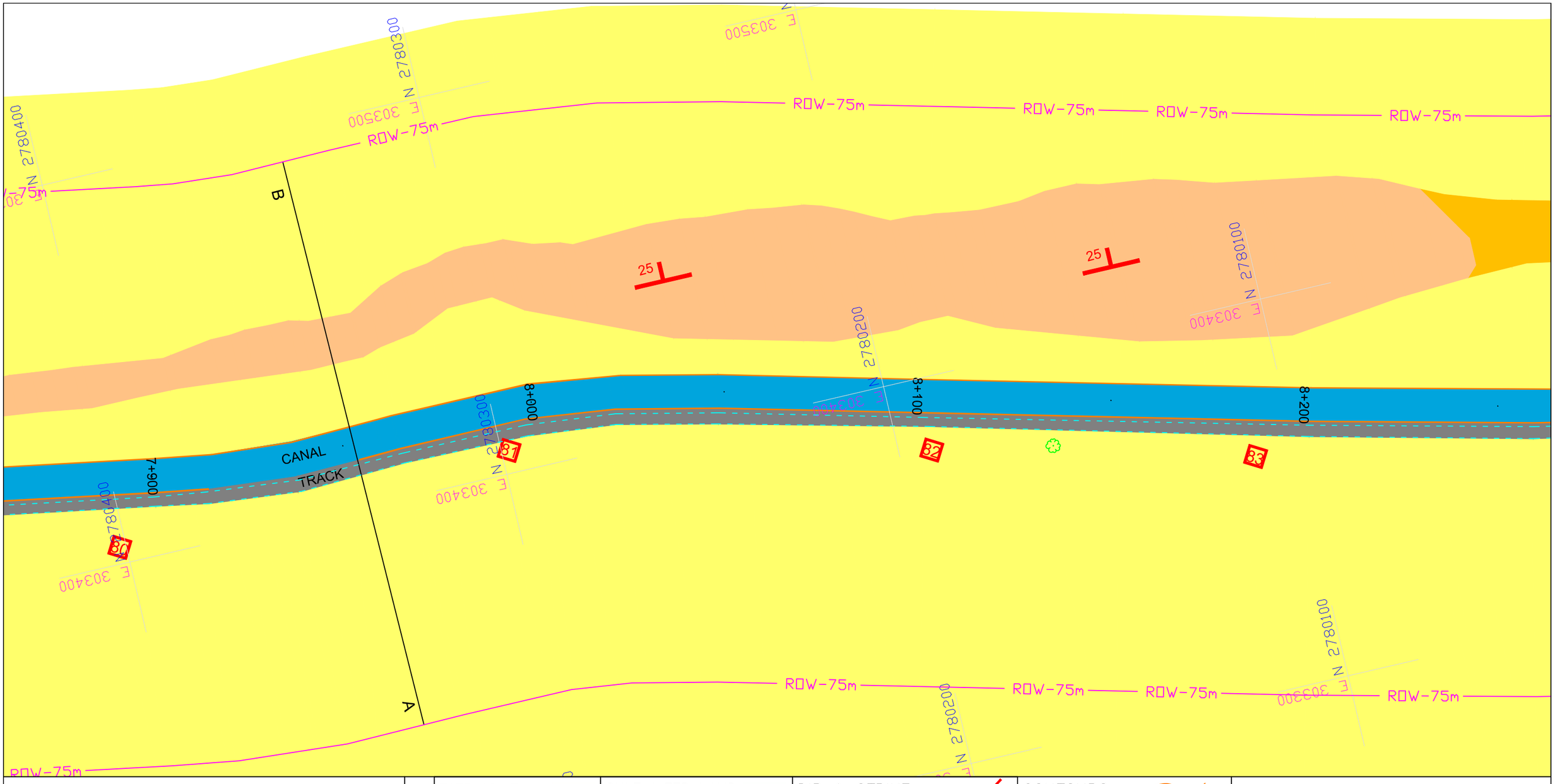


HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
		CLAY STONE	LIMESTONE	FAULT F	WATER TANK
		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE
		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE
HALCROW PAKSITAN		TEST PIT	CANAL	BORE HOLE	
		MASJID	CULVERT/BRIDGES	ROAD	
SURVEY TECH (PVT) LTD		TRACK	HOUSE/BUILDING	HAND PUMP HP	
		POND	ELECTRIC POLE	TELEPHONE POLE T	

NORTH ARROW:- N

SCALE:- 1:1000

SHEET NO:- 21

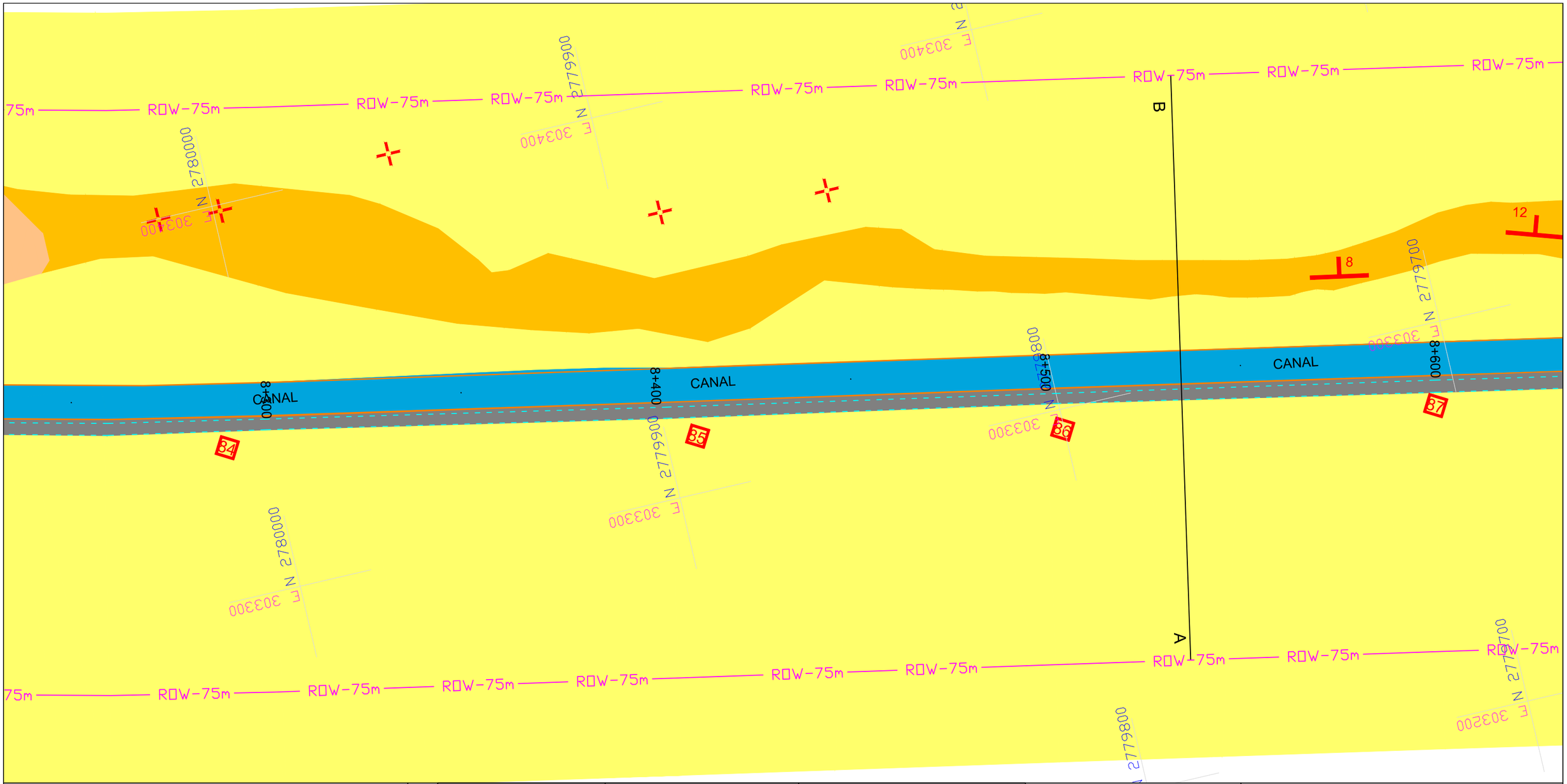


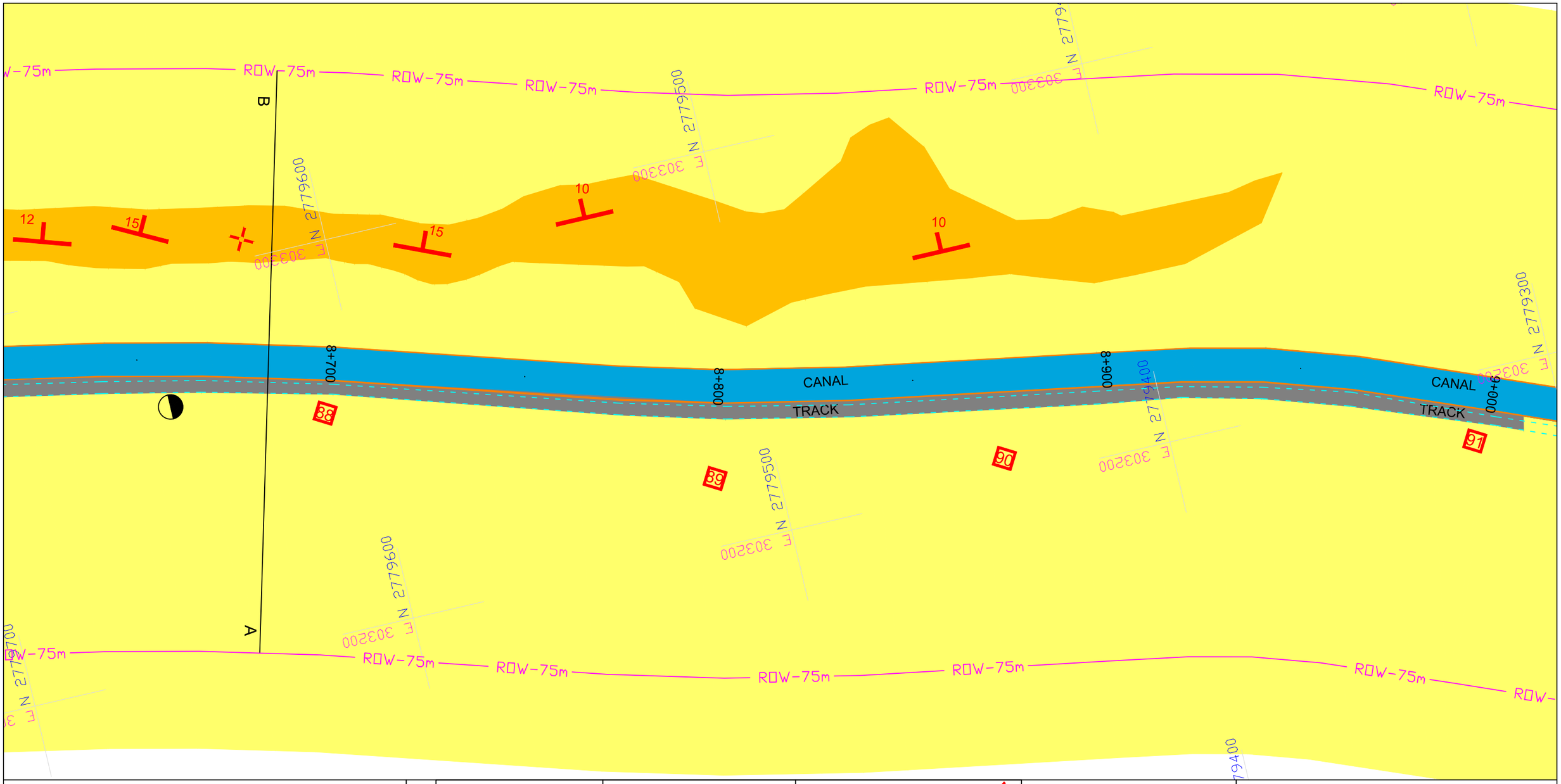
HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
MAP TITTLE:-		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
GEOLOGICAL MAPING		CLAY STONE	LIMESTONE	FAULT F	WATER TANK
HALCROW PAKSITAN		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE
SURVEY TECH (PVT) LTD		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE
		TEST PIT	CANAL	BORE HOLE	
		MASJID	CULVERT/BRIDGES	ROAD	
		TRACK	HOUSE/BUILDING	HAND PUMP HP	
		POND	ELECTRIC POLE	TELEPHONE POLE T	

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 22


ROW-75m
ROW-75m
ROW-75m



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT — F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED - - - - F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 24
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			

HUB CANAL PROJECT

MAP TITTLE:-

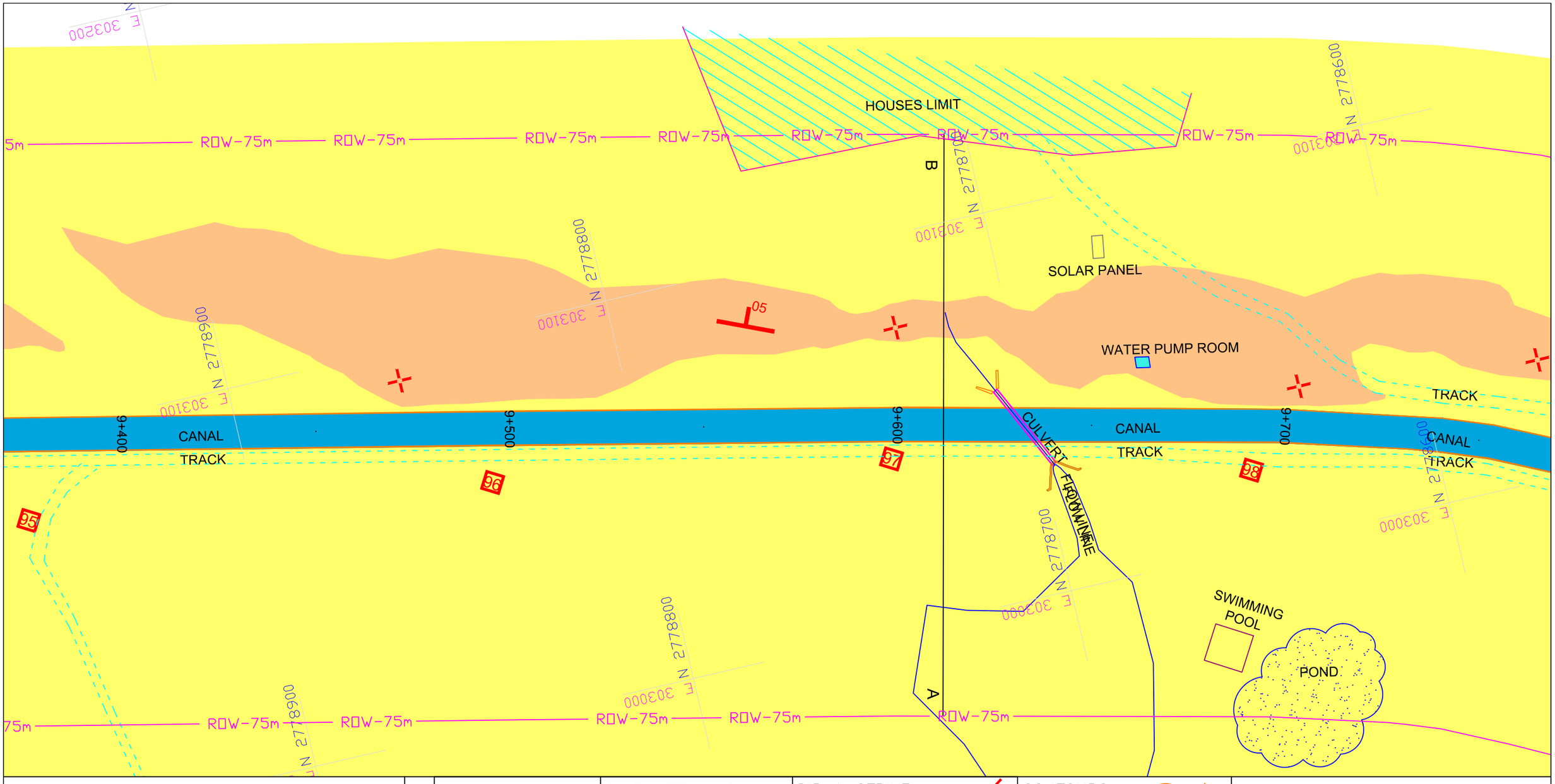
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 25
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

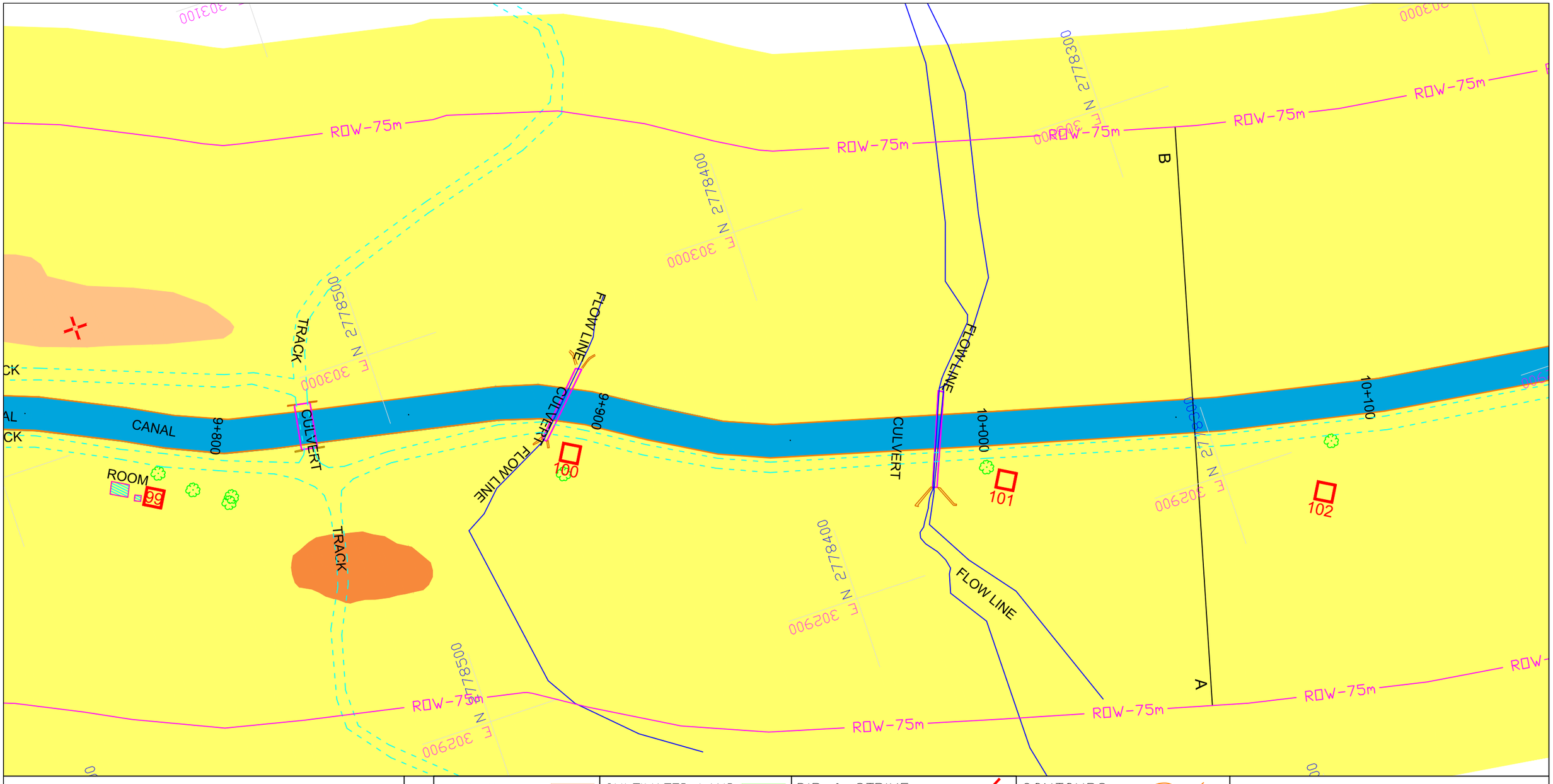
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 26
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
MAP TITTLE:-		SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
GEOLOGICAL MAPING		CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
HALCROW PAKSITAN		SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
SURVEY TECH (PVT) LTD		QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
		TEST PIT	CANAL	BORE HOLE		SCALE:- 1:1000	SHEET NO:- 27
		MASJID	CULVERT/BRIDGES	ROAD			
		TRACK	HOUSE/BUILDING	HAND PUMP HP			
		POND	ELECTRIC POLE	TELEPHONE POLE T			

HUB CANAL PROJECT

MAP TITTLE:-

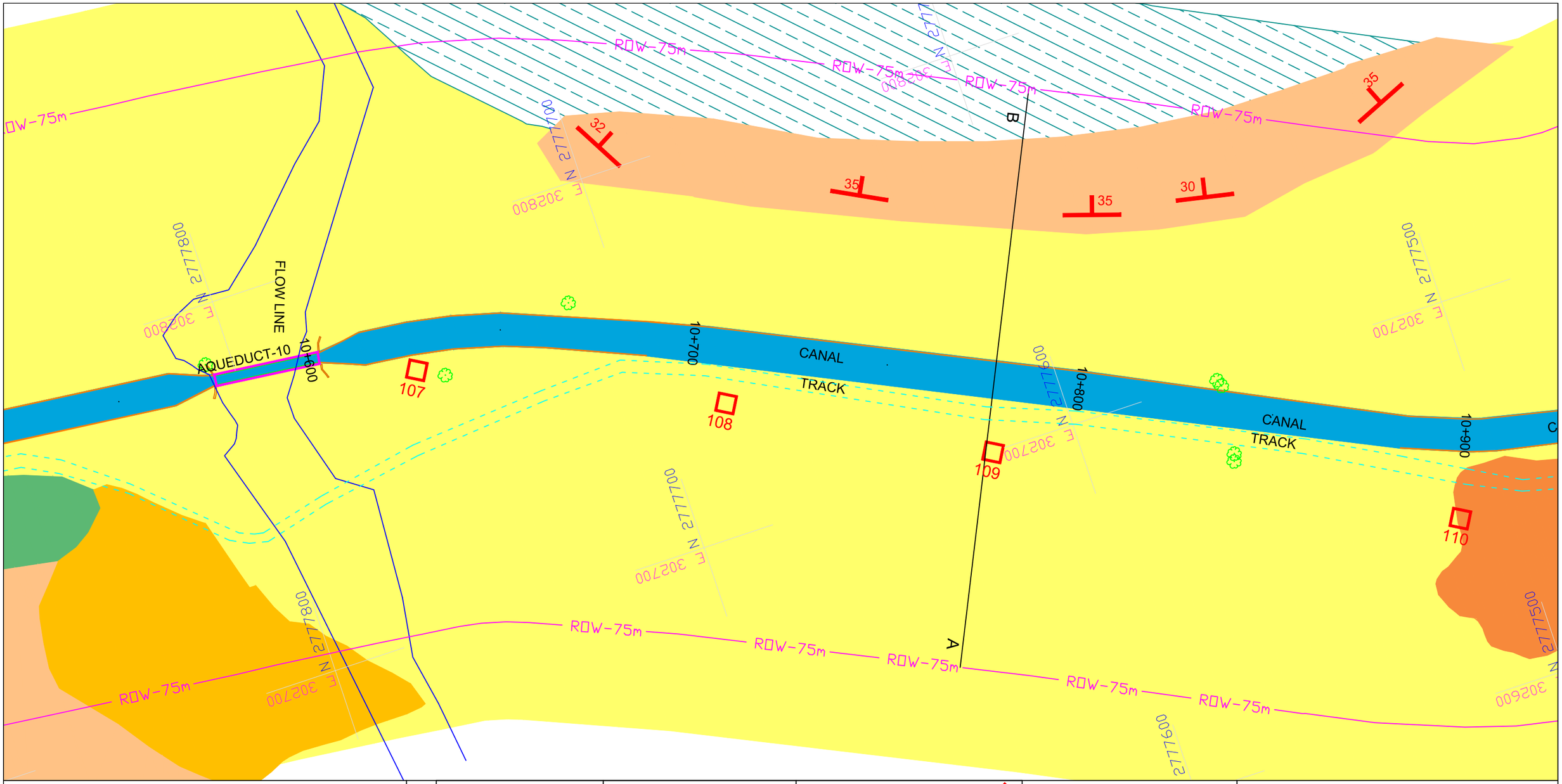
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 28
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			


ROW-75m
ROW-75m
ROW-75m

HUB CANAL PROJECT

MAP TITTLE:-

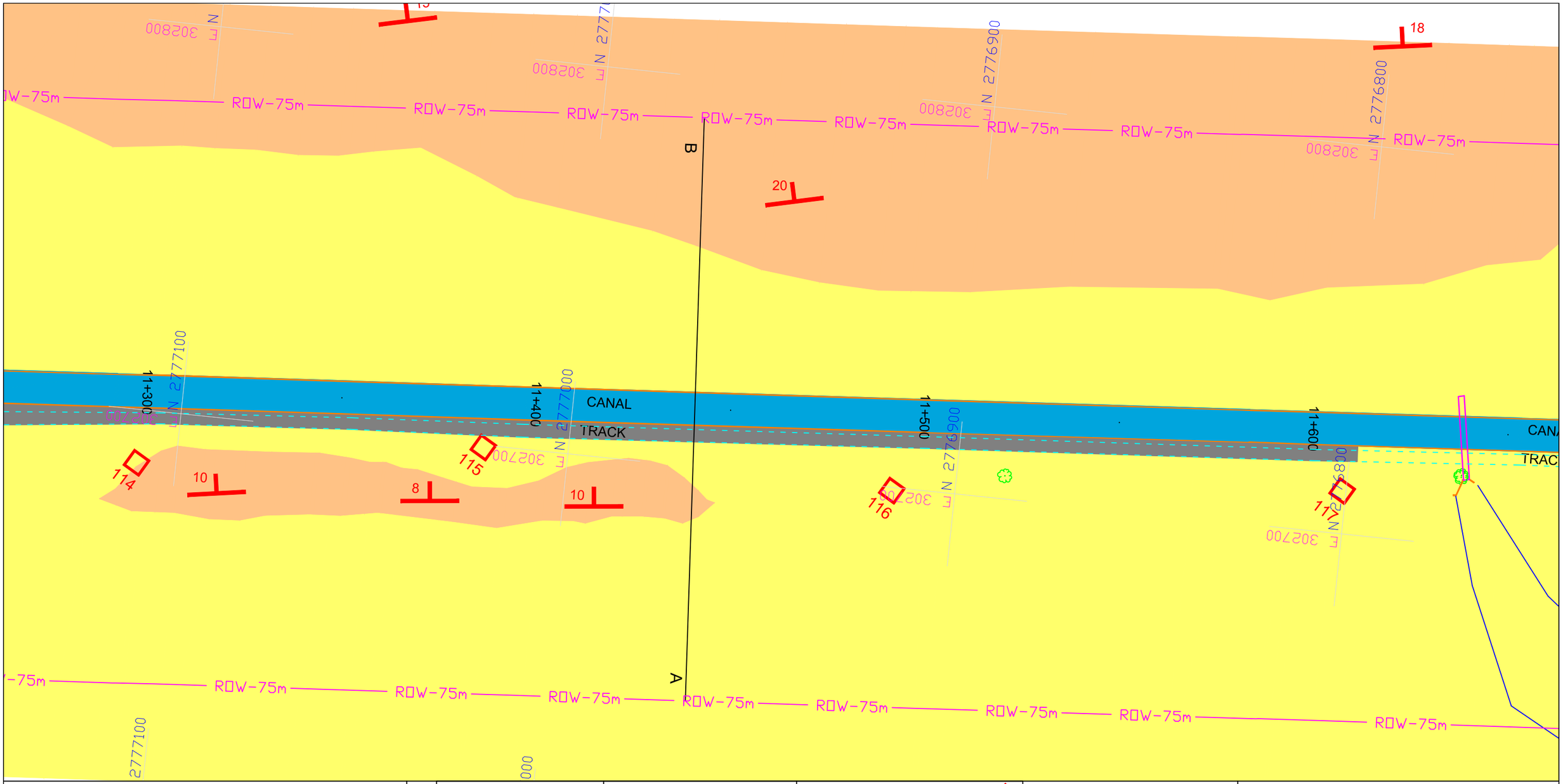
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 30
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

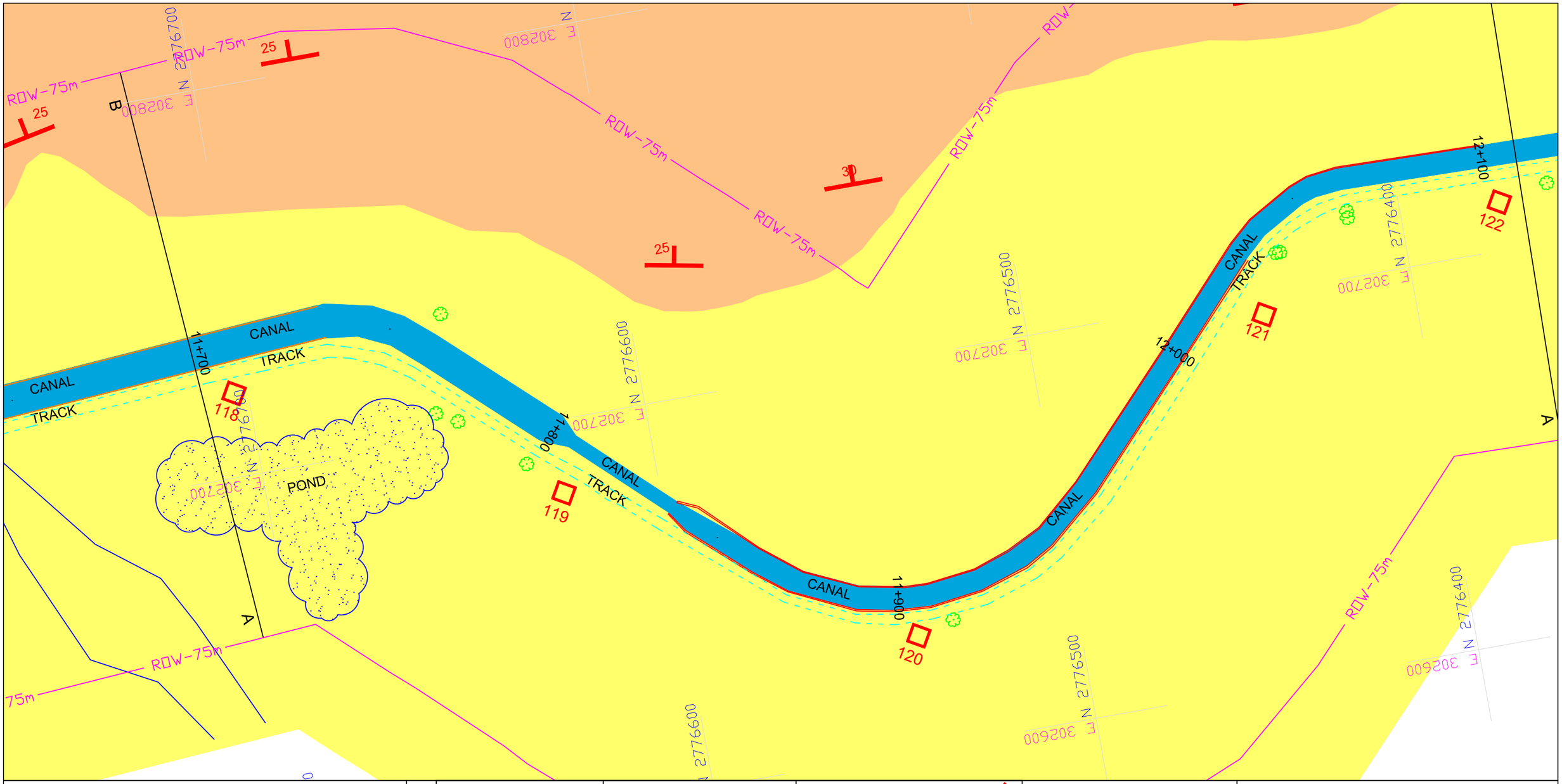
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 31
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 32
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			

HUB CANAL PROJECT

MAP TITTLE:-

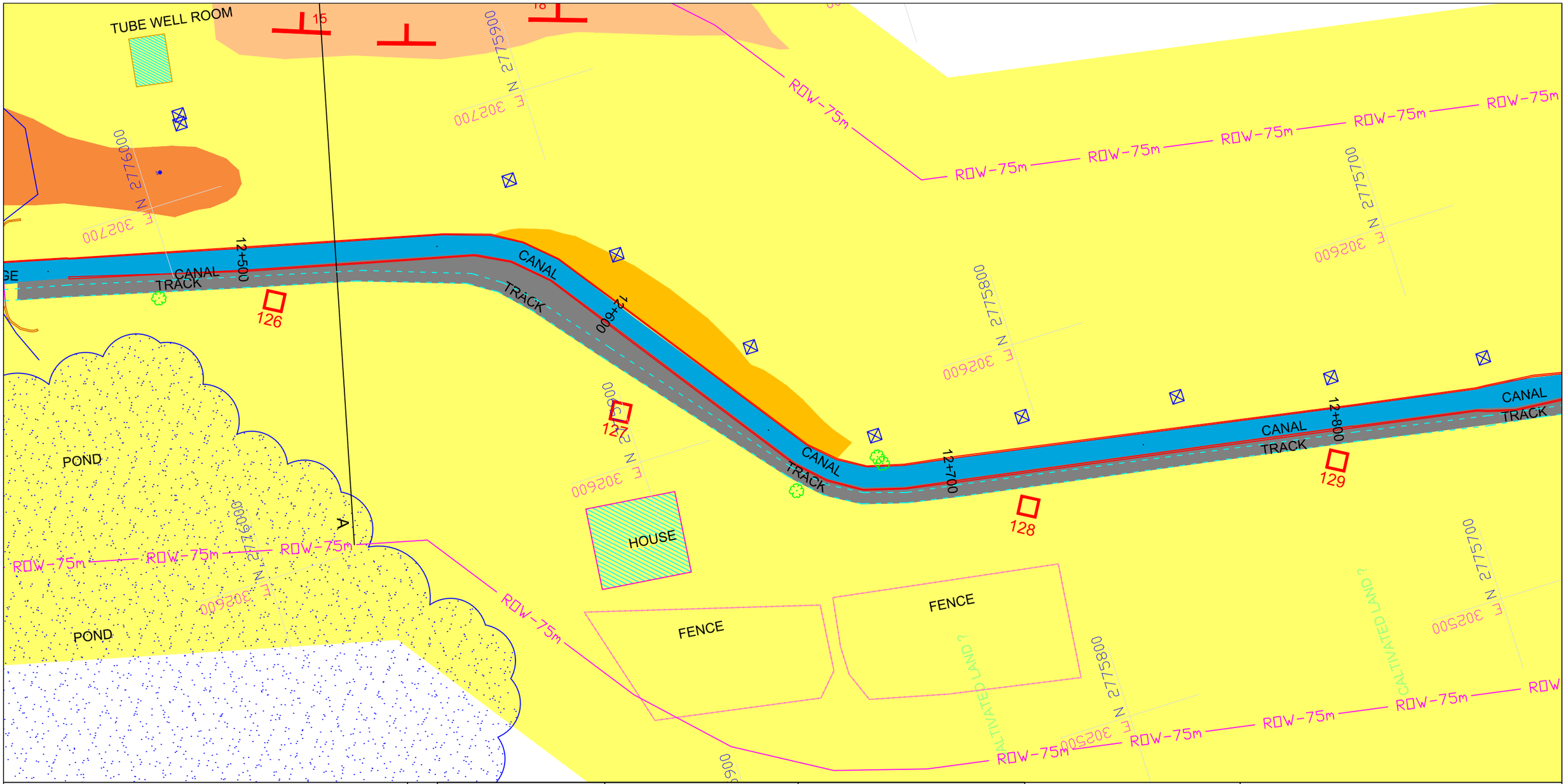
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 33
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

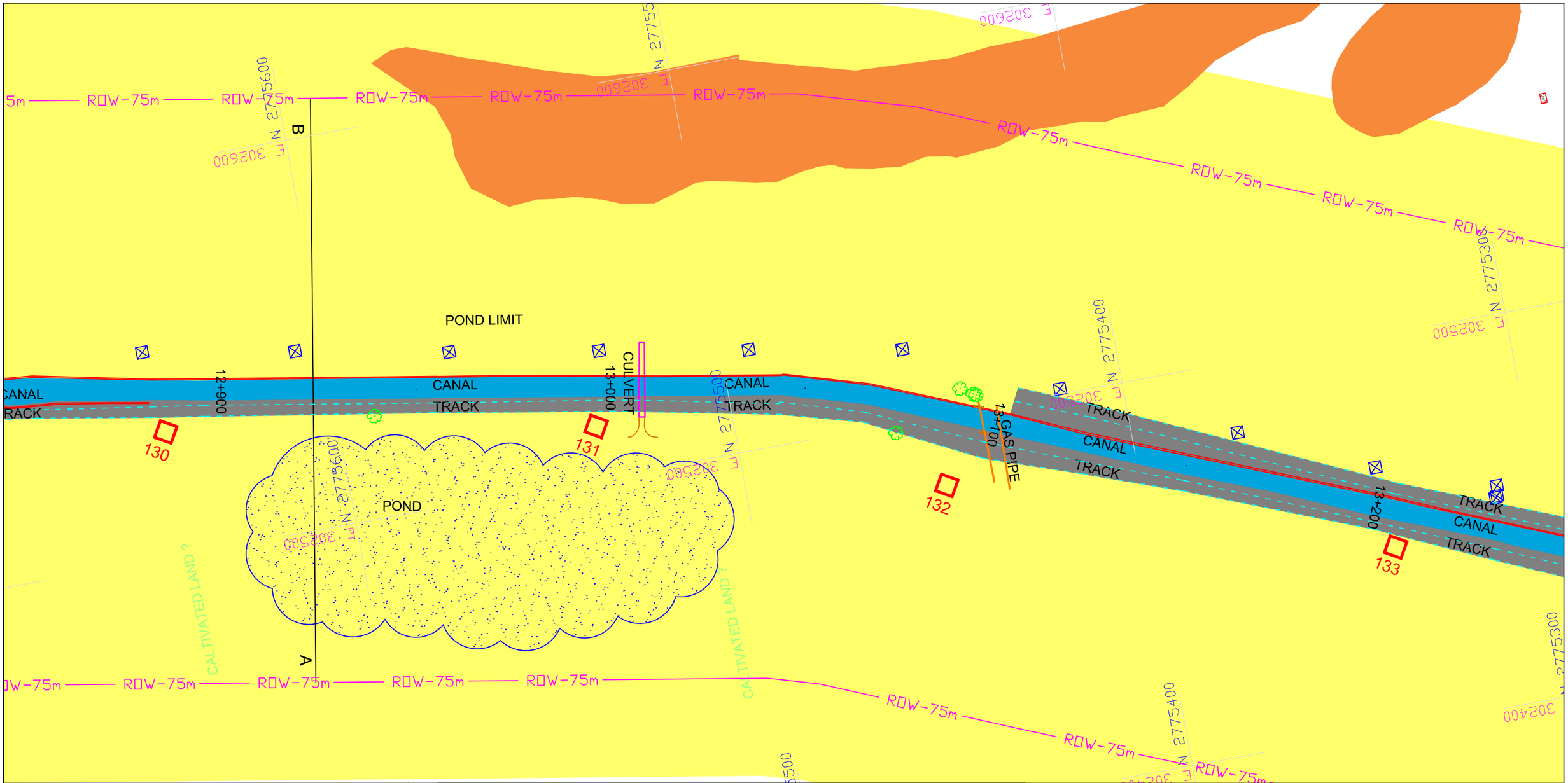
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 34
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

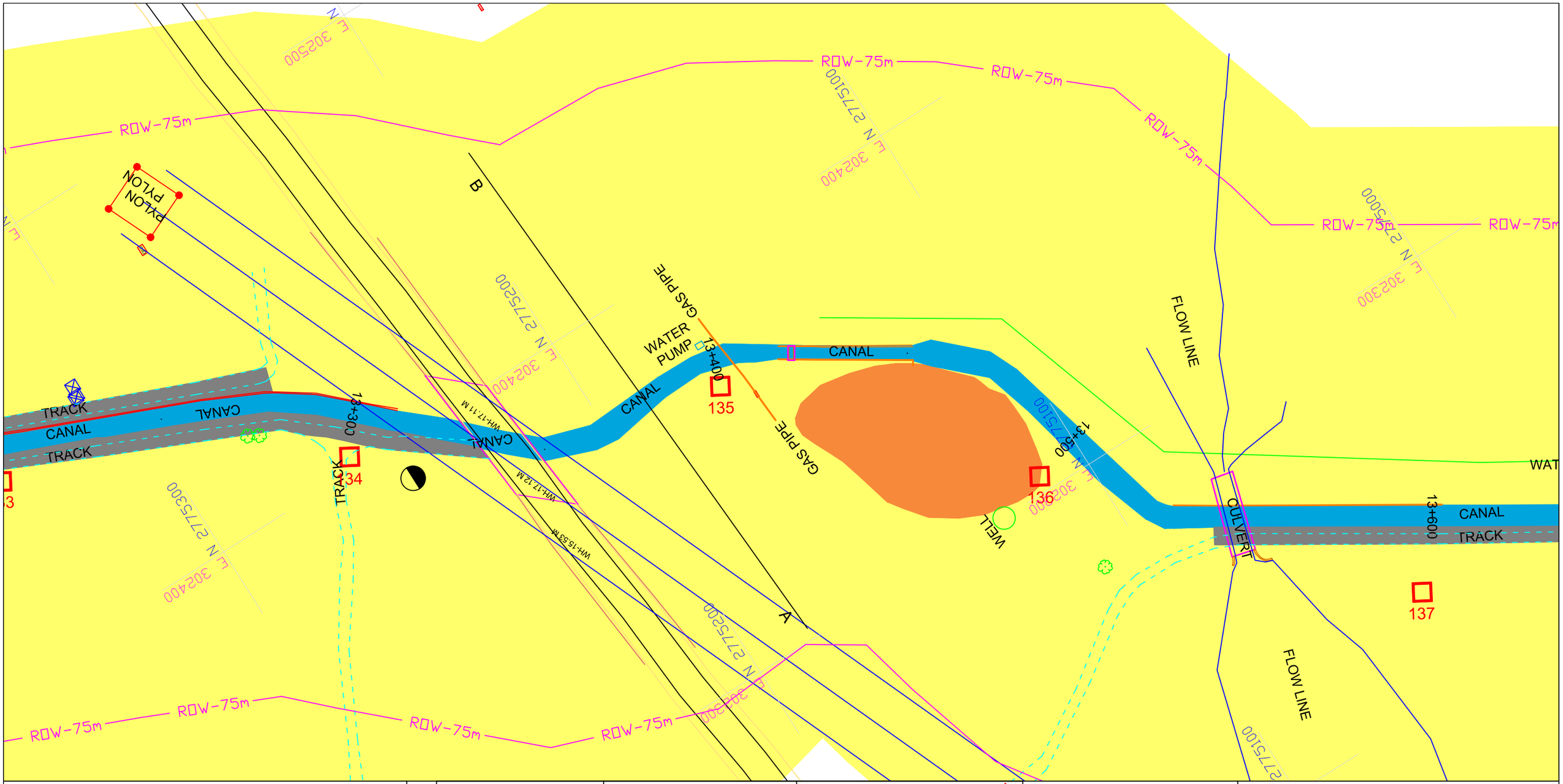
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 35
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 36
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			

HUB CANAL PROJECT

MAP TITTLE:-

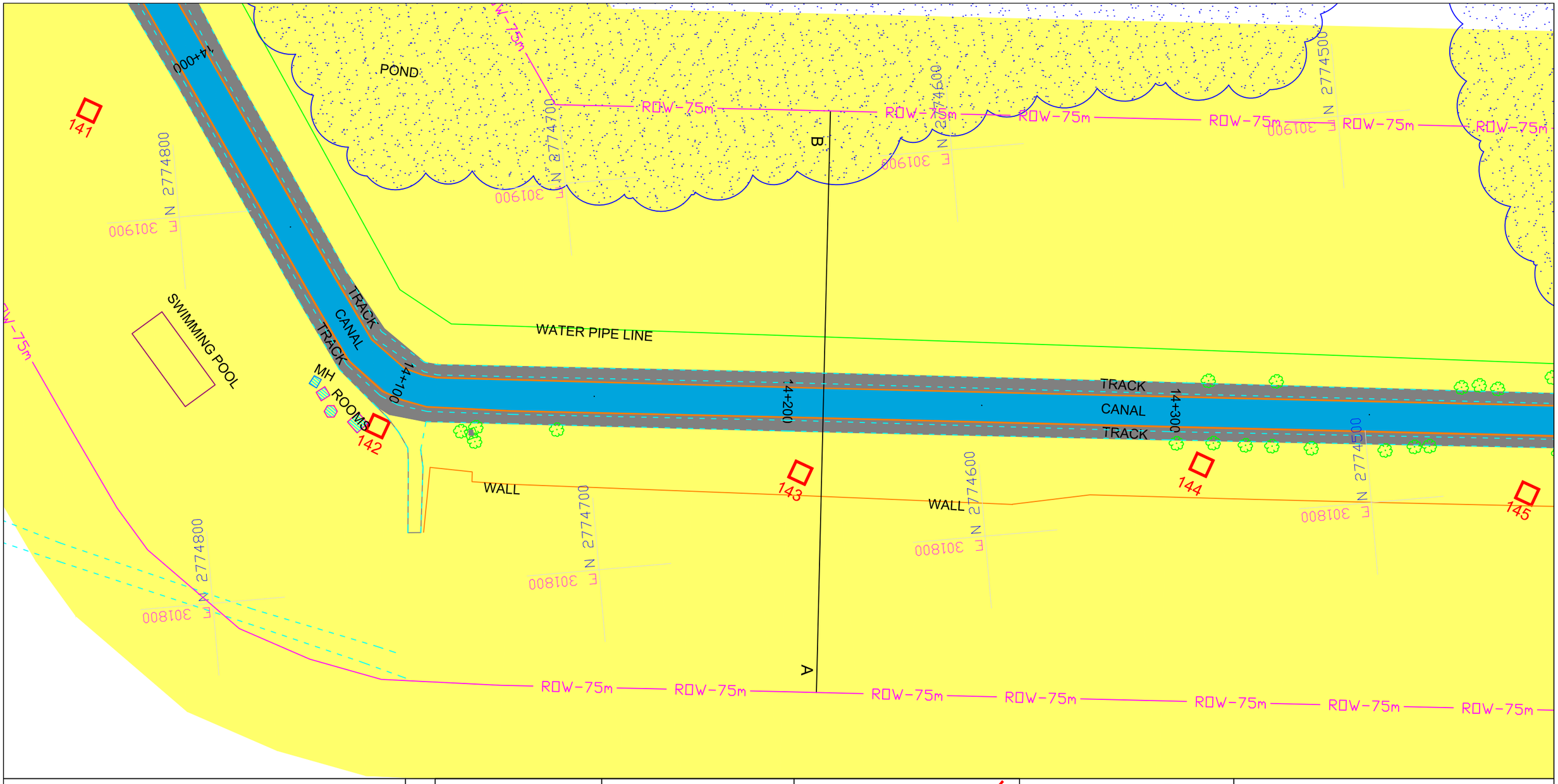
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 37
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

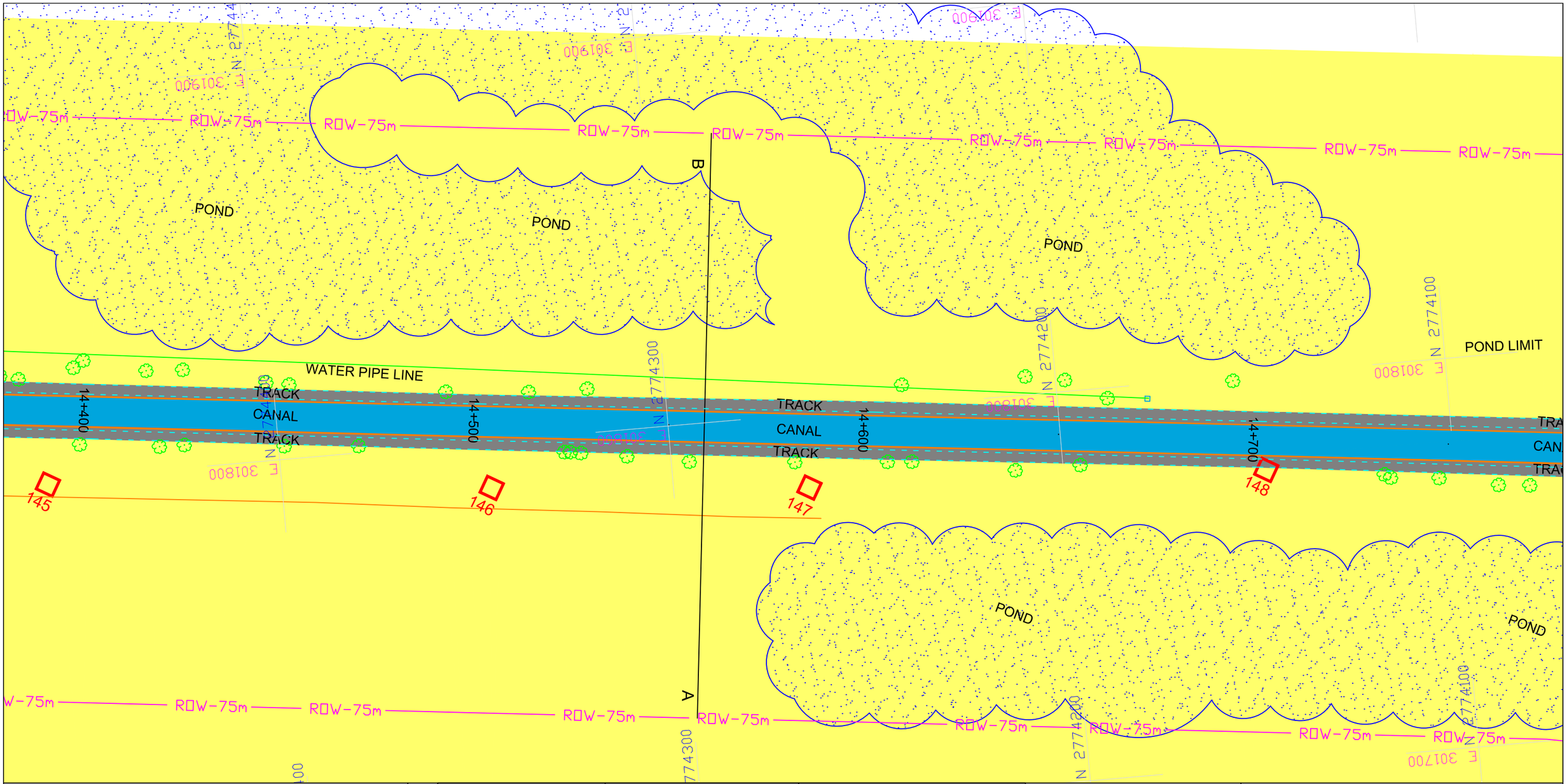
LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 38



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

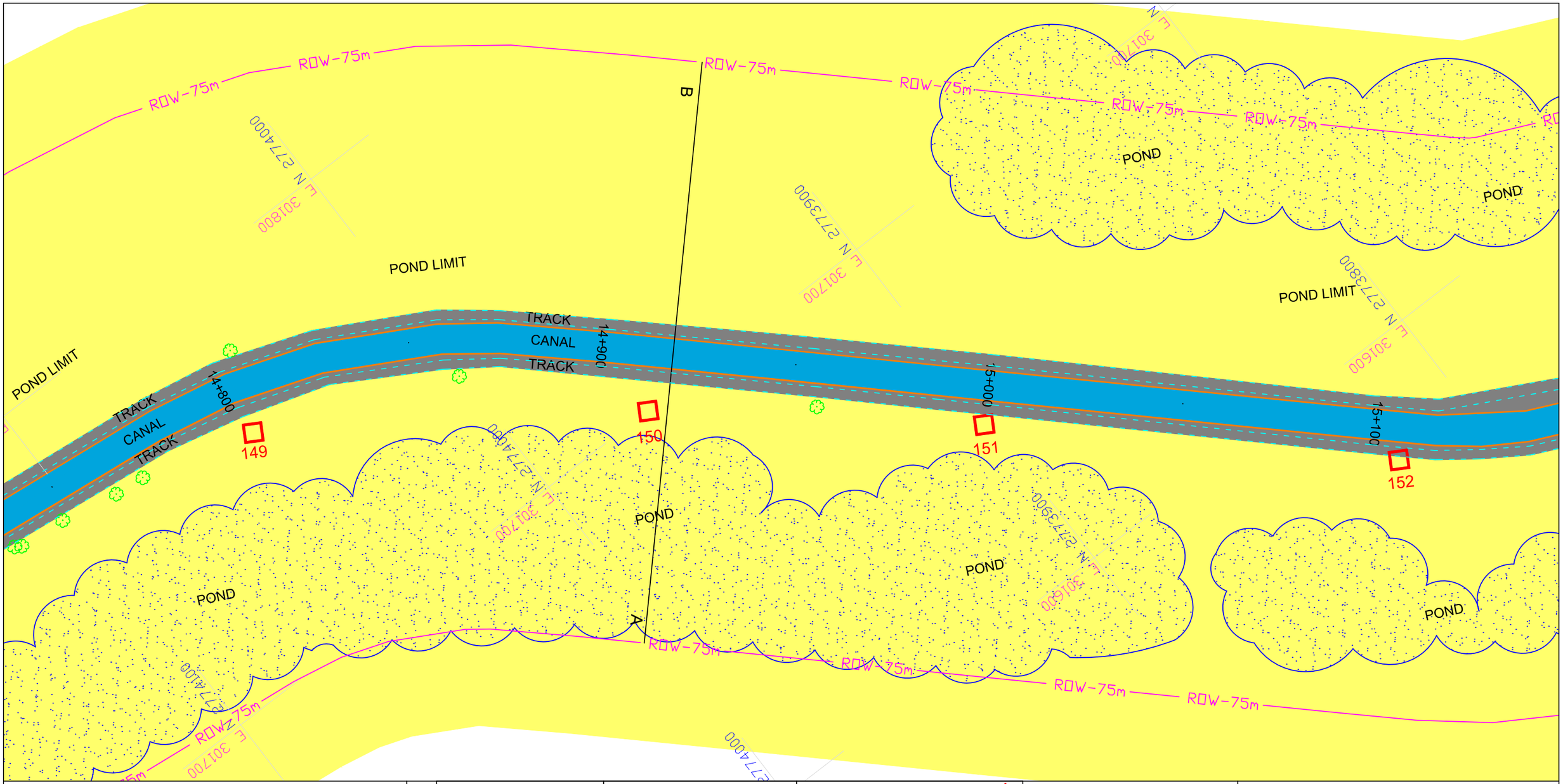
PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

N

SCALE:- 1:1000

SHEET NO:- 39



HUB CANAL PROJECT

MAP TITTLE:-

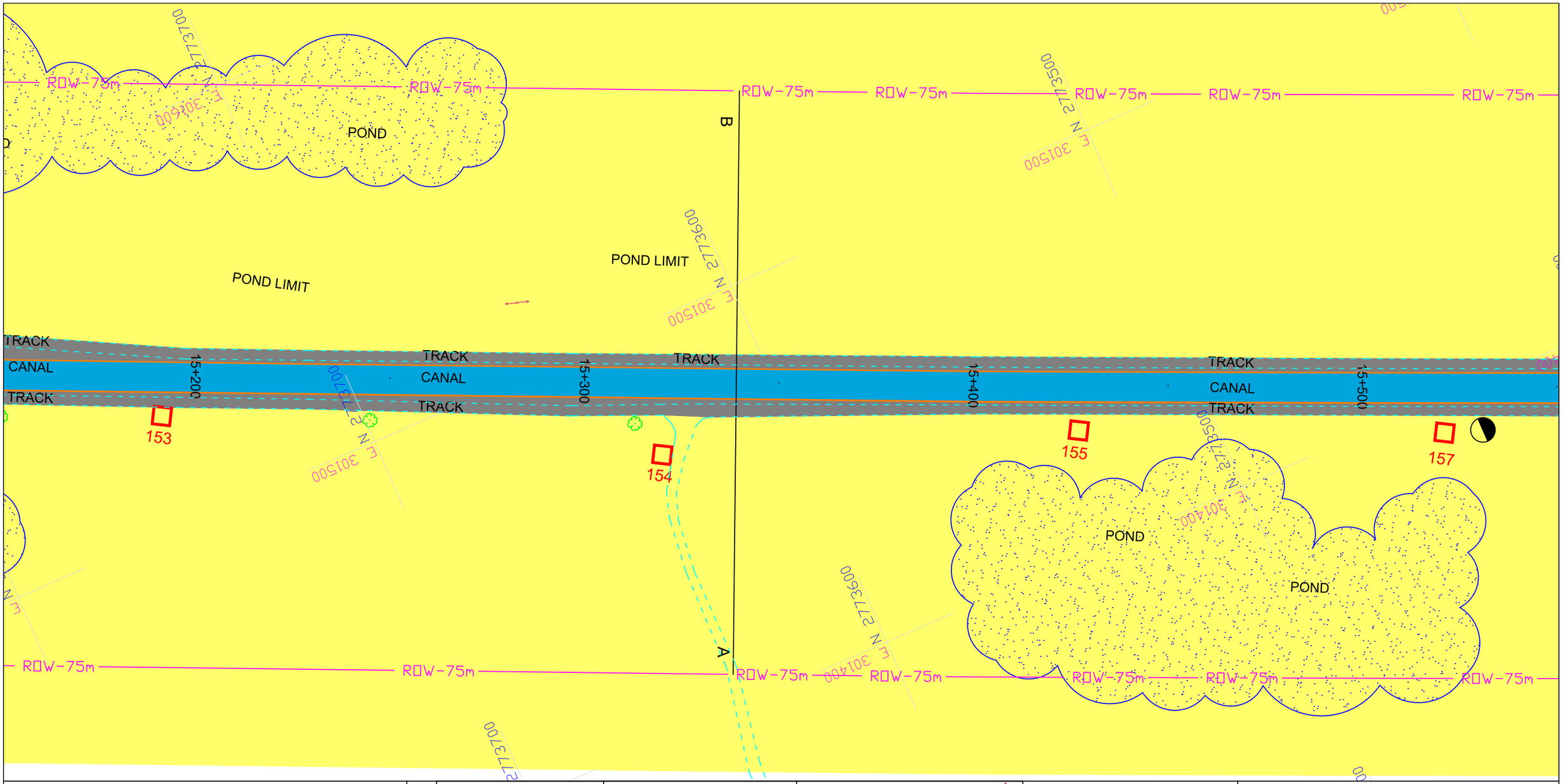
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:-	SHEET NO:-
TRACK	HOUSE/BUILDING	HAND PUMP HP		1:1000	40
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

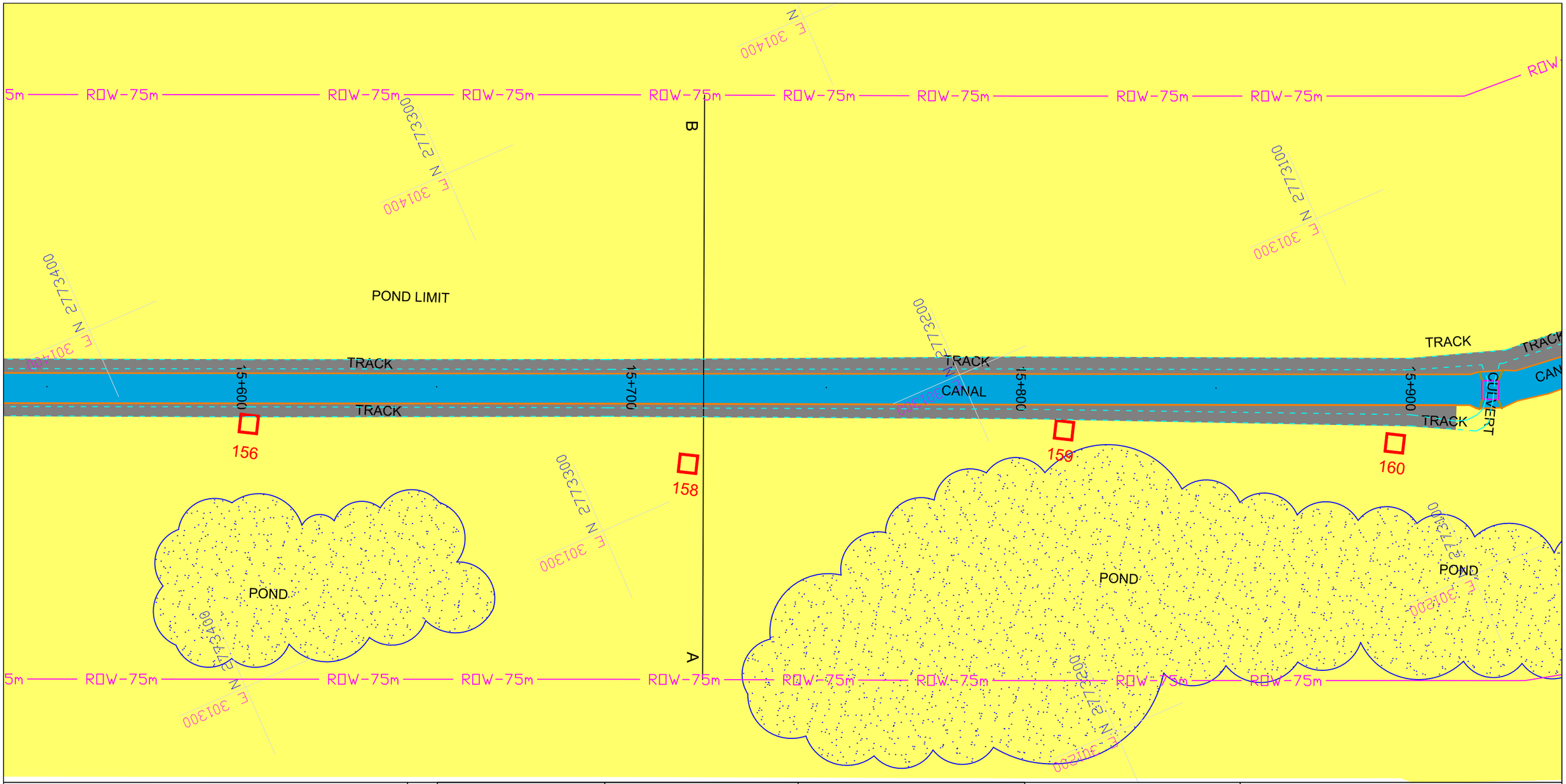
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 41
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

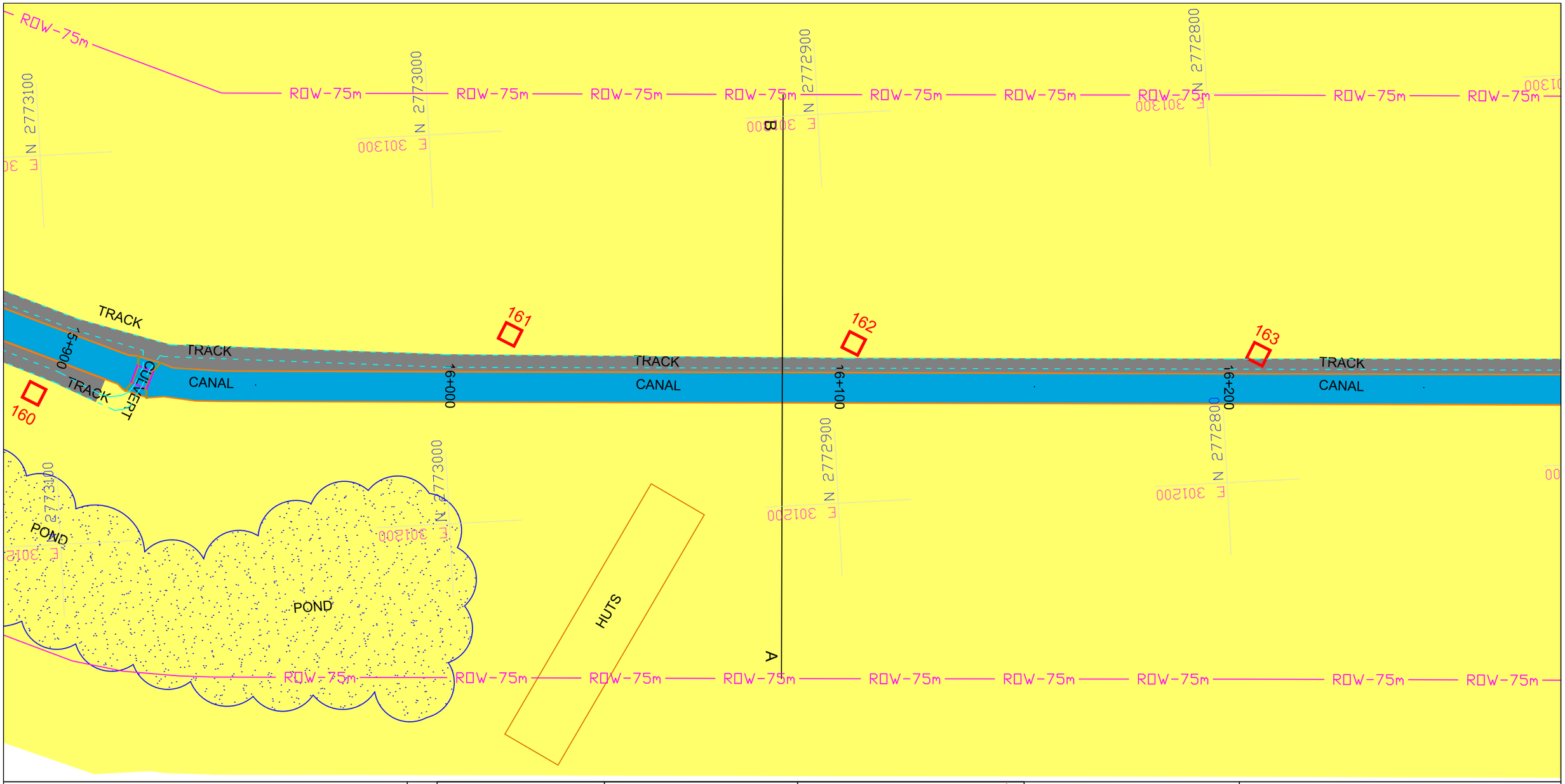
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 42
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 43

ROW-75m
ROW-75m
ROW-75m

HUB CANAL PROJECT

MAP TITTLE:-

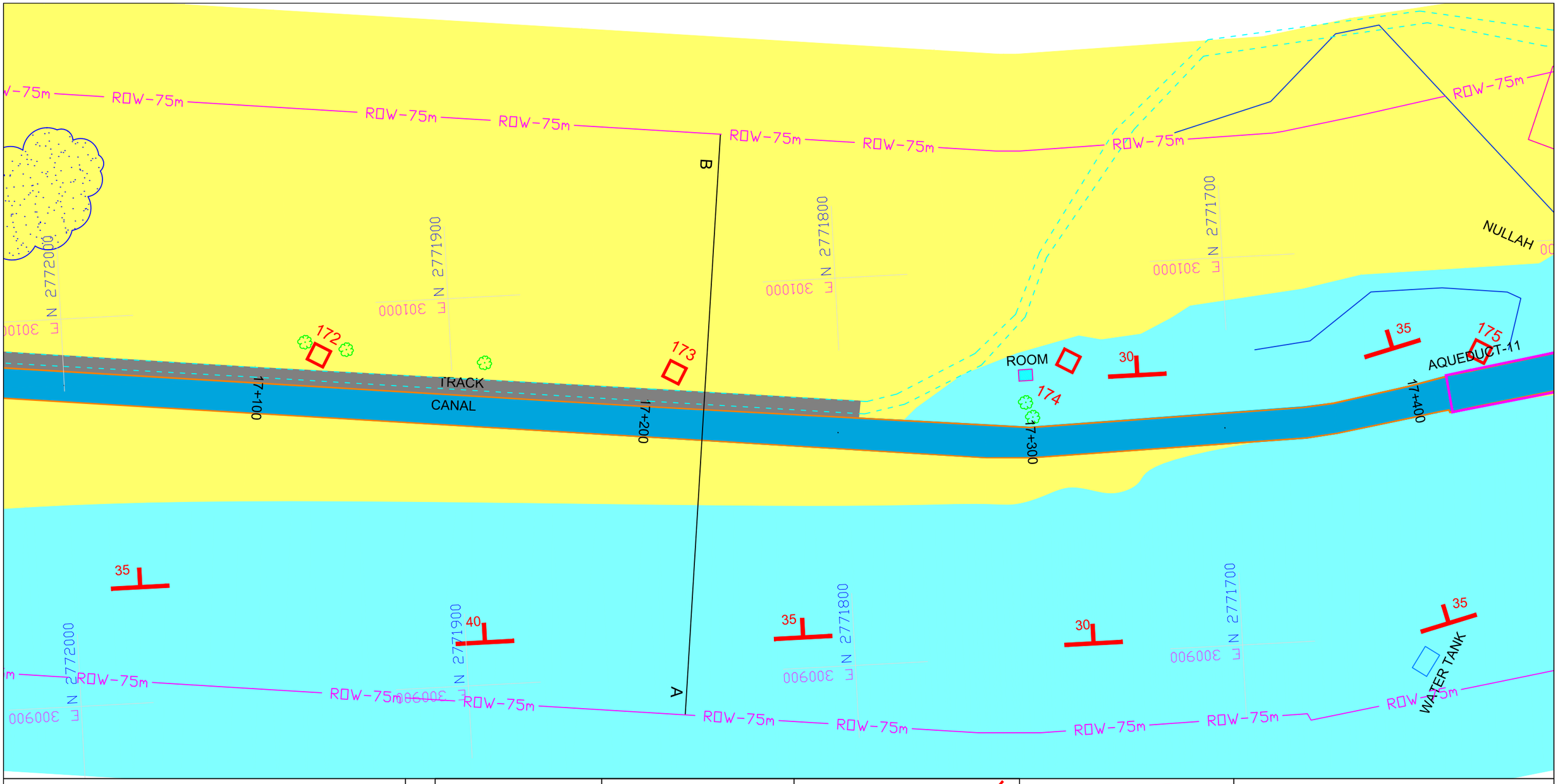
GEOLOGICAL MAPING

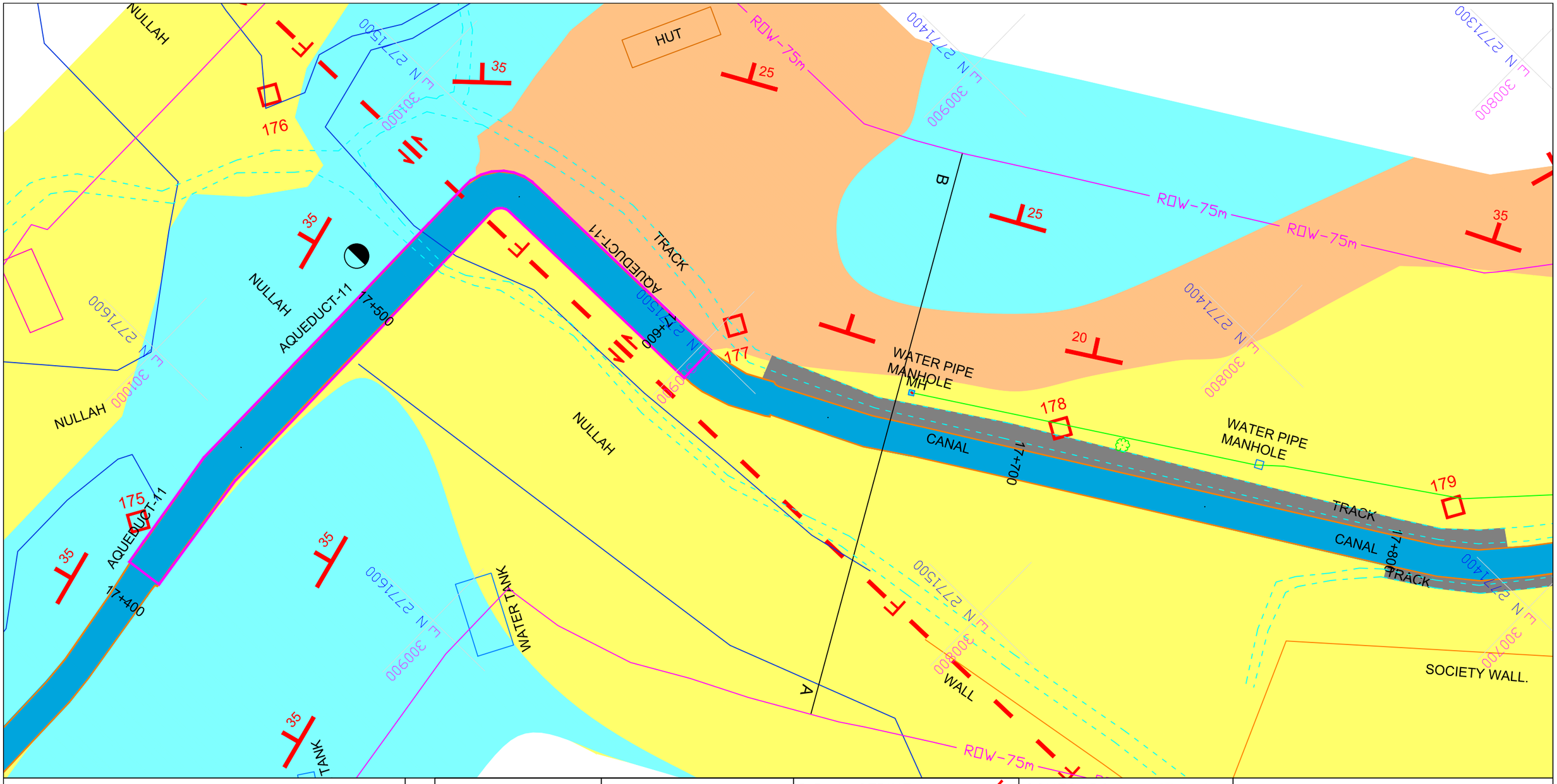
HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 45
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			


ROW-75m
ROW-75m
ROW-75m



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

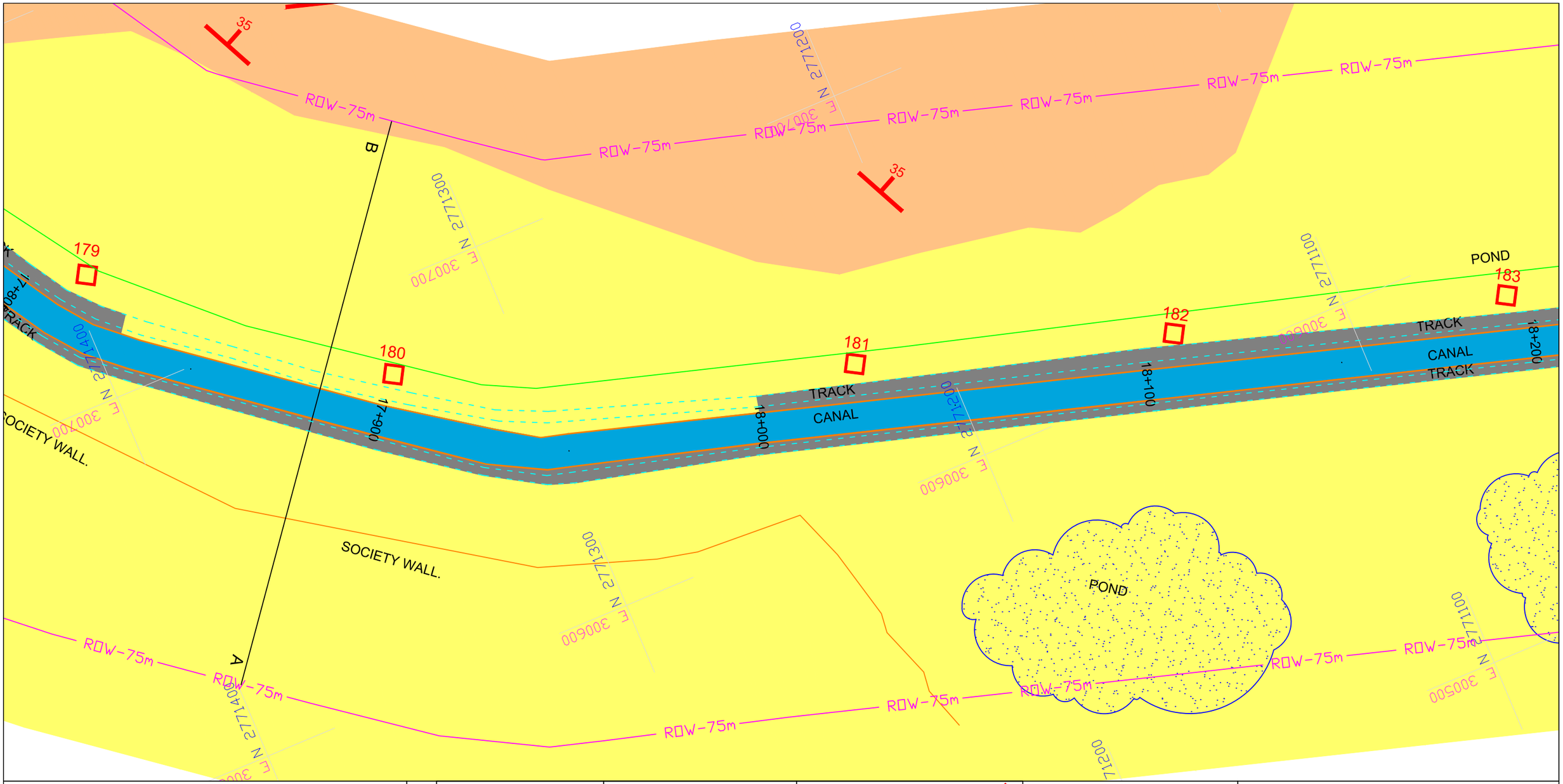
LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
CLAY STONE	LIMESTONE	FAULT	WATER TANK
SHALE	MUD STONE	FAULT INFERRED	FLOW LINE
QAL	OVER BURDEN	UNIDENTIFIED	GAS PIPE
TEST PIT	CANAL	BORE HOLE	
MASJID	CULVERT/BRIDGES	ROAD	
TRACK	HOUSE/BUILDING	HAND PUMP	
POND	ELECTRIC POLE	TELEPHONE POLE	

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 47



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

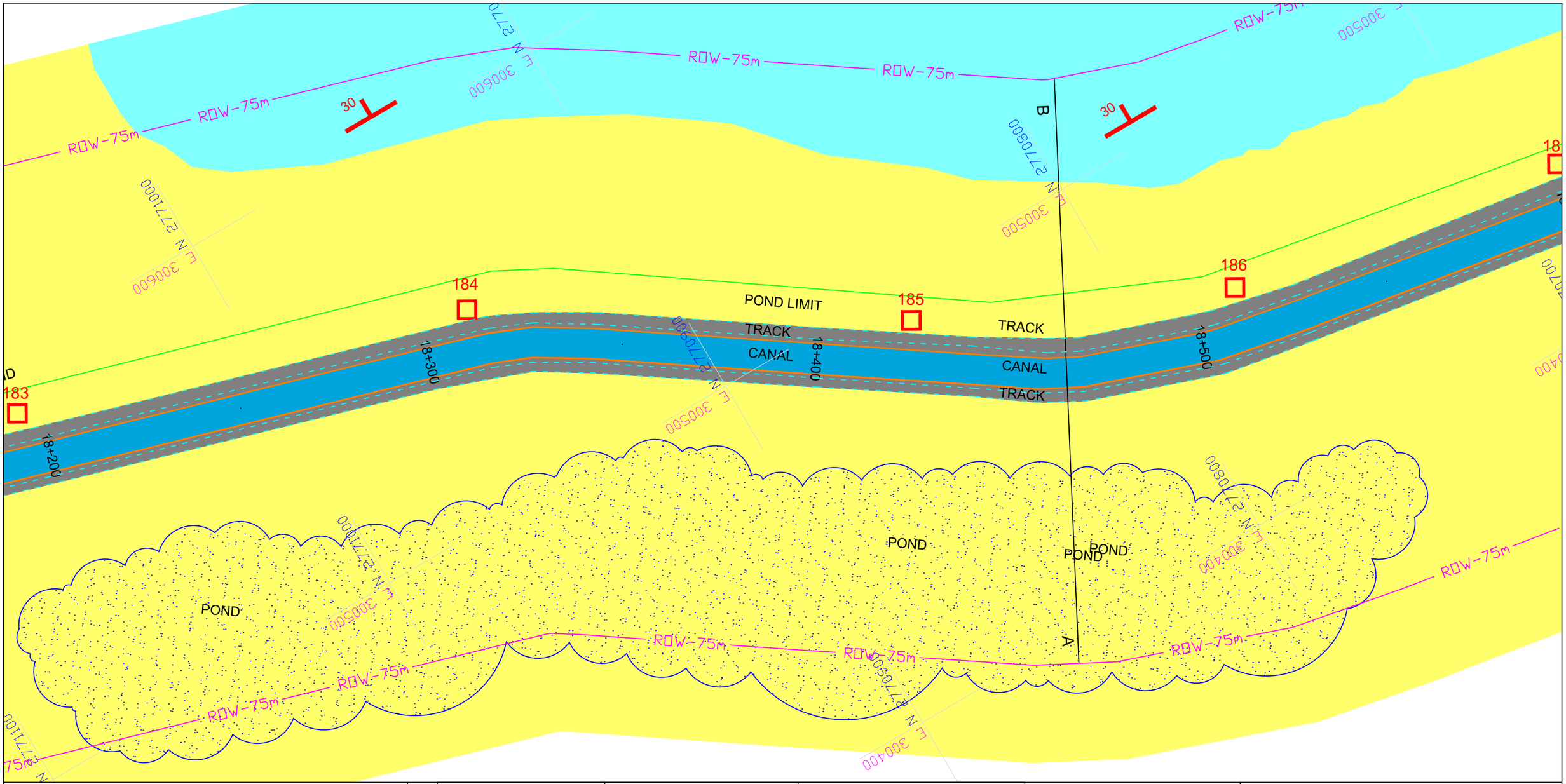
LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 48



HUB CANAL PROJECT

MAP TITTLE:-

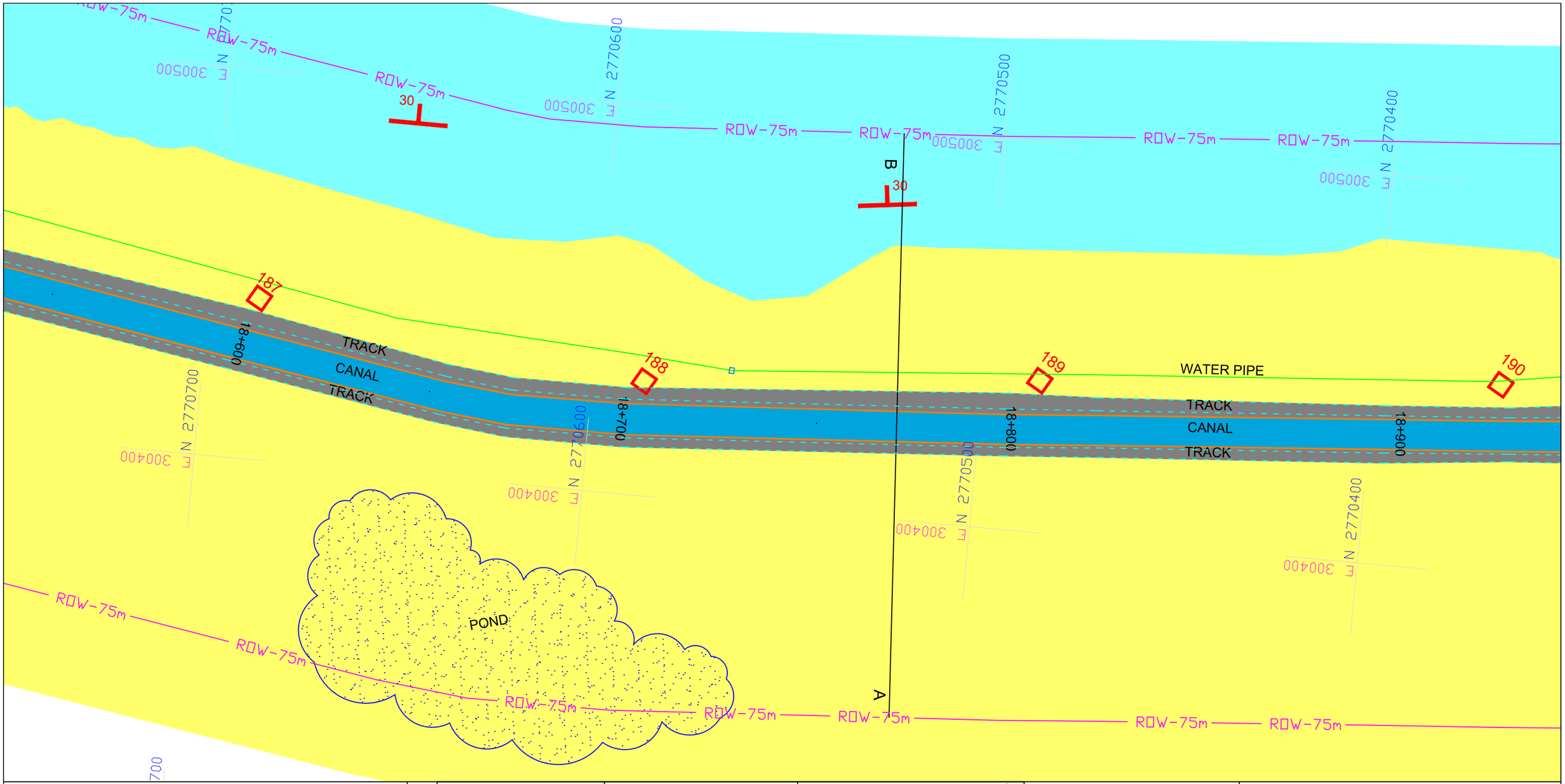
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 49
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

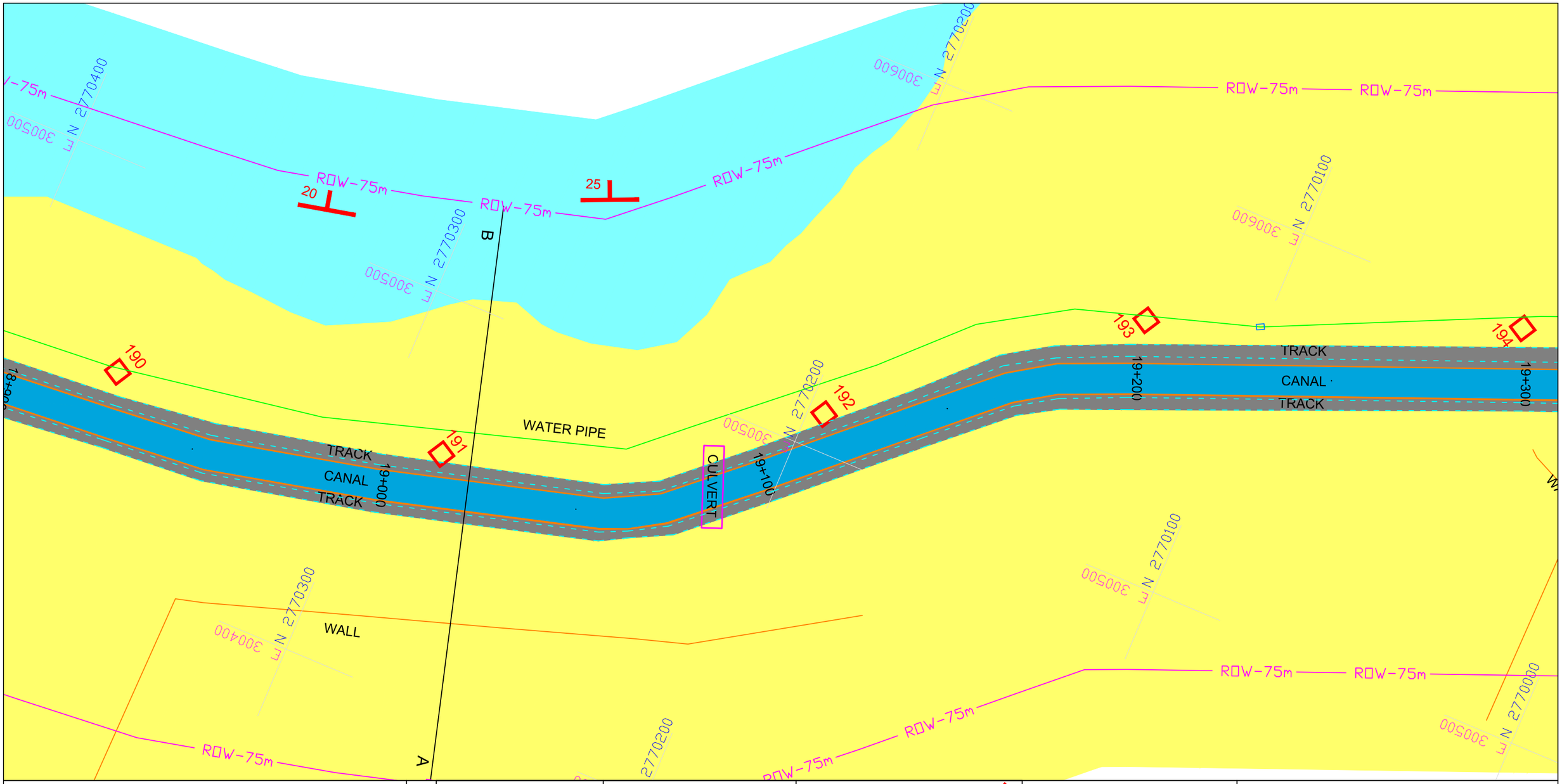
GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT — F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED - - - - F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 50
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			



HUB CANAL PROJECT

MAP TITTLE:-

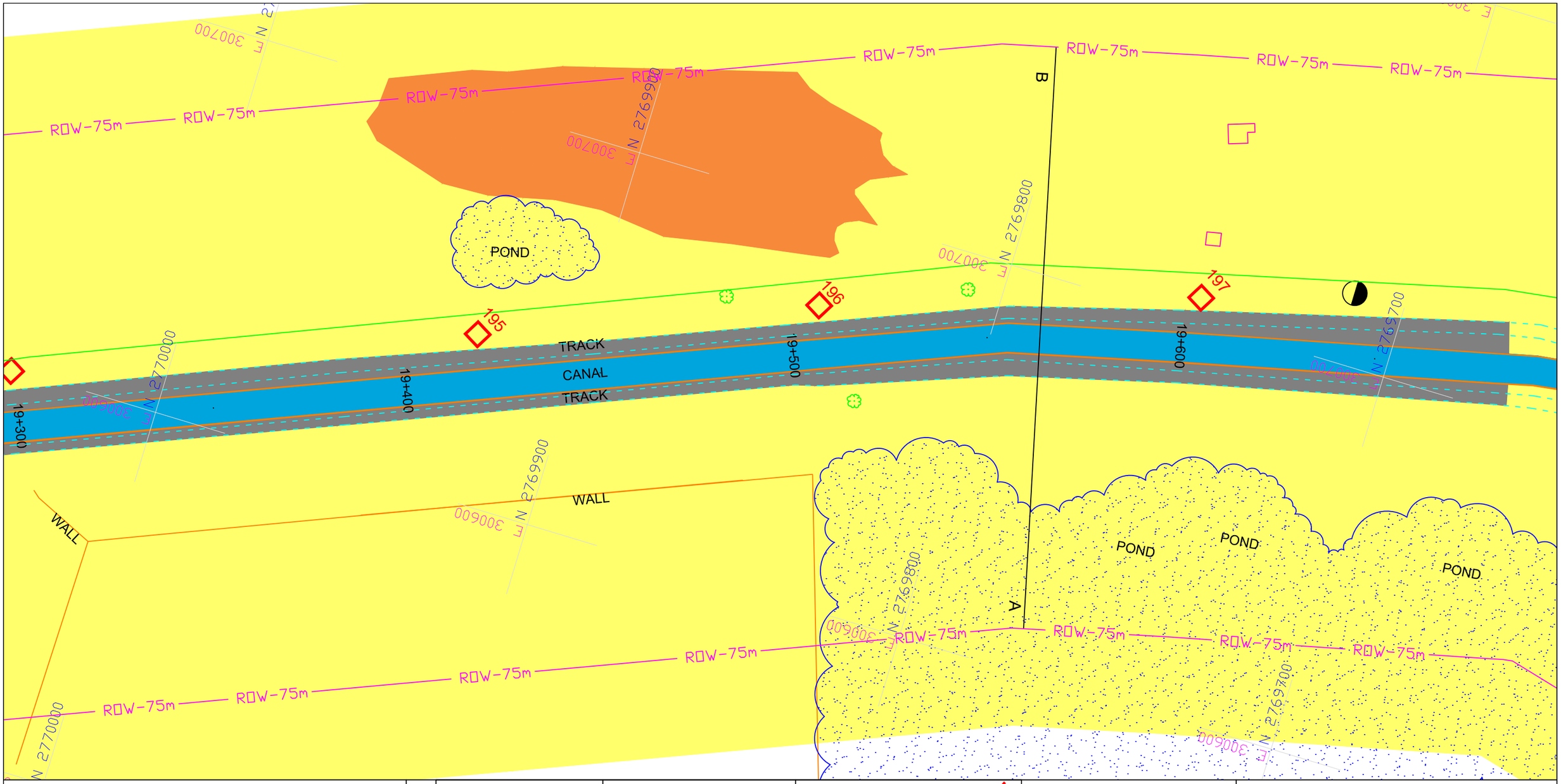
GEOLOGICAL MAPING

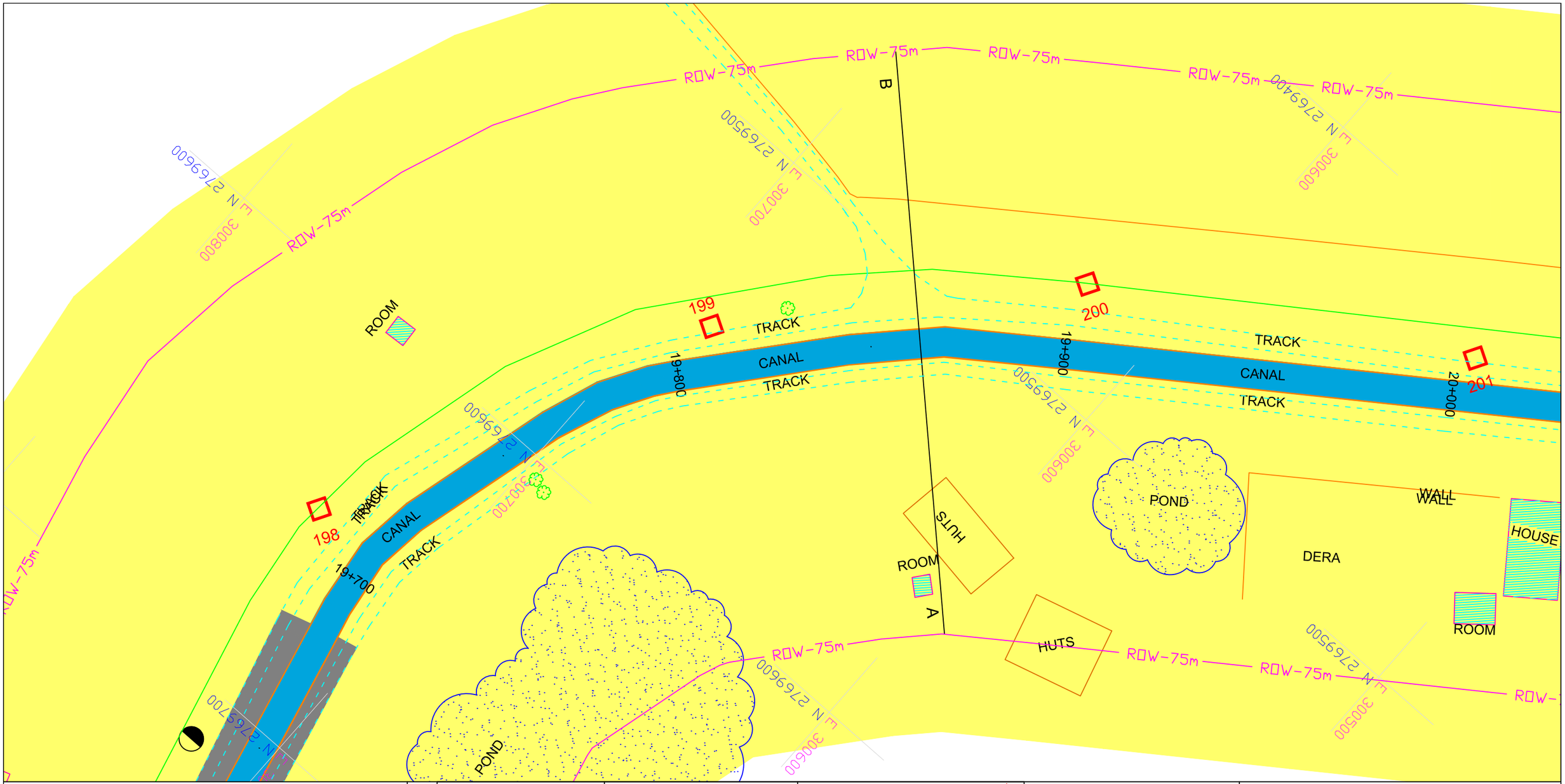
HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 51
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			


ROW-75m
ROW-75m
ROW-75m



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

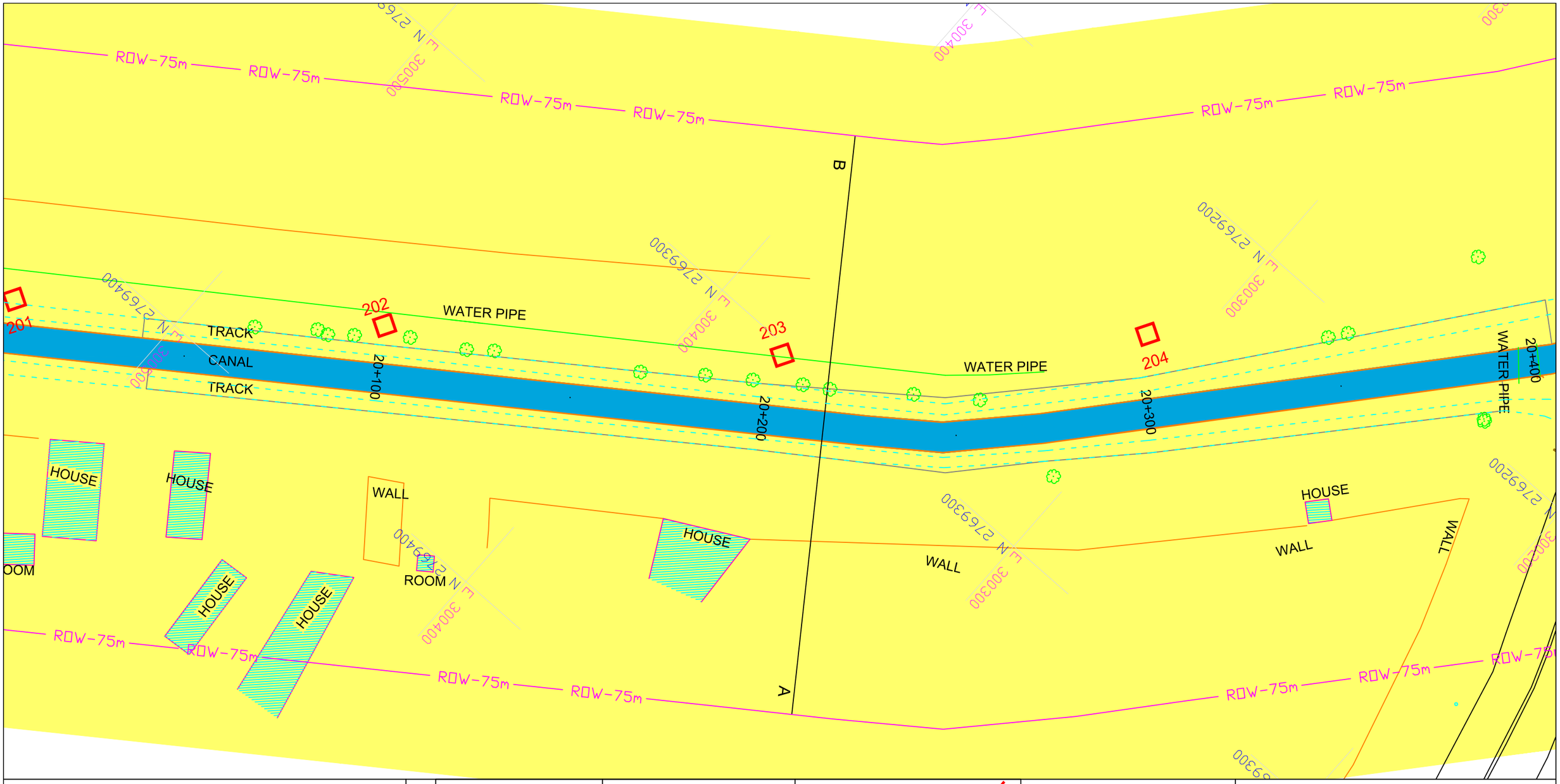
LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

SCALE:- 1:1000

SHEET NO:- 53



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

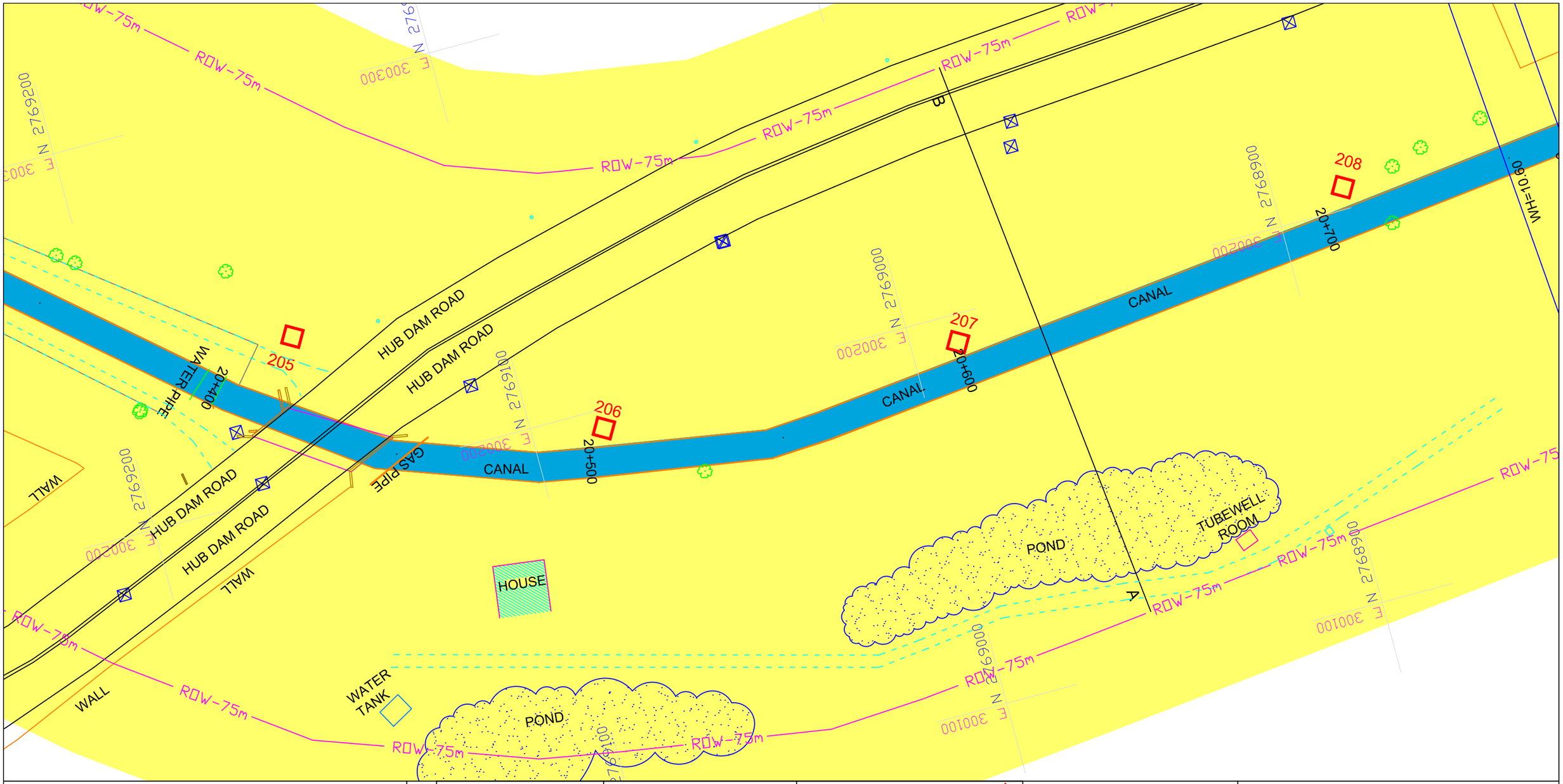
LEGENDS:-

PIEDMONT		CULTIVATED LAND		DIP & STRIKE		CONTOURS	
SAND STONE		GRAVELLY SOIL		HORIZONTAL BEDDING		TREE	
CLAY STONE		LIMESTONE		FAULT	F	WATER TANK	
SHALE		MUD STONE		FAULT INFERRED	F	FLOW LINE	
QAL		OVER BURDEN		UNIDENTIFIED	?	GAS PIPE	
TEST PIT		CANAL		BORE HOLE			
MASJID		CULVERT/BRIDGES		ROAD			
TRACK		HOUSE/BUILDING		HAND PUMP	HP		
POND		ELECTRIC POLE		TELEPHONE POLE	T		

NORTH ARROW:-

SCALE:-
1:1000

SHEET NO:-
54



HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS	NORTH ARROW:-	
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE		
CLAY STONE	LIMESTONE	FAULT F	WATER TANK		
SHALE	MUD STONE	FAULT INFERRED F	FLOW LINE		
QAL	OVER BURDEN	UNIDENTIFIED ?	GAS PIPE		
TEST PIT	CANAL	BORE HOLE			
MASJID	CULVERT/BRIDGES	ROAD		SCALE:- 1:1000	SHEET NO:- 55
TRACK	HOUSE/BUILDING	HAND PUMP HP			
POND	ELECTRIC POLE	TELEPHONE POLE T			

HUB CANAL PROJECT

MAP TITTLE:-

GEOLOGICAL MAPING

HALCROW PAKSITAN

SURVEY TECH (PVT) LTD

LEGENDS:-

PIEDMONT	CULTIVATED LAND	DIP & STRIKE	CONTOURS
SAND STONE	GRAVELLY SOIL	HORIZONTAL BEDDING	TREE
CLAY STONE	LIMESTONE	FAULT	WATER TANK
SHALE	MUD STONE	FAULT INFERRED	FLOW LINE
QAL	OVER BURDEN	UNIDENTIFIED	GAS PIPE
TEST PIT	CANAL	BORE HOLE	
MASJID	CULVERT/BRIDGES	ROAD	
TRACK	HOUSE/BUILDING	HAND PUMP	
POND	ELECTRIC POLE	TELEPHONE POLE	

NORTH ARROW:-

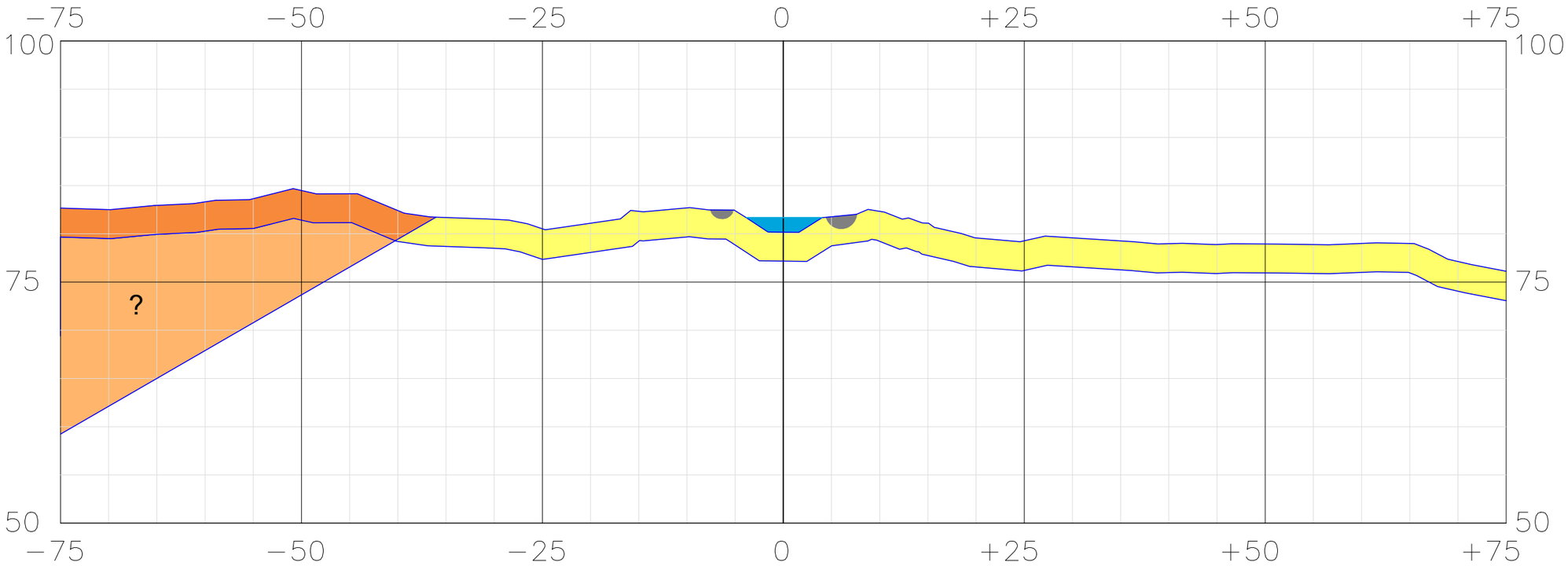
SCALE:- 1:1000

SHEET NO:- 56

ANNEXURE-B

GEOLOGICAL CROSS SECTIONS

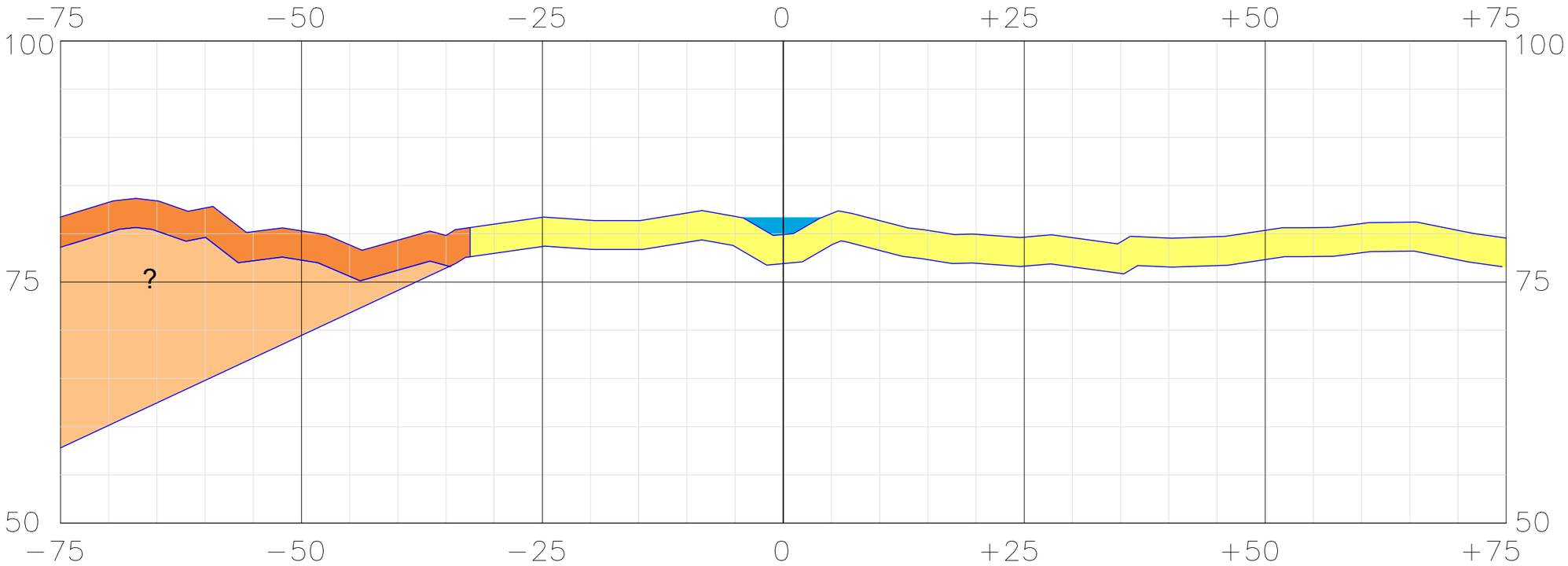
GEOLOGICAL SECTION 0+180



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		01
		DIP & STRIKE	FAULT INFERRED F		

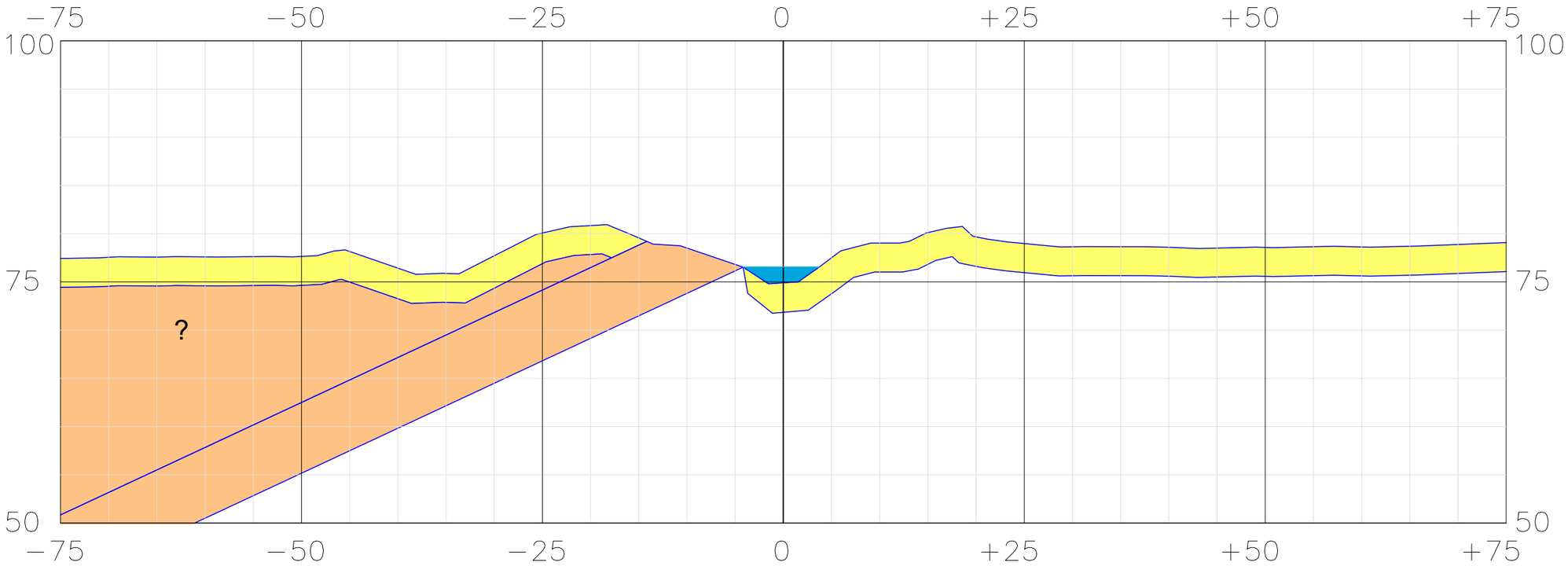
GEOLOGICAL SECTION 0+450



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		02
		DIP & STRIKE	FAULT INFERRED F		

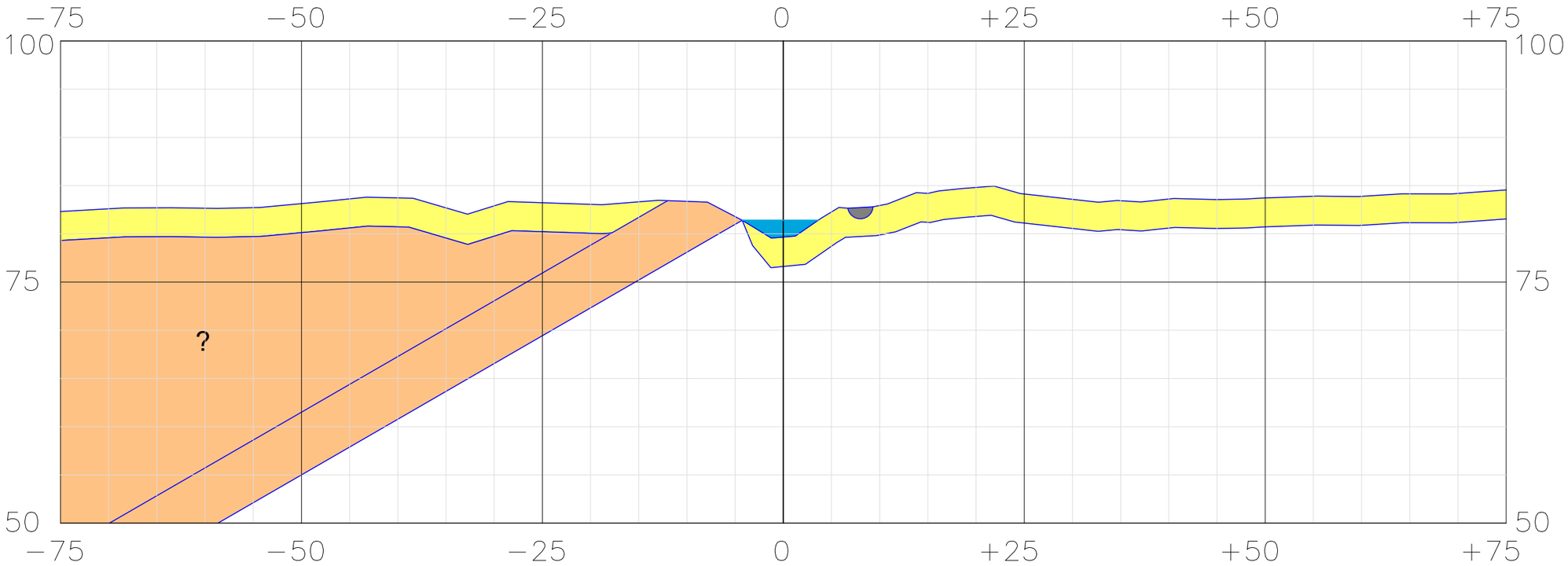
GEOLOGICAL SECTION 1+060



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 03
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

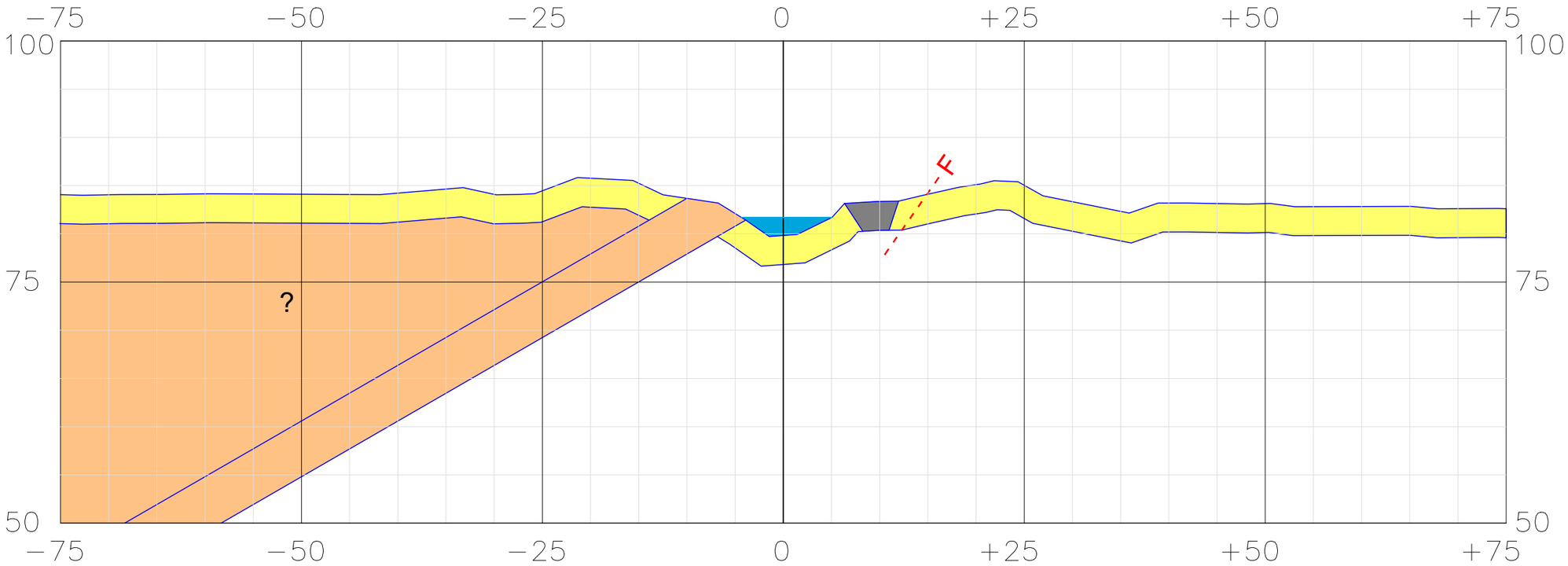
GEOLOGICAL SECTION 1+160



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		04
		DIP & STRIKE	FAULT INFERRED F		

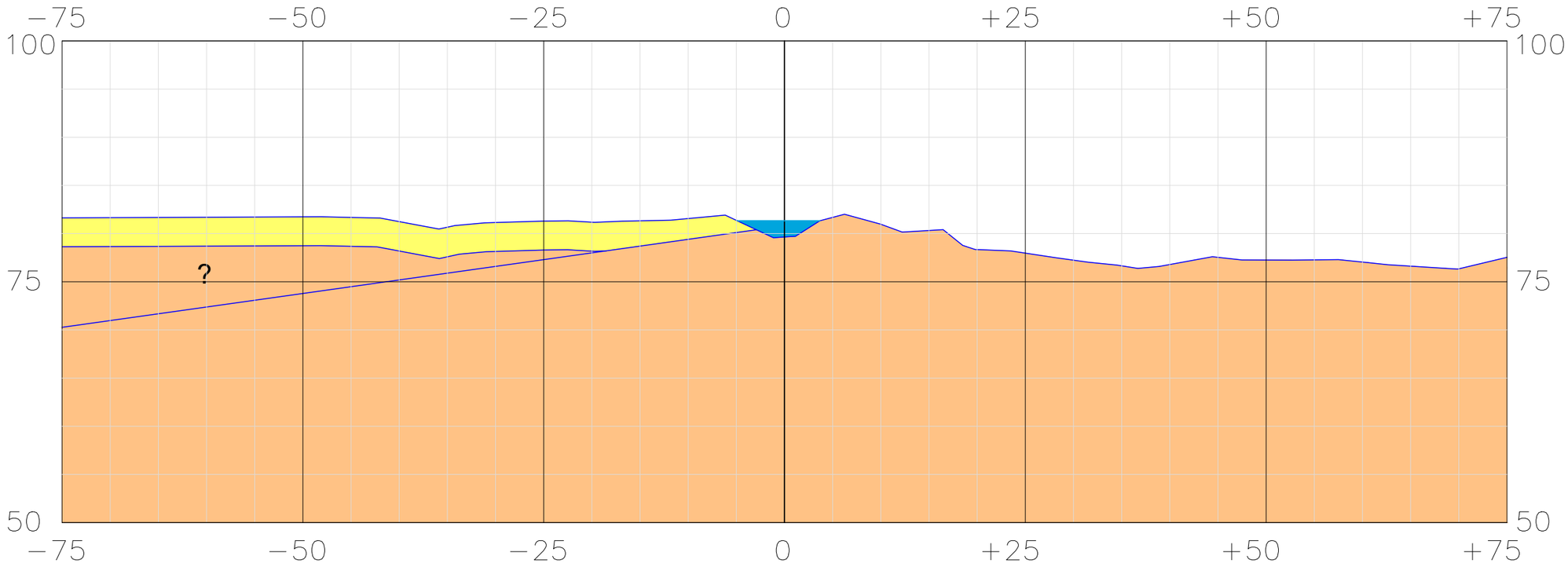
GEOLOGICAL SECTION 1+710



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		05
		DIP & STRIKE	FAULT INFERRED F		

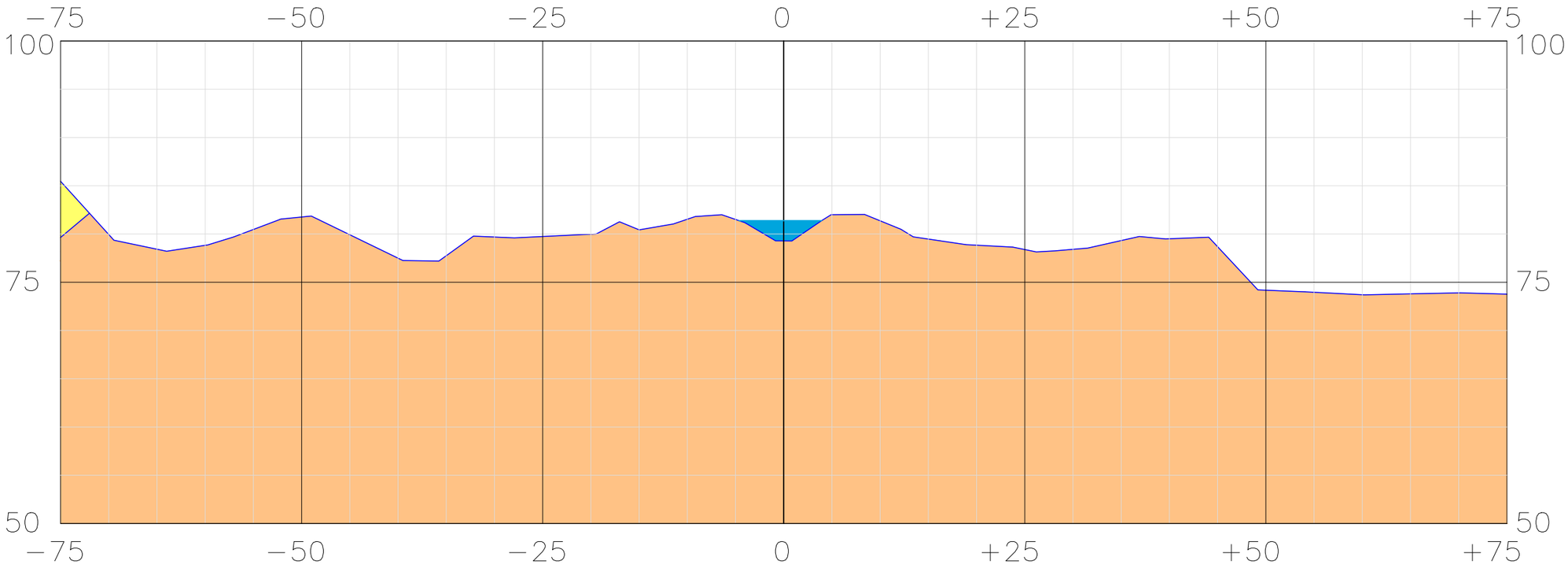
GEOLOGICAL SECTION 1+160



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 06
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

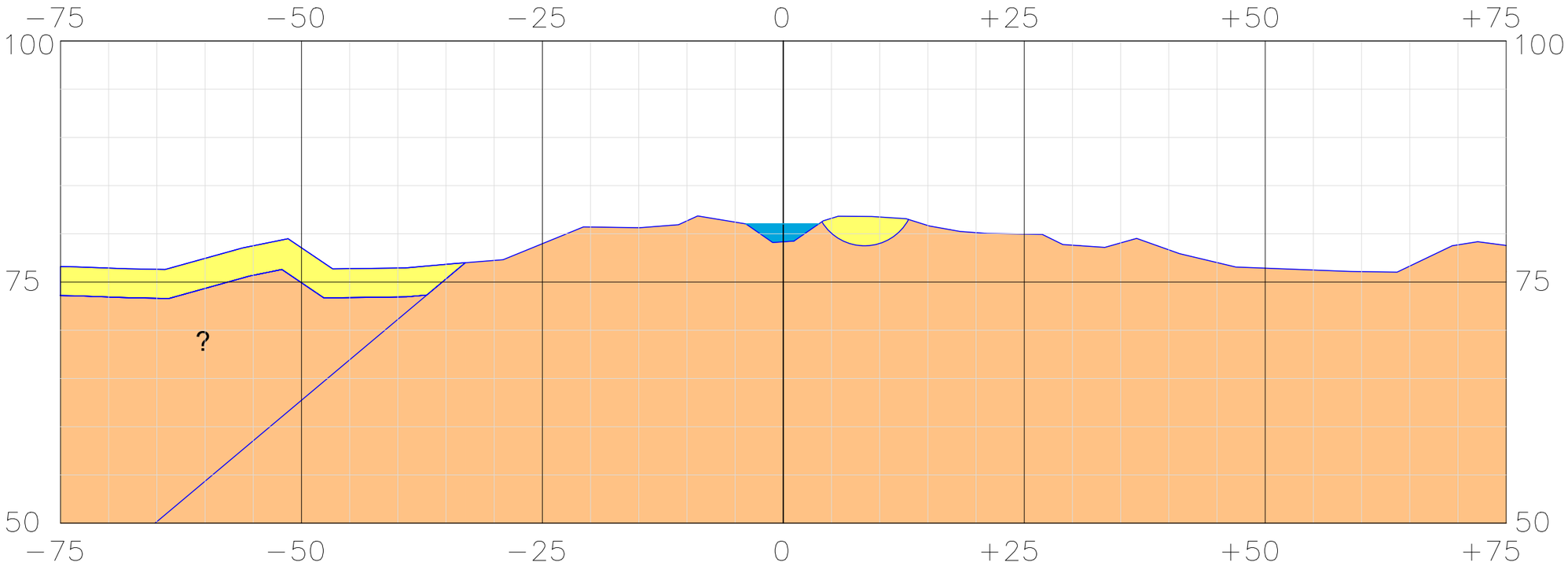
GEOLOGICAL SECTION 2+540



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 07
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

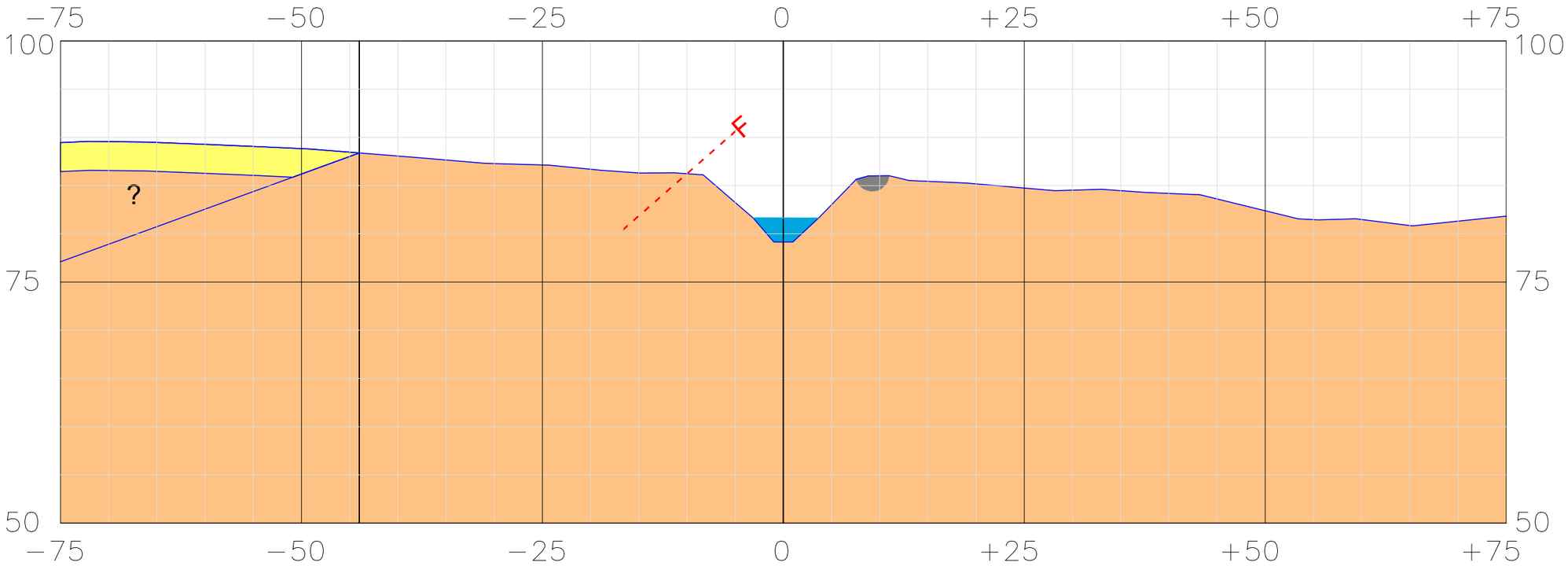
GEOLOGICAL SECTION 2+910



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 08
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

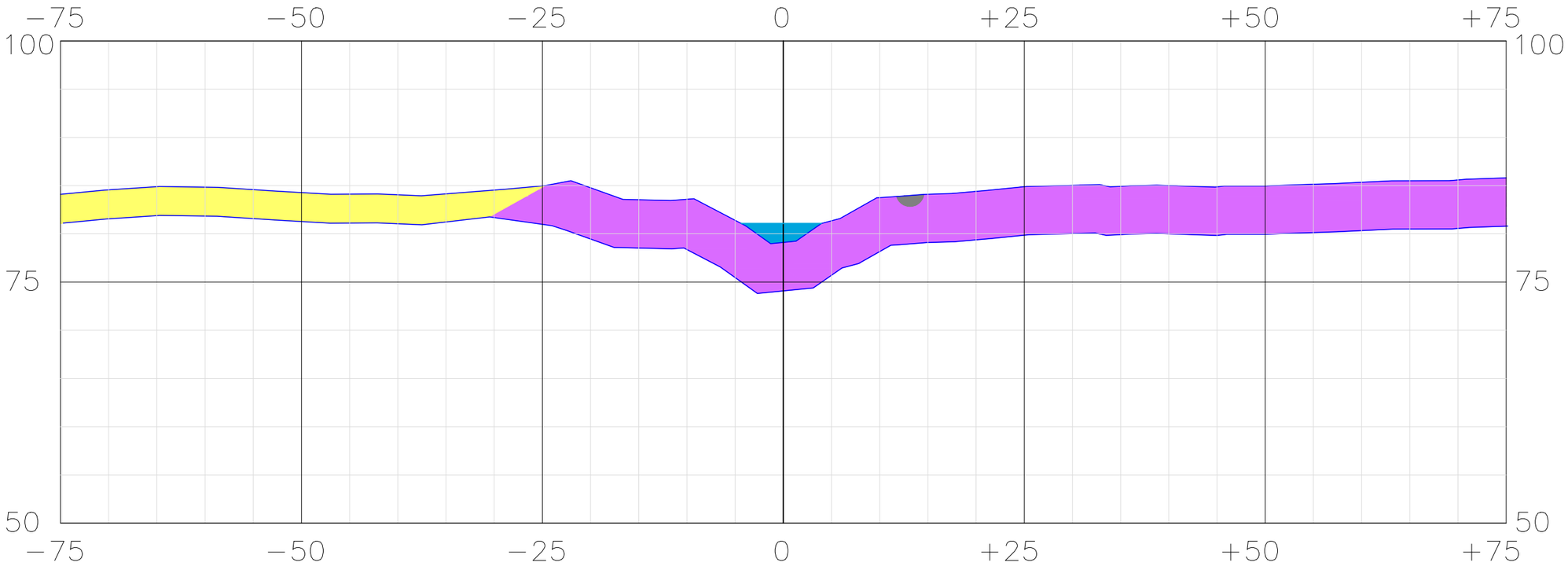
GEOLOGICAL SECTION 3+190



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 09
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

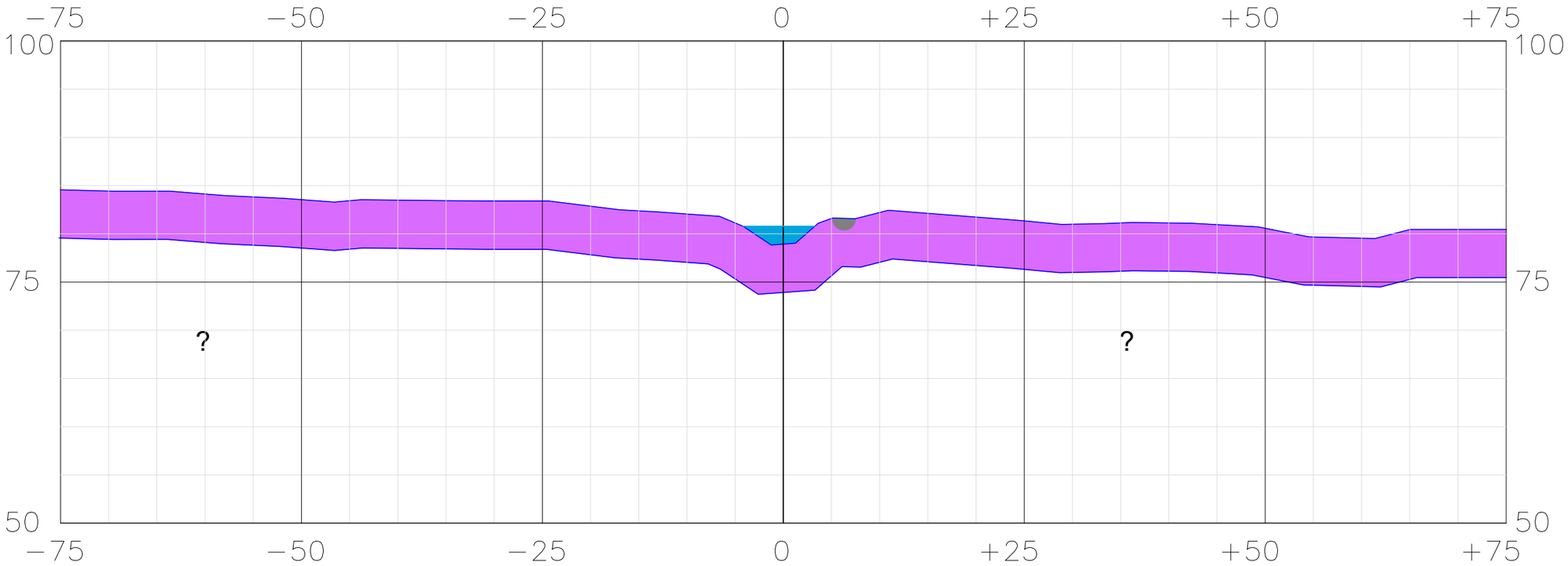
GEOLOGICAL SECTION 3+620



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 10
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

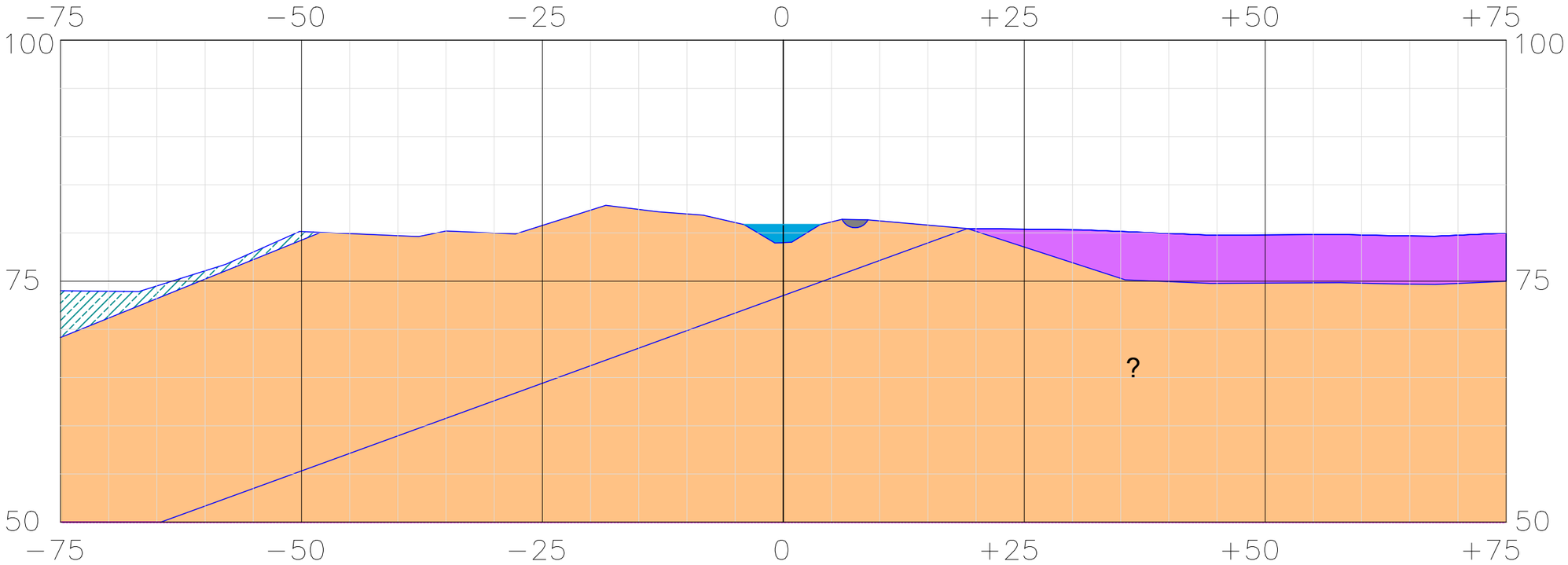
GEOLOGICAL SECTION 4+040



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 11
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

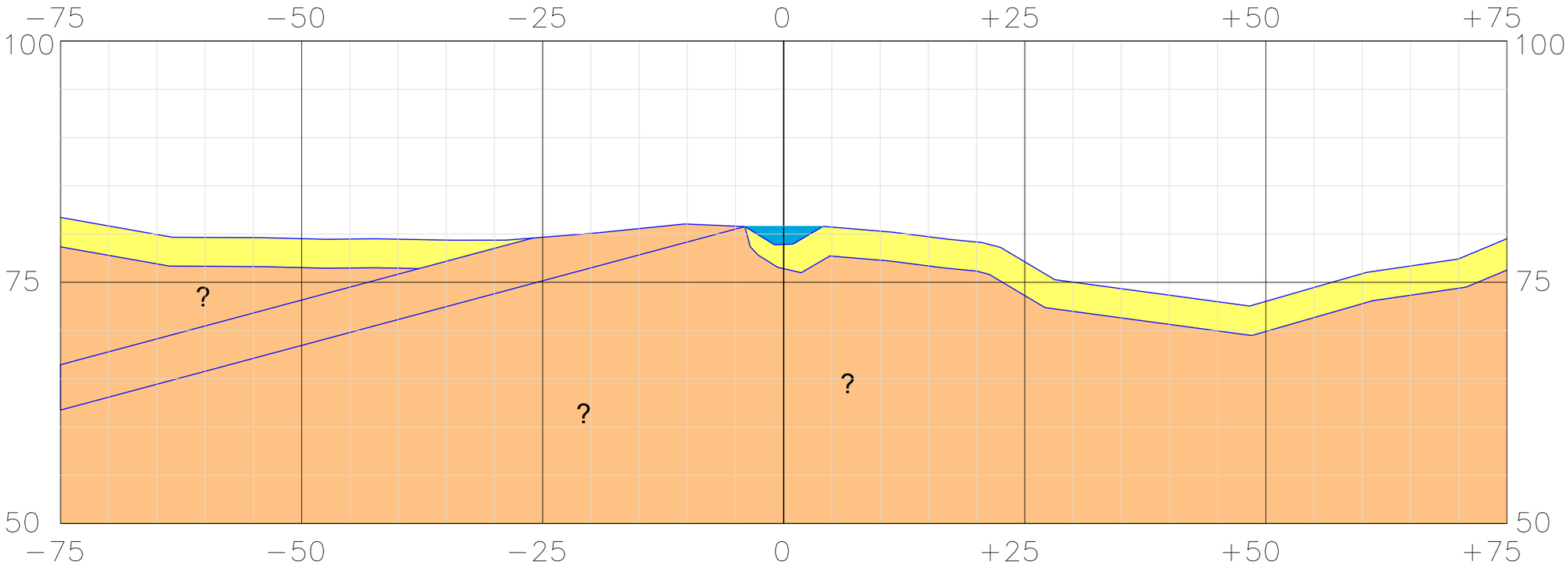
GEOLOGICAL SECTION 4+370



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
SURVEY TECH (PVT) LTD		SHALE	MUD STONE	UNIDENTIFIED ?	
		TEST PIT	HORIZONTAL BEDDING		SHEET NO 12
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

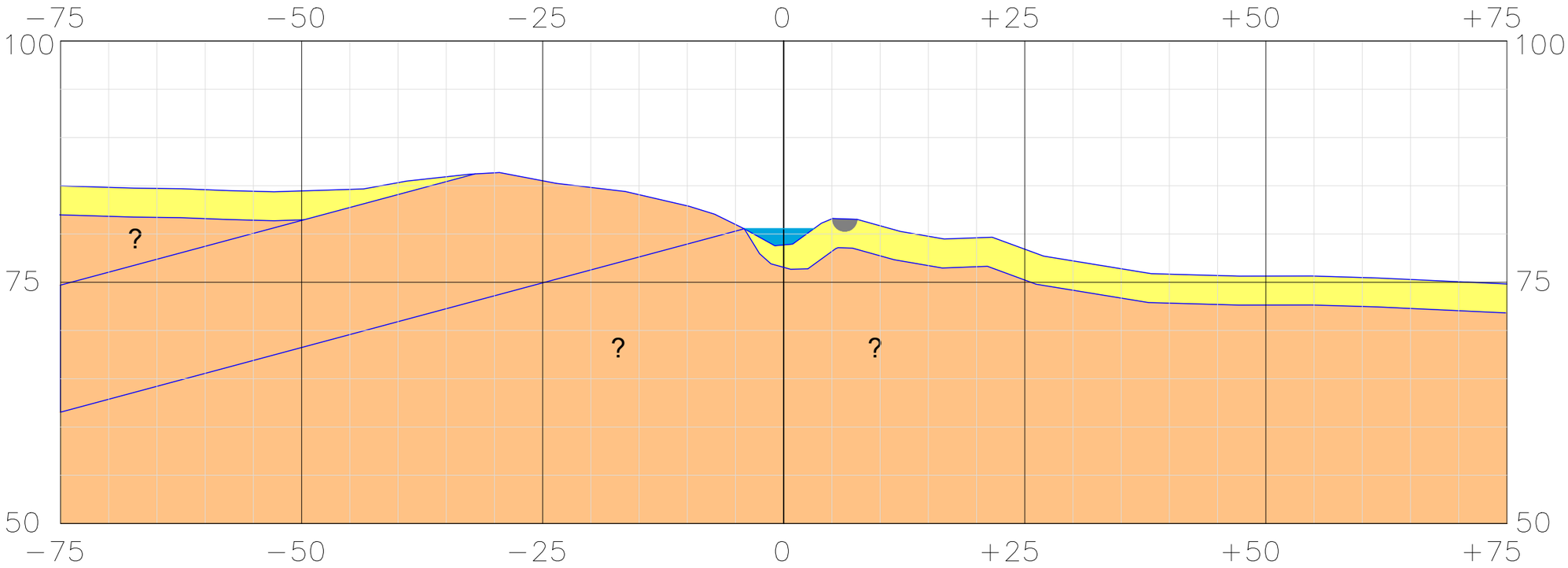
GEOLOGICAL SECTION 4+580



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 13
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

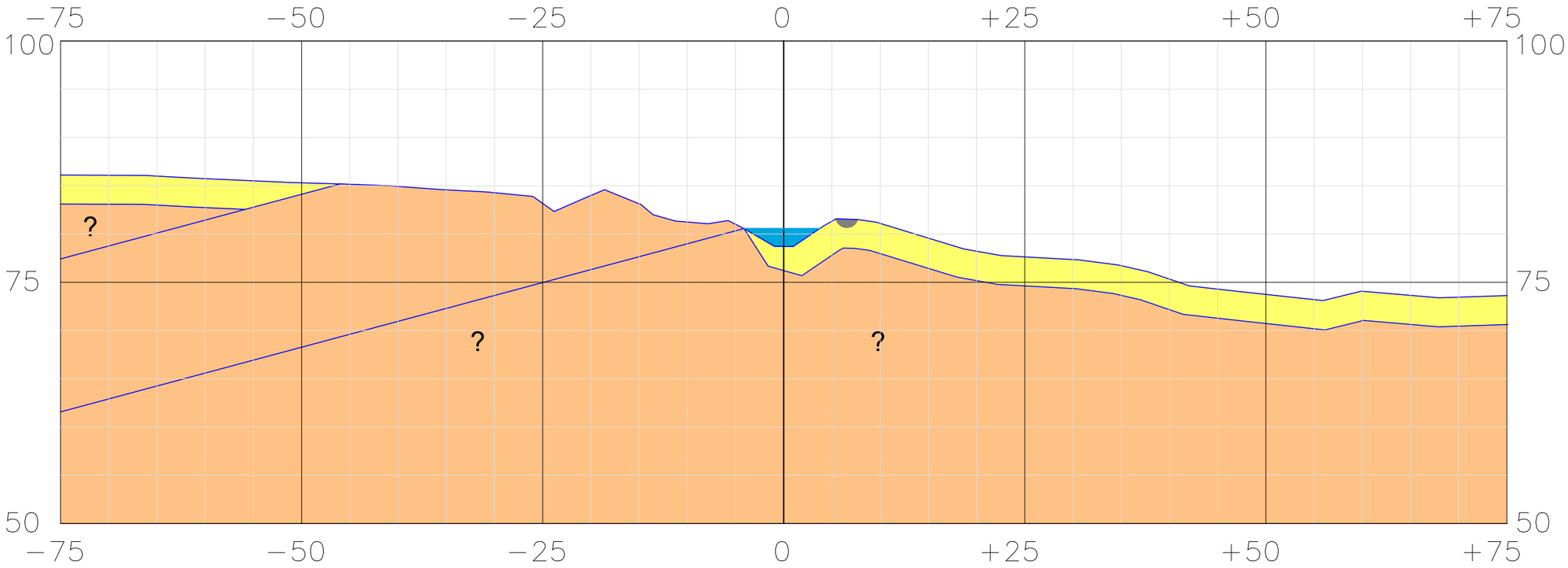
GEOLOGICAL SECTION 5+000



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 14
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

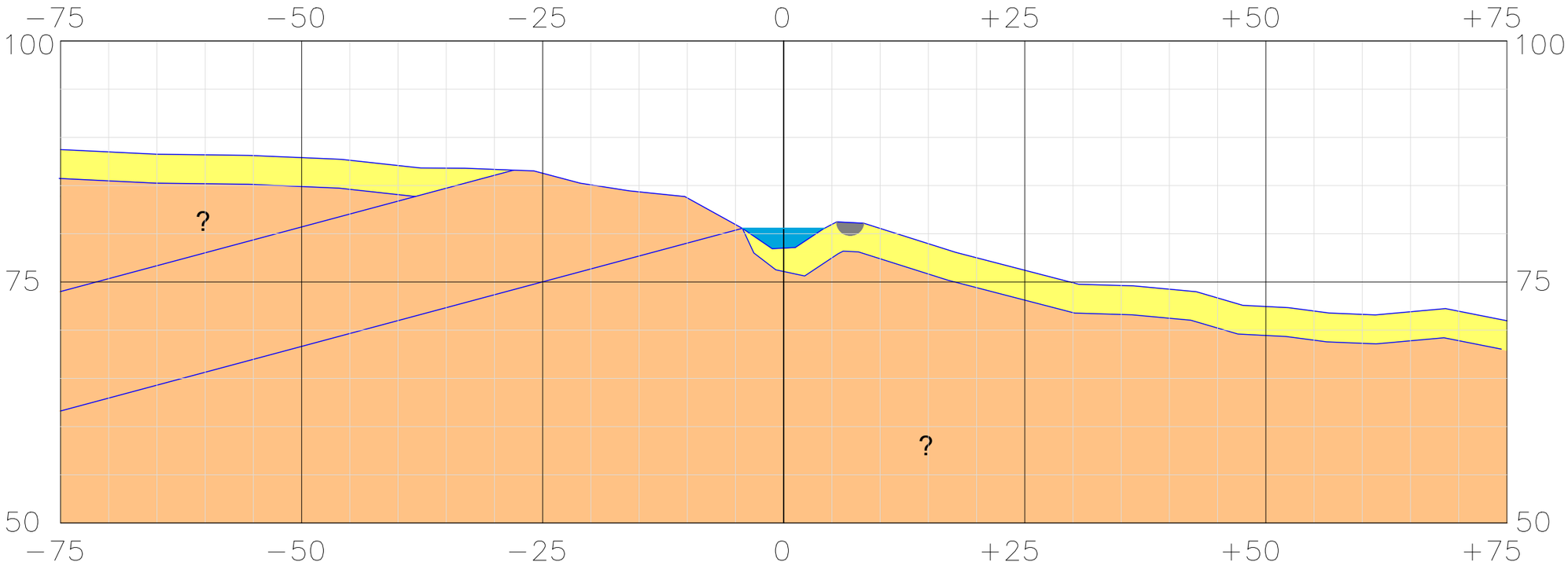
GEOLOGICAL SECTION 5+280



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		15
		DIP & STRIKE	FAULT INFERRED F		

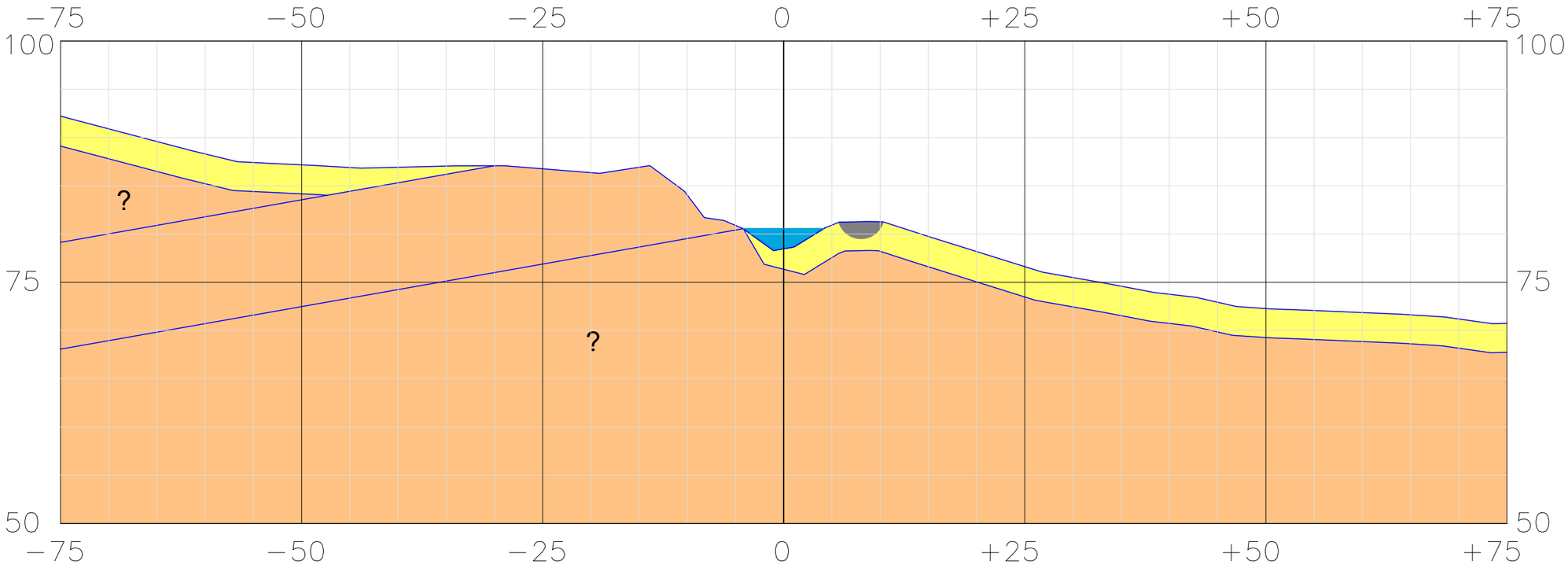
GEOLOGICAL SECTION 5+880



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 16
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

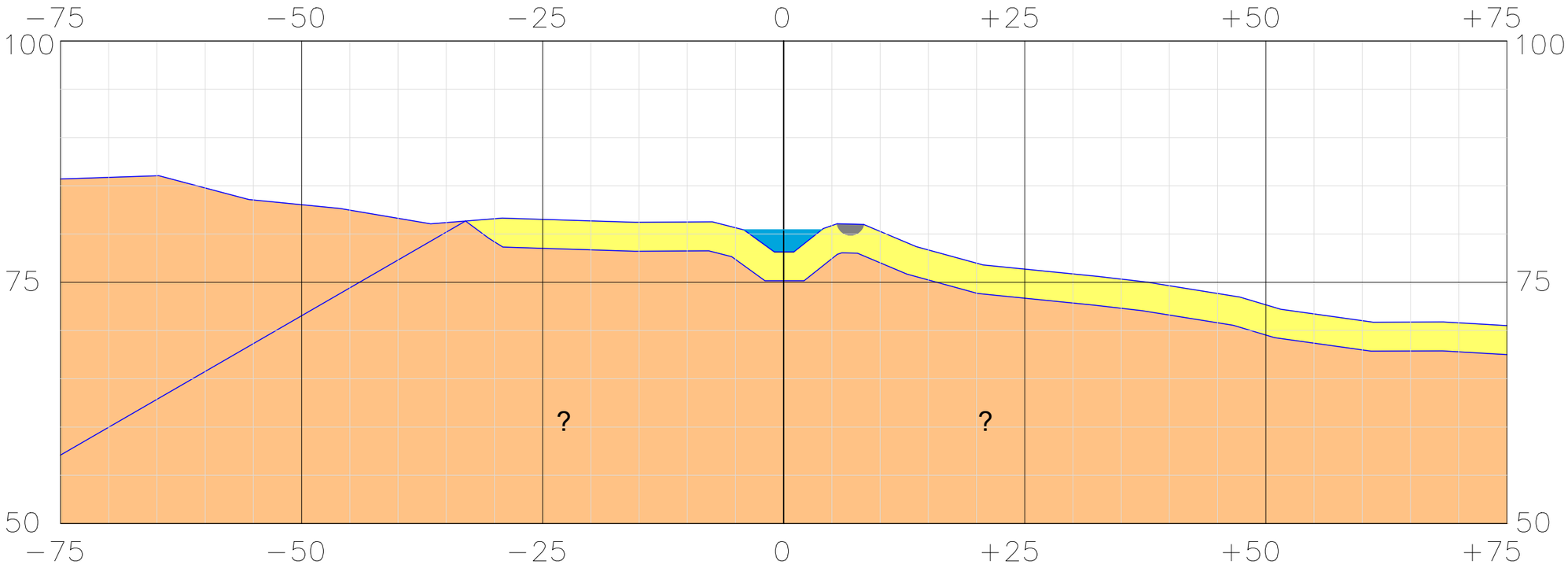
GEOLOGICAL SECTION 6+050



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		17
		DIP & STRIKE	FAULT INFERRED F		

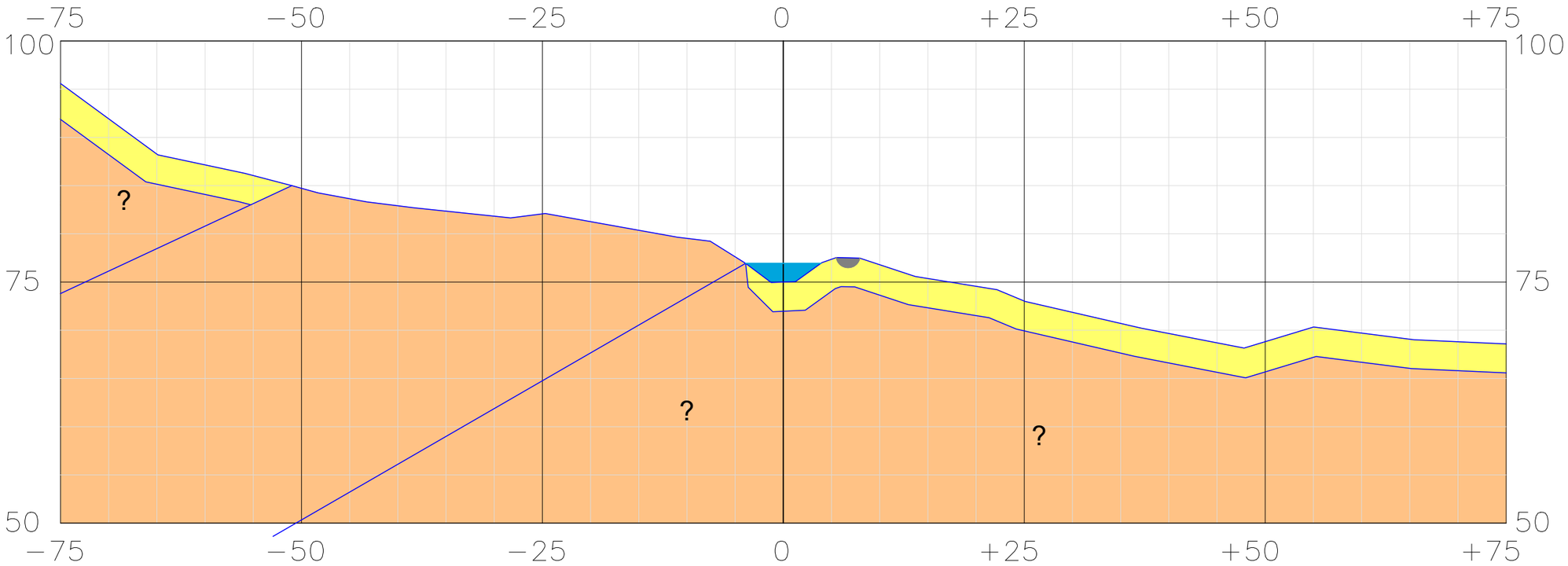
GEOLOGICAL SECTION 6+520



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 18
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

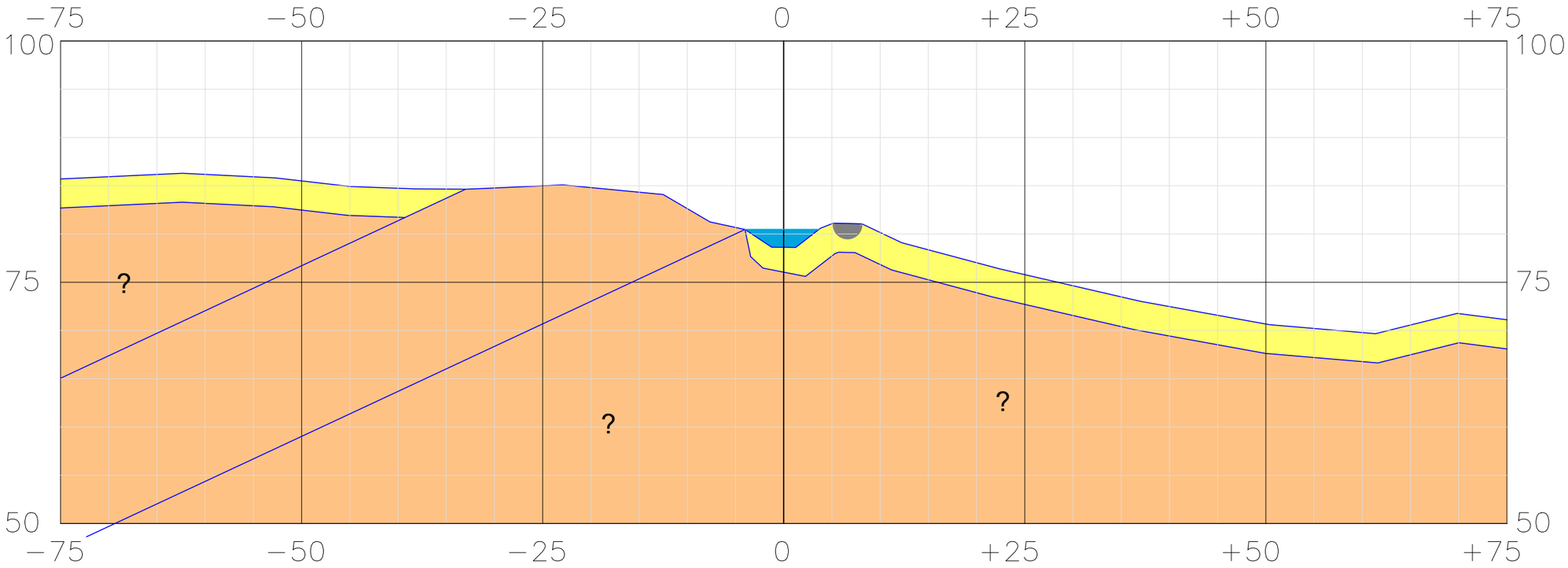
GEOLOGICAL SECTION 6+950



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 19
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

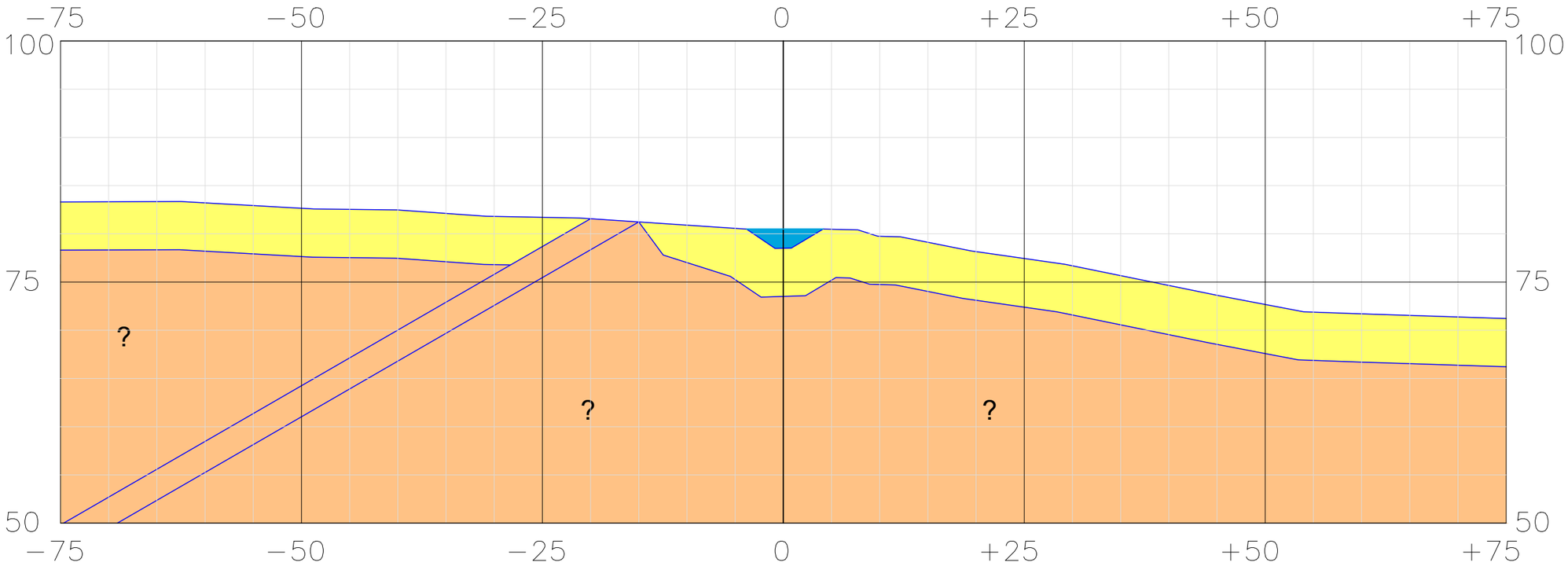
GEOLOGICAL SECTION 7+290



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 20
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

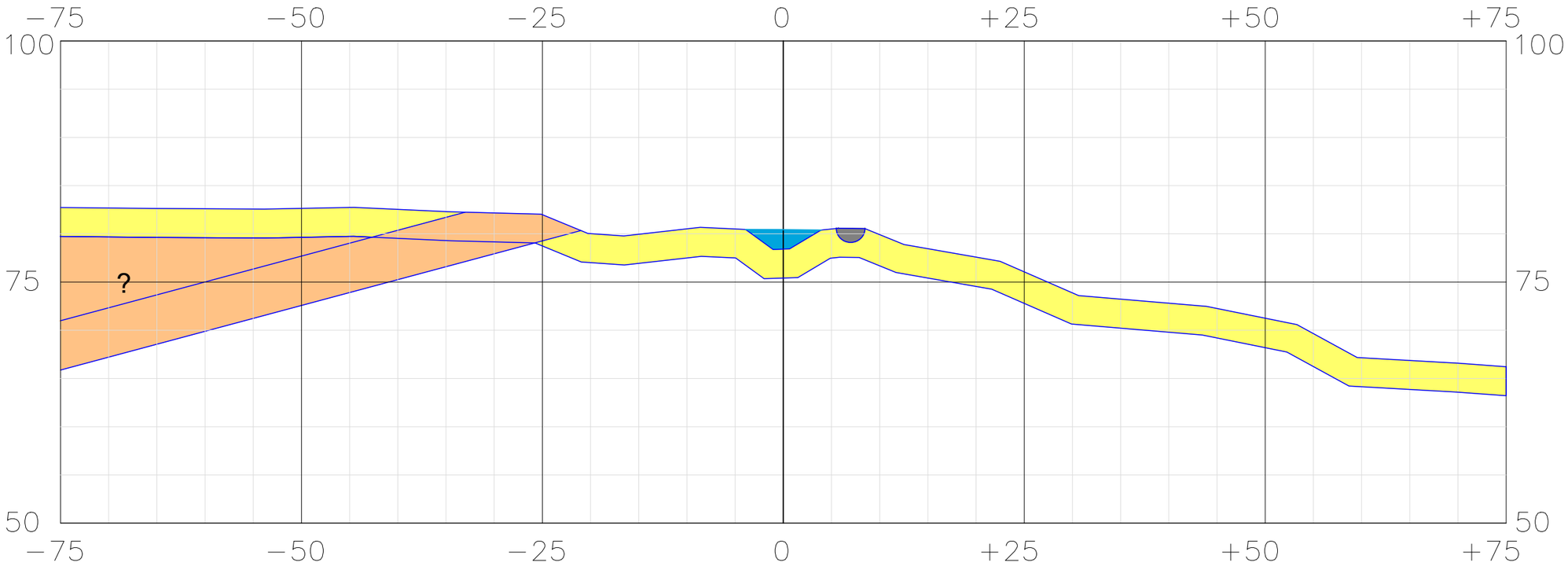
GEOLOGICAL SECTION 7+790



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 21
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

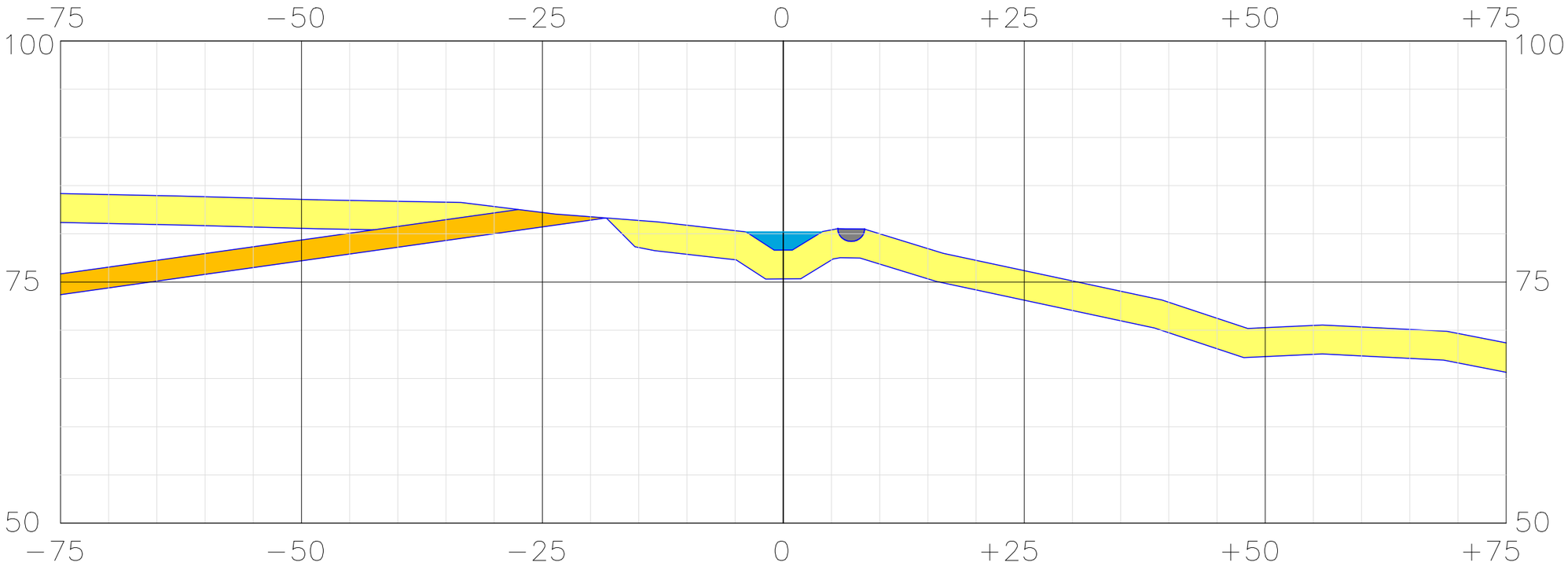
GEOLOGICAL SECTION 7+950



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		22
		DIP & STRIKE	FAULT INFERRED F		

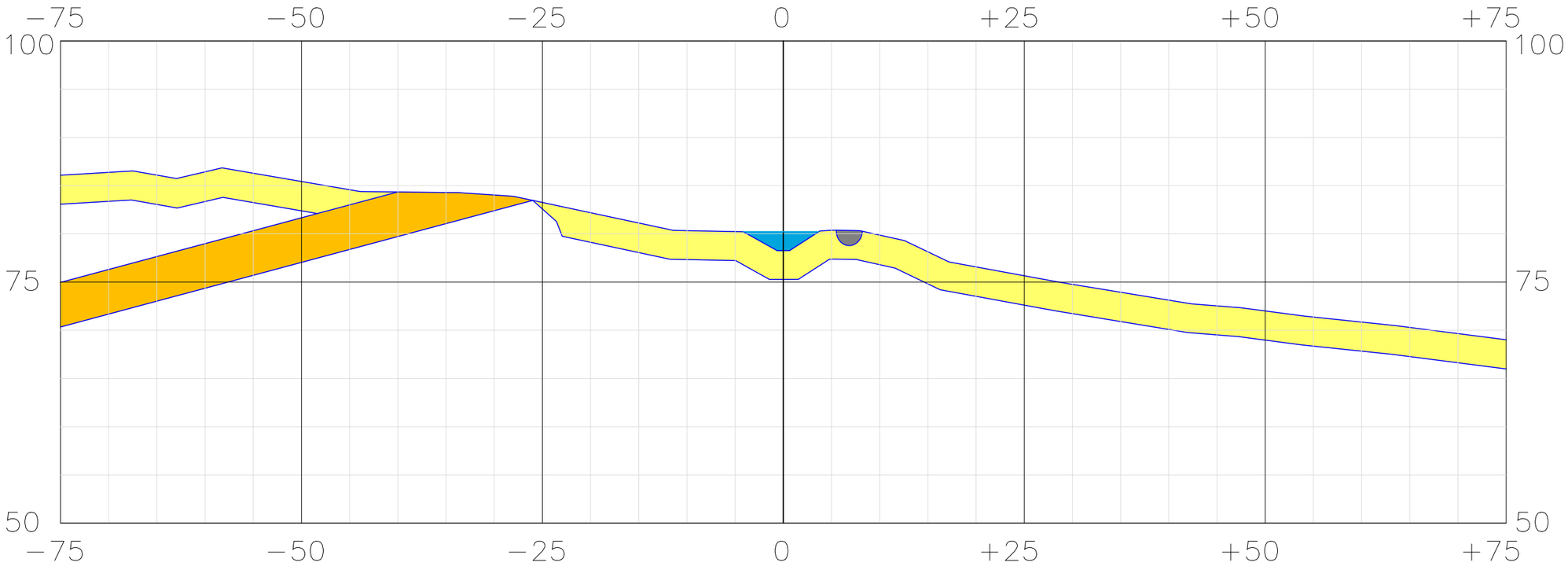
GEOLOGICAL SECTION 8+530



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 23
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

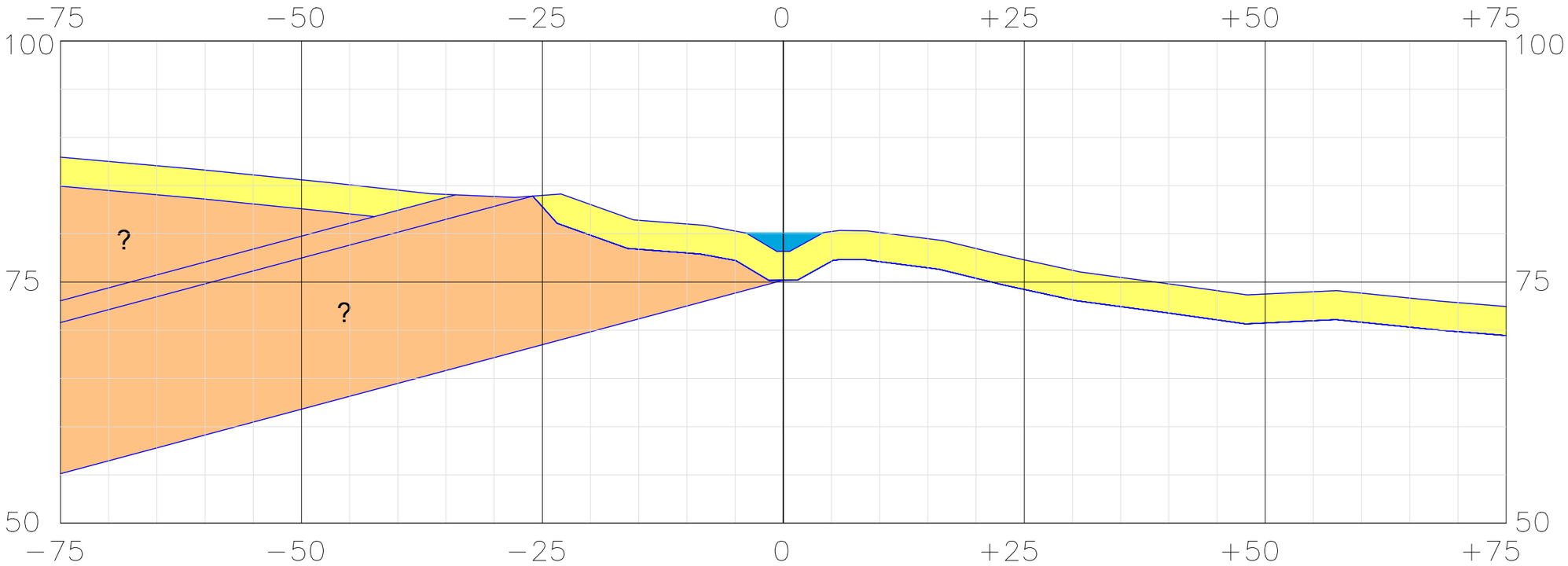
GEOLOGICAL SECTION 8+680



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 24
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

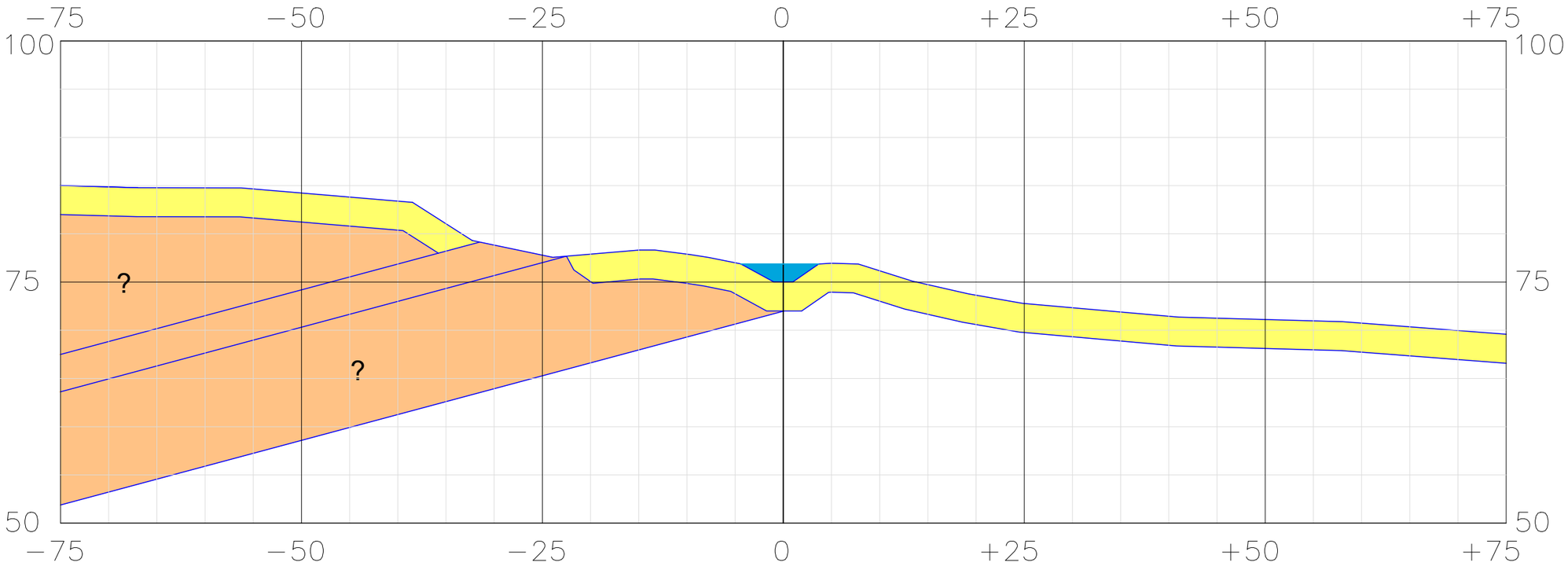
GEOLOGICAL SECTION 9+290



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		25
		DIP & STRIKE	FAULT INFERRED F		

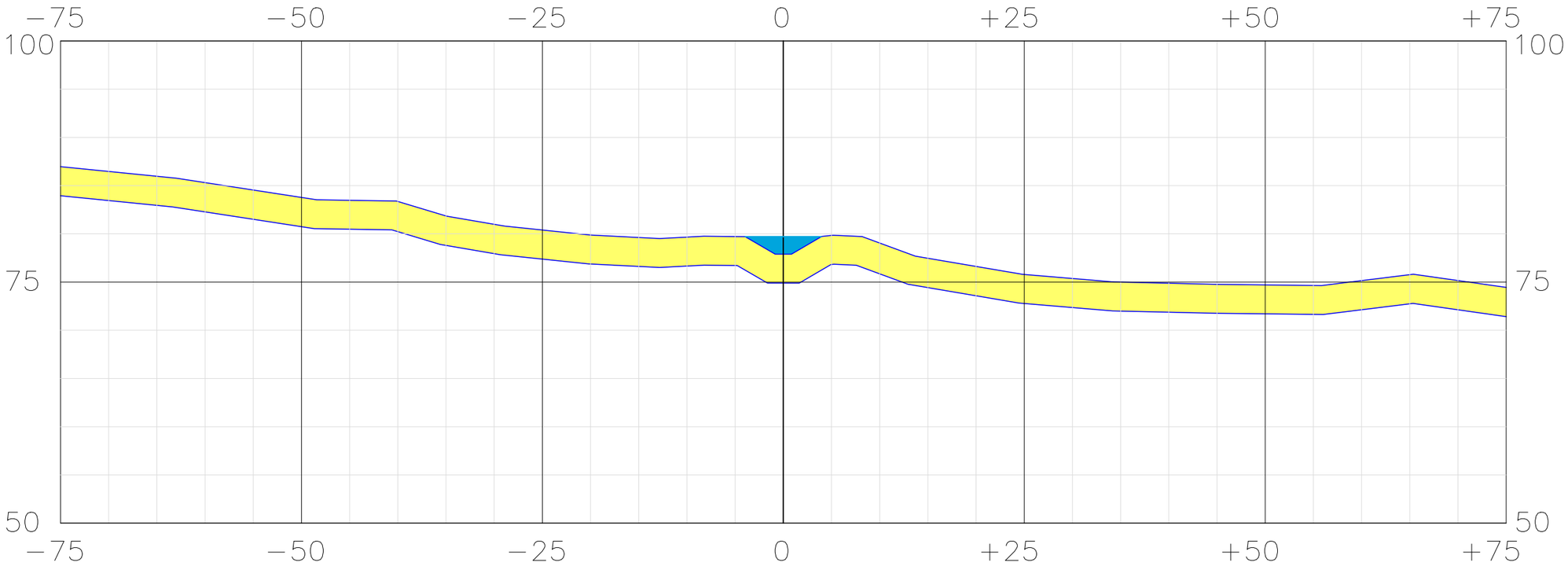
GEOLOGICAL SECTION 9+610



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		26
		DIP & STRIKE	FAULT INFERRED F		

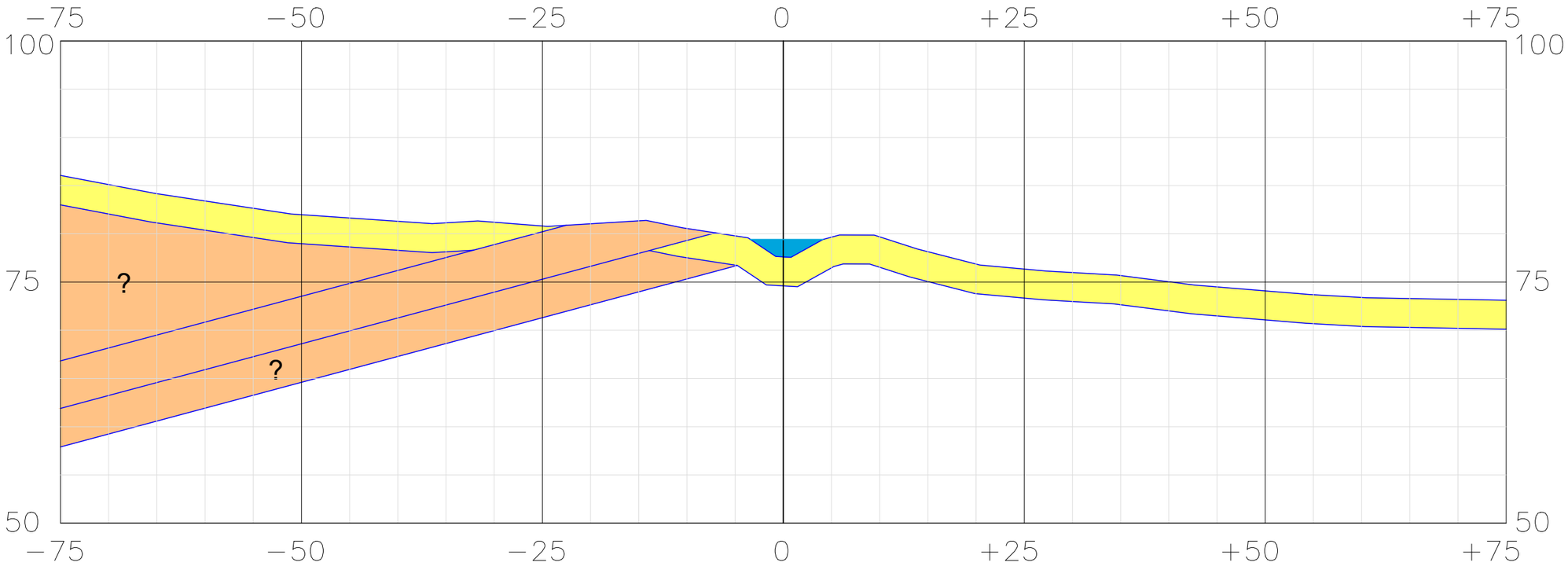
GEOLOGICAL SECTION 10+050



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 27
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

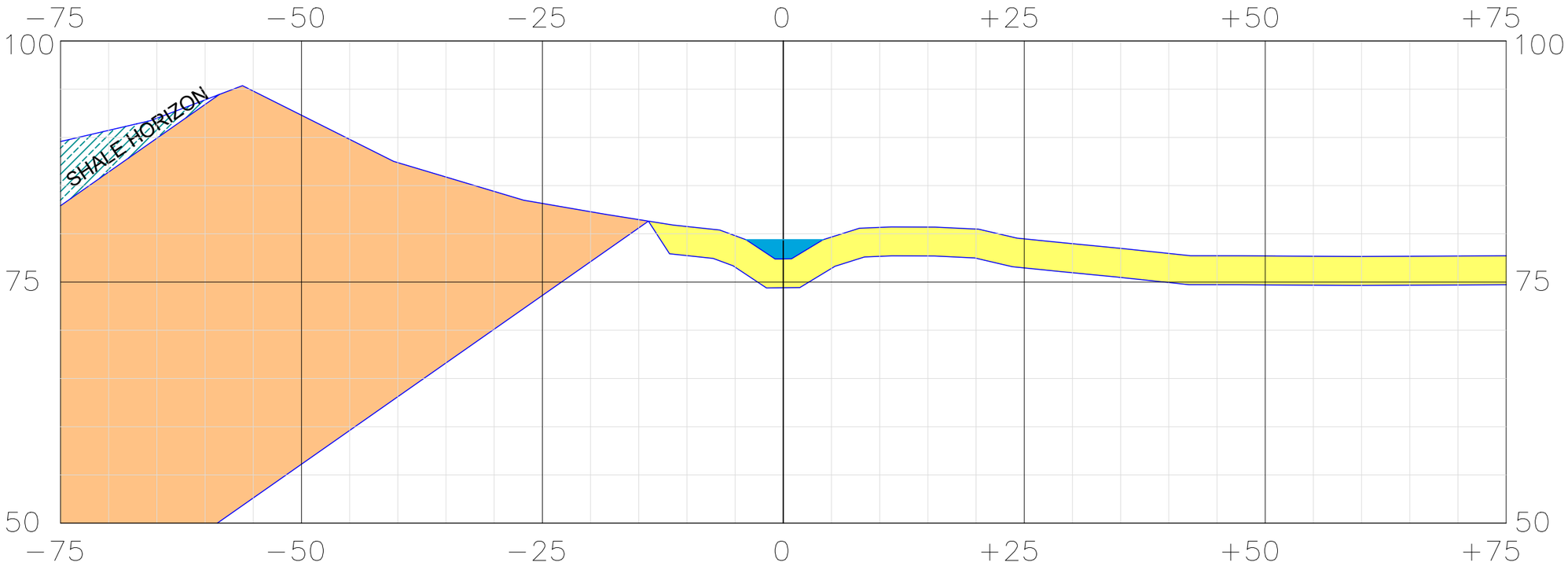
GEOLOGICAL SECTION 10+390



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		28
		DIP & STRIKE	FAULT INFERRED F		

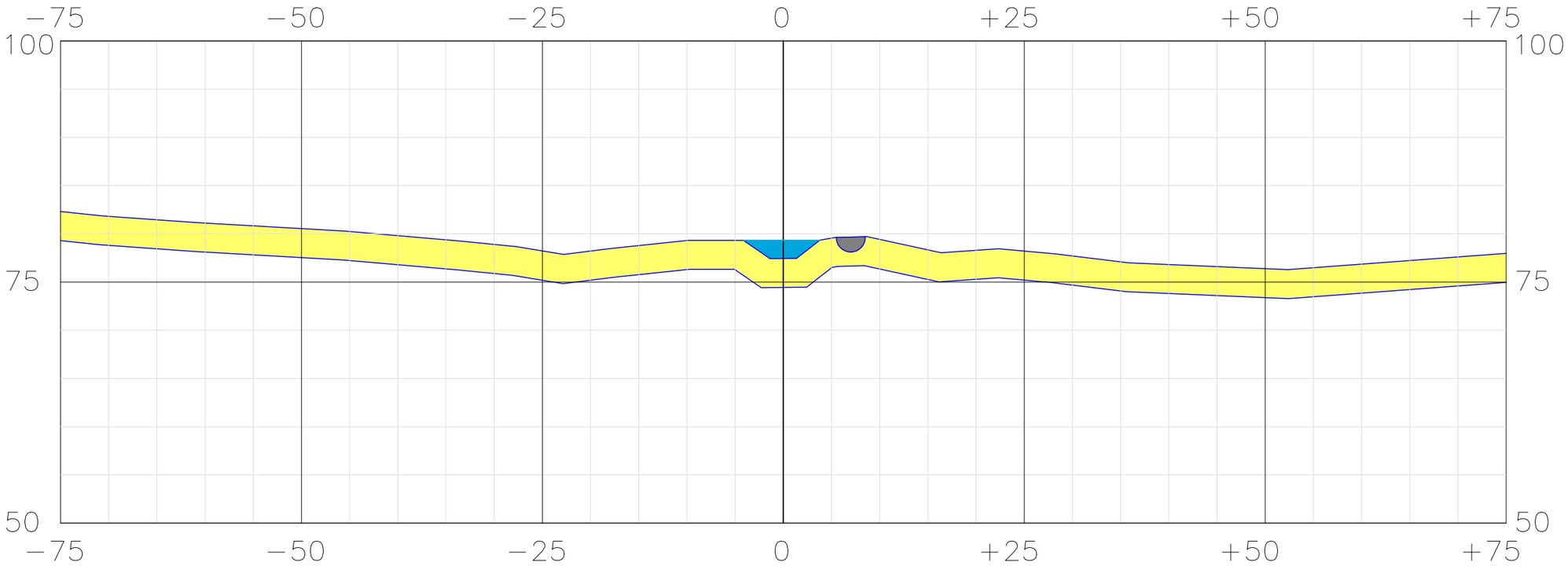
GEOLOGICAL SECTION 10+780



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		29
		DIP & STRIKE	FAULT INFERRED F		

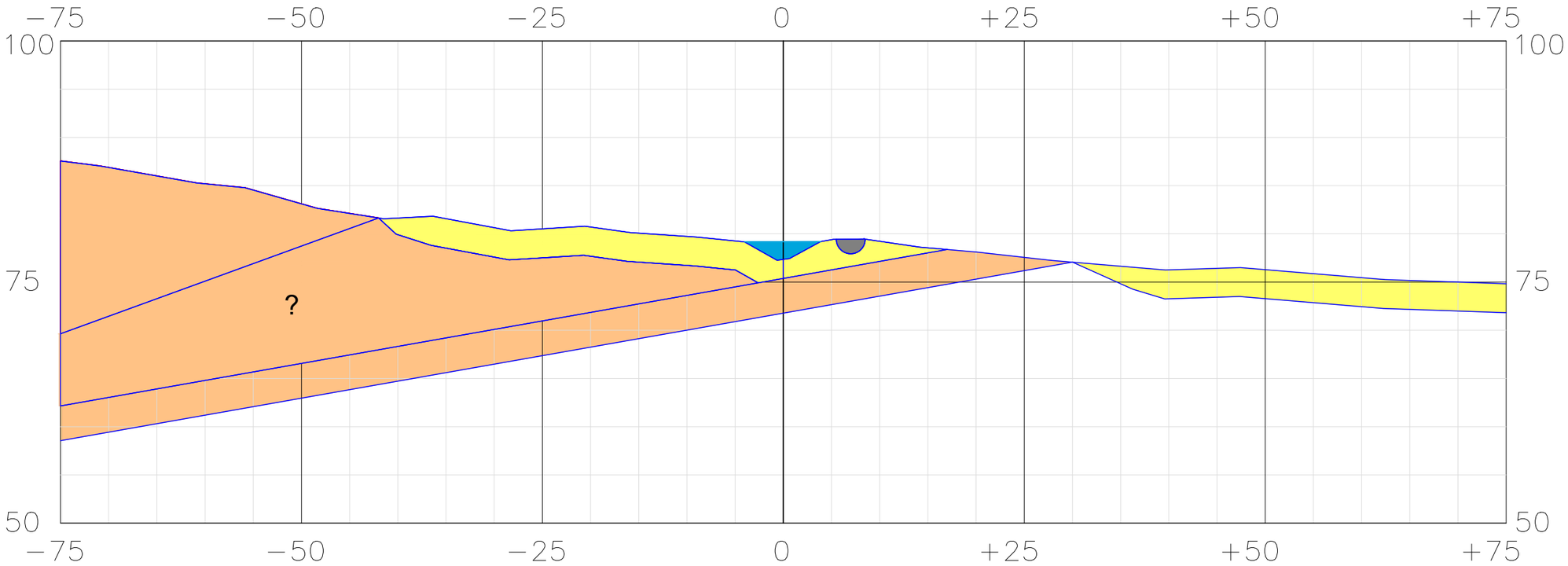
GEOLOGICAL SECTION 11+030



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 30
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

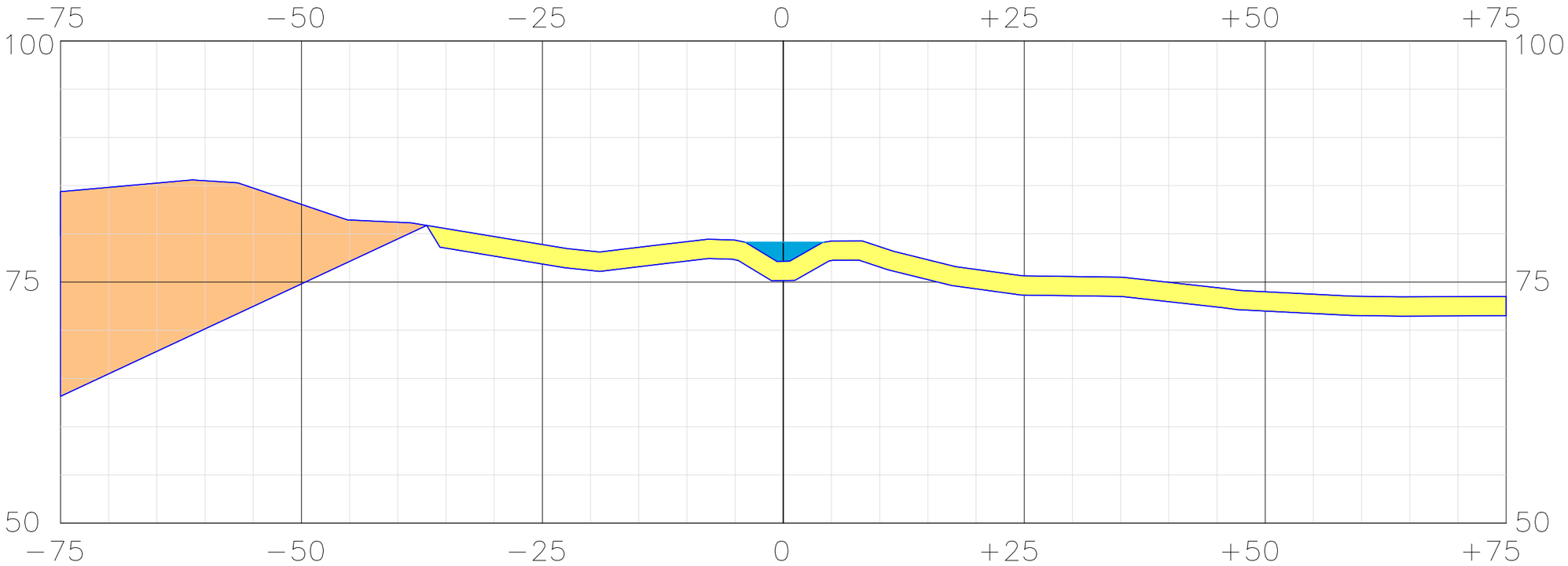
GEOLOGICAL SECTION 11+440



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		31
		DIP & STRIKE	FAULT INFERRED F		

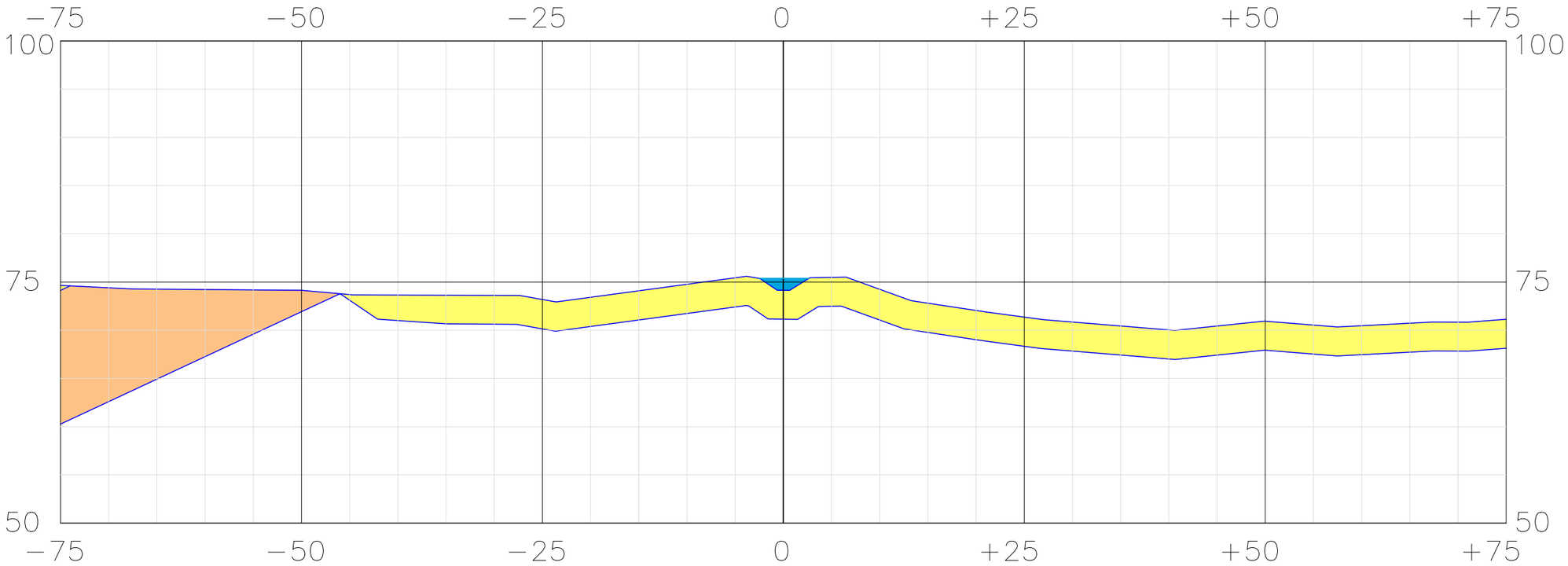
GEOLOGICAL SECTION 11+700



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 32
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

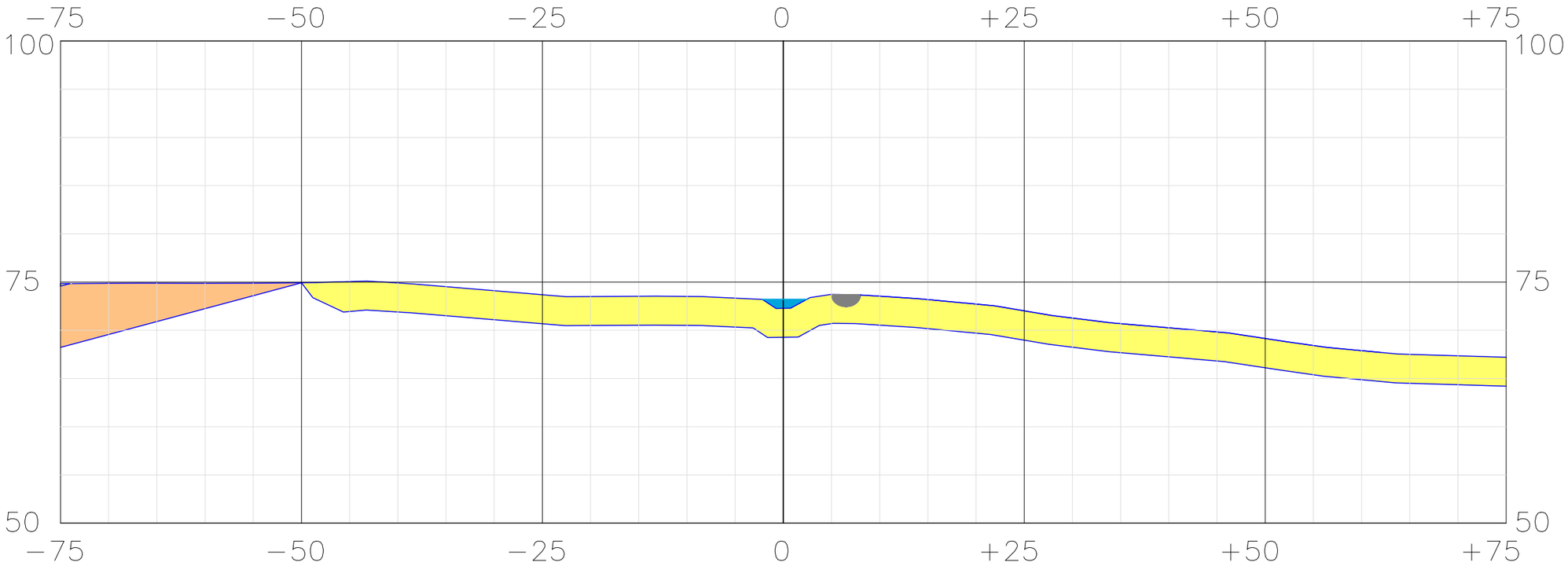
GEOLOGICAL SECTION 12+110



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		33
		DIP & STRIKE	FAULT INFERRED F		

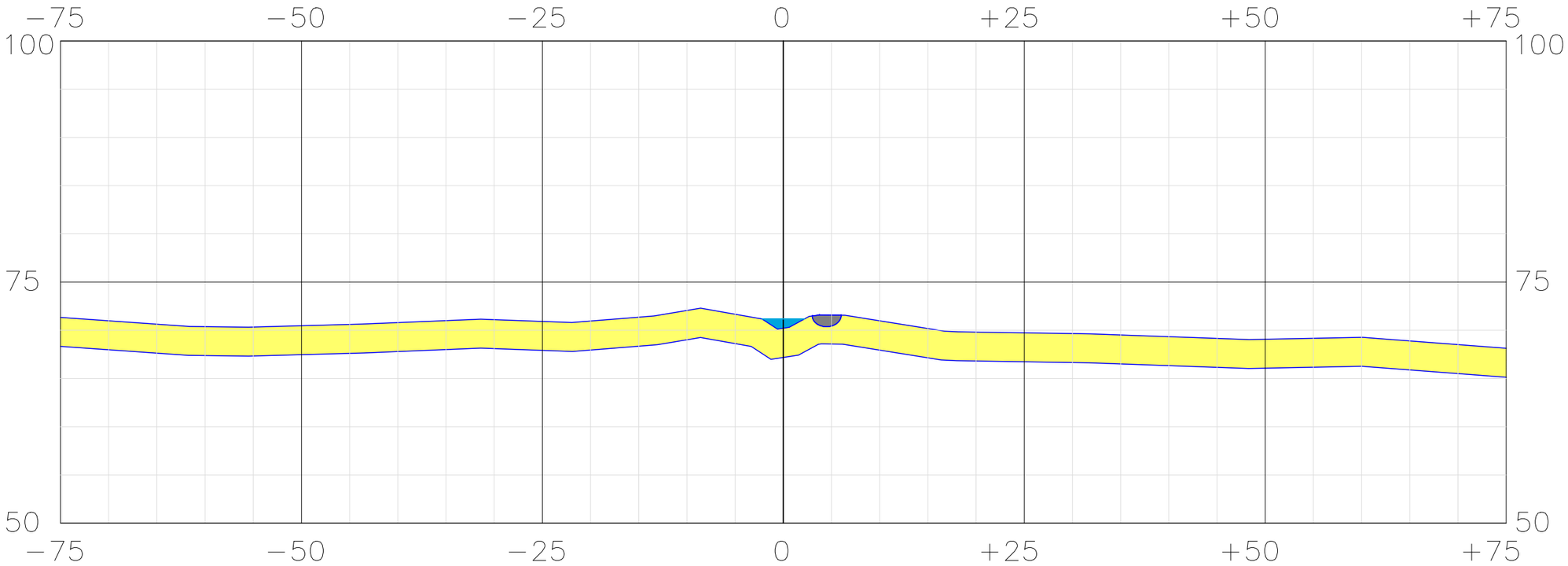
GEOLOGICAL SECTION 12+520



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 34
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

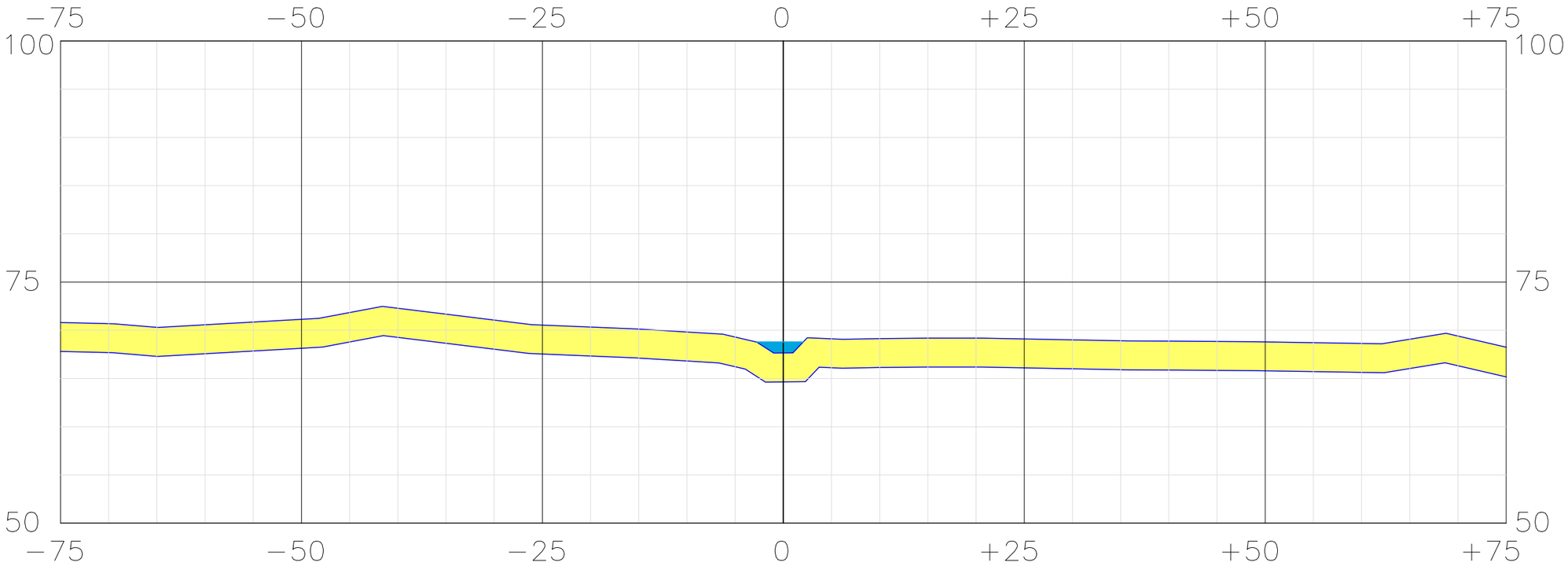
GEOLOGICAL SECTION 12+920



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 35
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

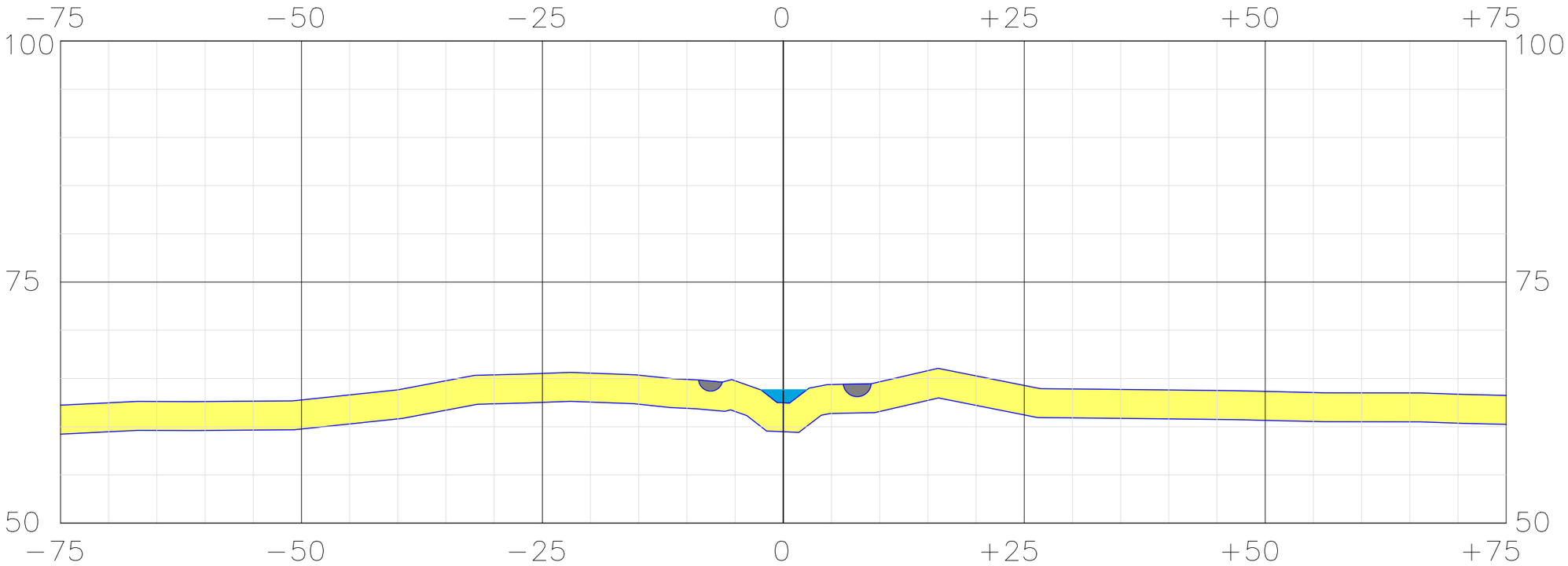
GEOLOGICAL SECTION 13+380



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 36
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

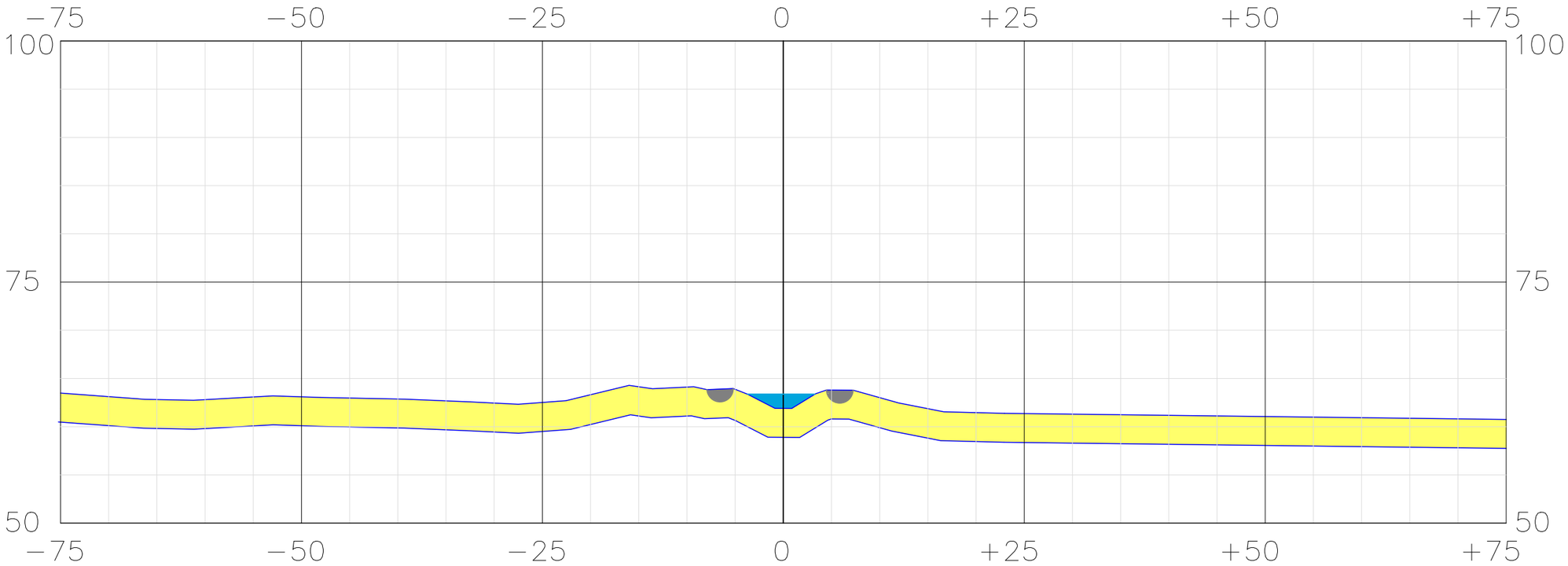
GEOLOGICAL SECTION 13+800



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 37
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

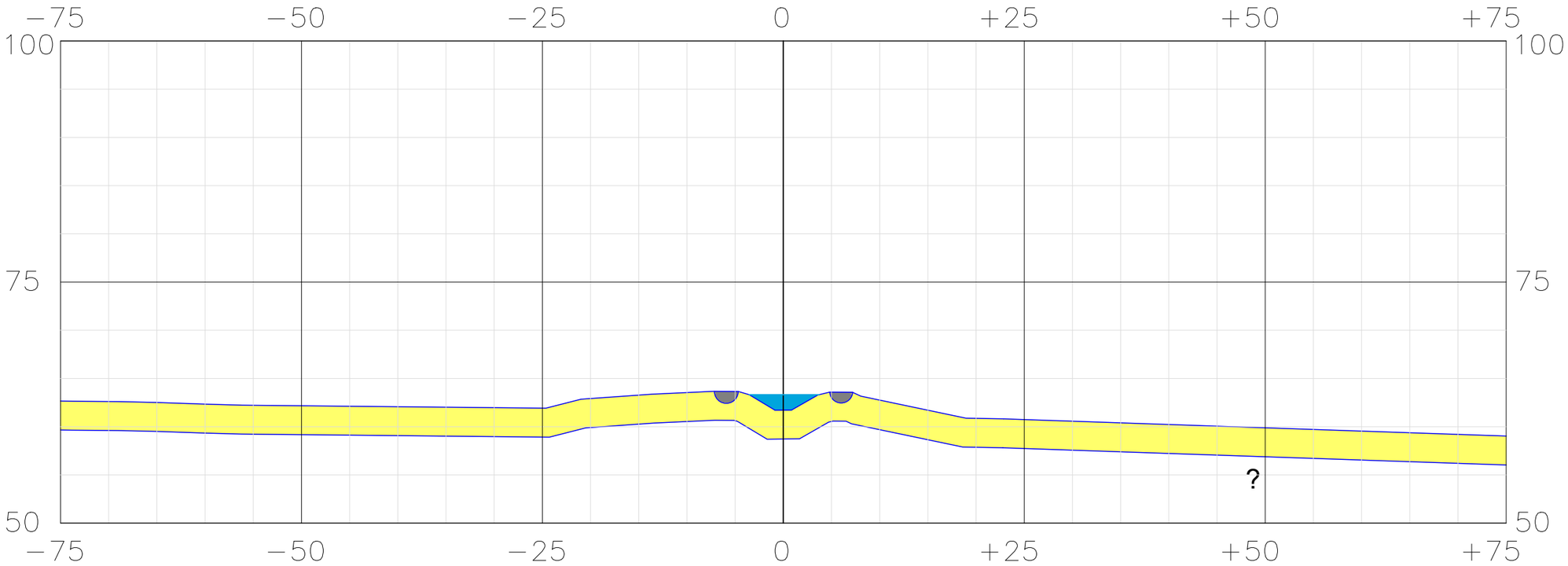
GEOLOGICAL SECTION 14+210



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 38
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

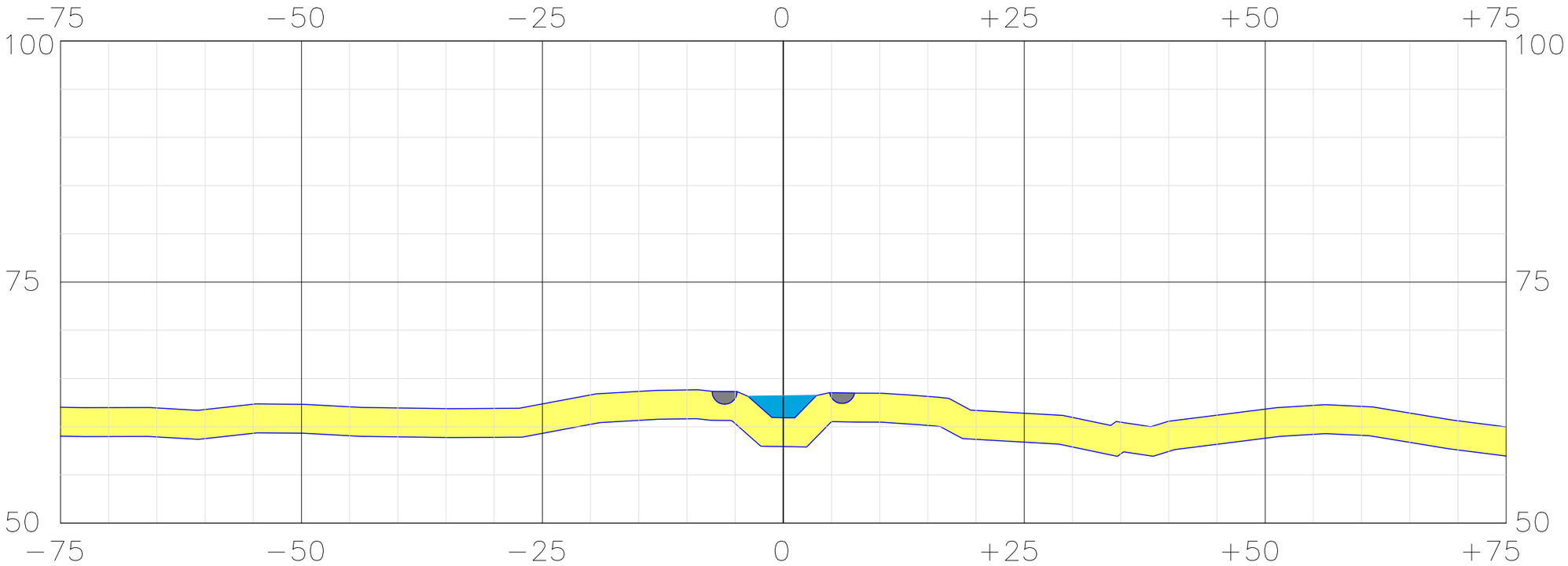
GEOLOGICAL SECTION 14+560



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		39
		DIP & STRIKE	FAULT INFERRED F		

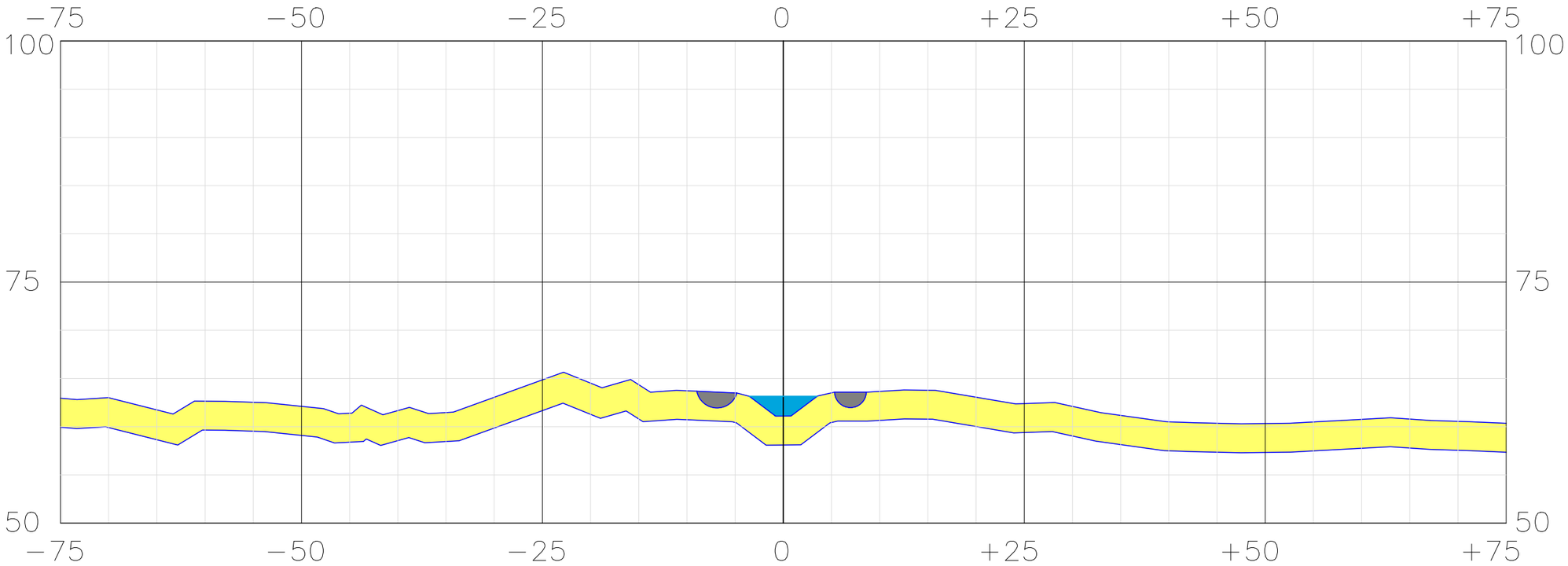
GEOLOGICAL SECTION 14+920



STRUCTURAL CROSS SECTION LOOKING SOUTH

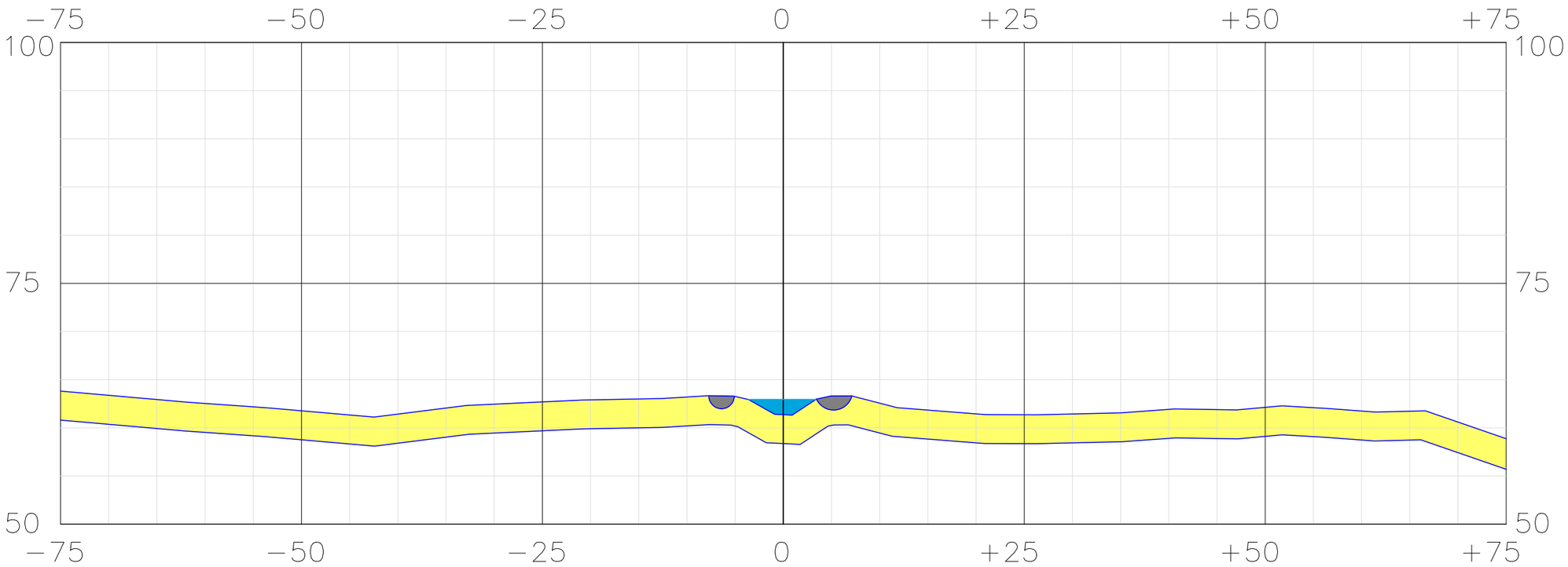
HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 40
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

GEOLOGICAL SECTION 15+340



STRUCTURAL CROSS SECTION LOOKING SOUTH

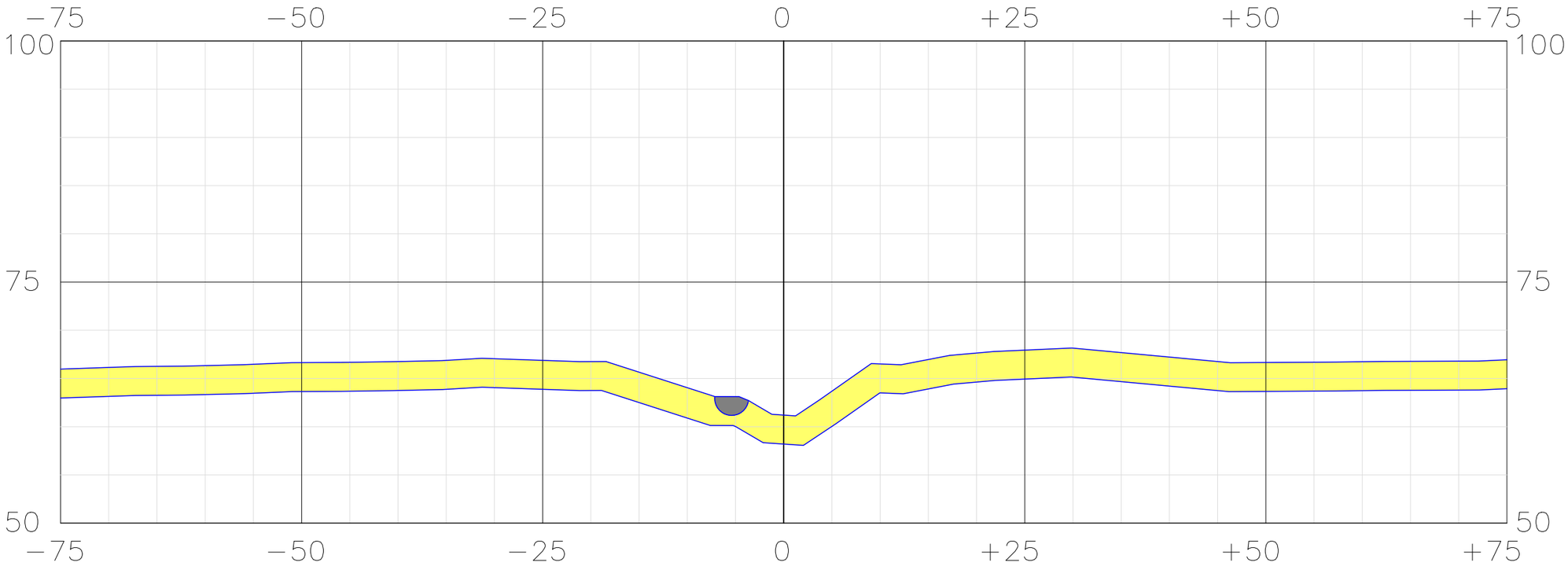
HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 41
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 42
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

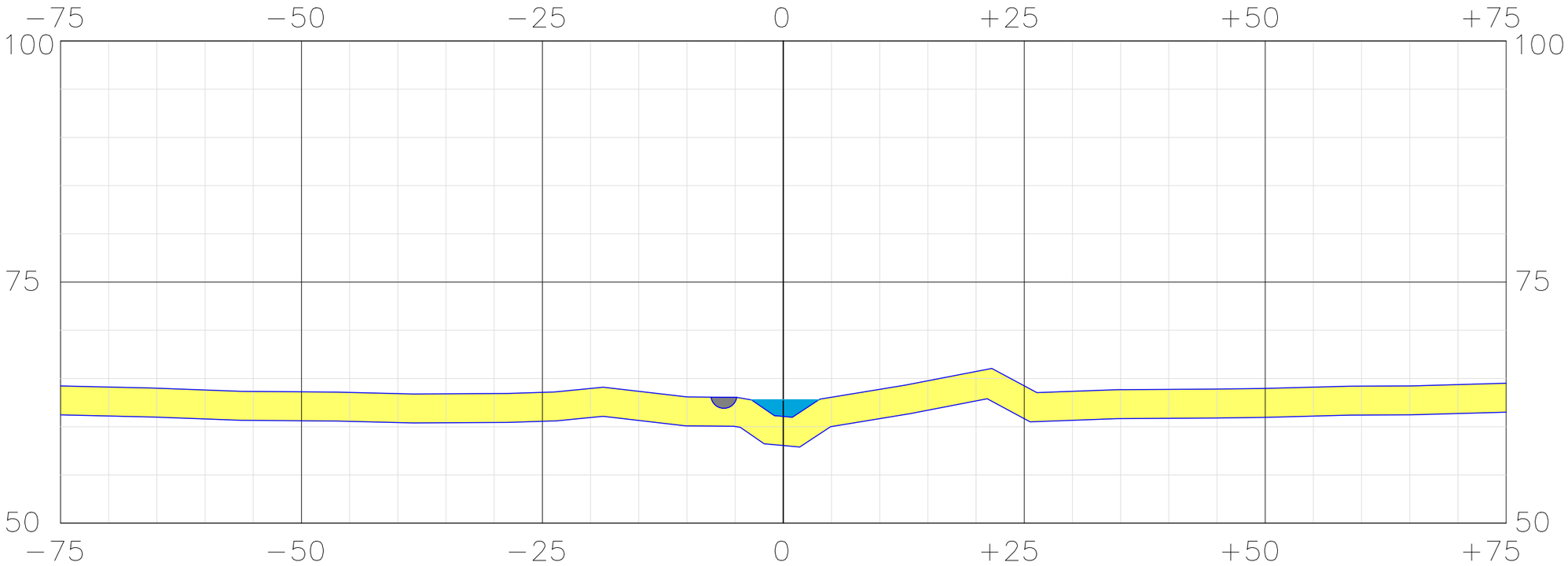
GEOLOGICAL SECTION 16+080



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 43
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

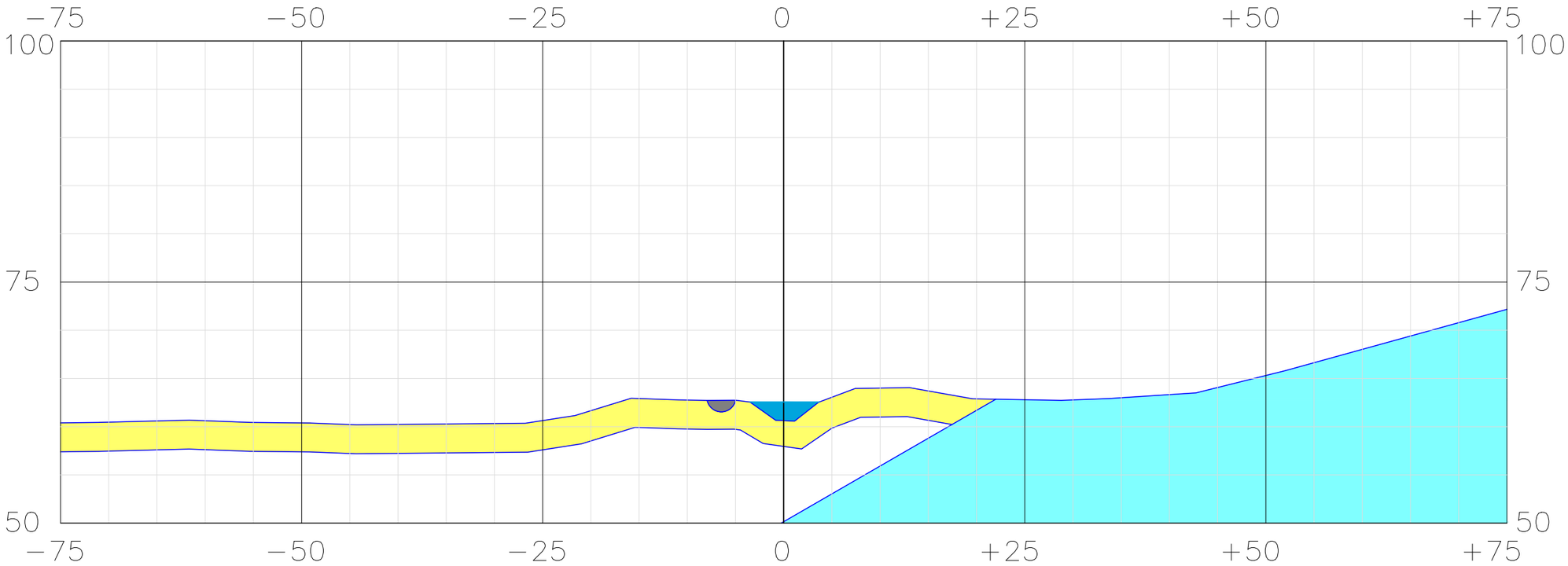
GEOLOGICAL SECTION 16+410



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 44
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

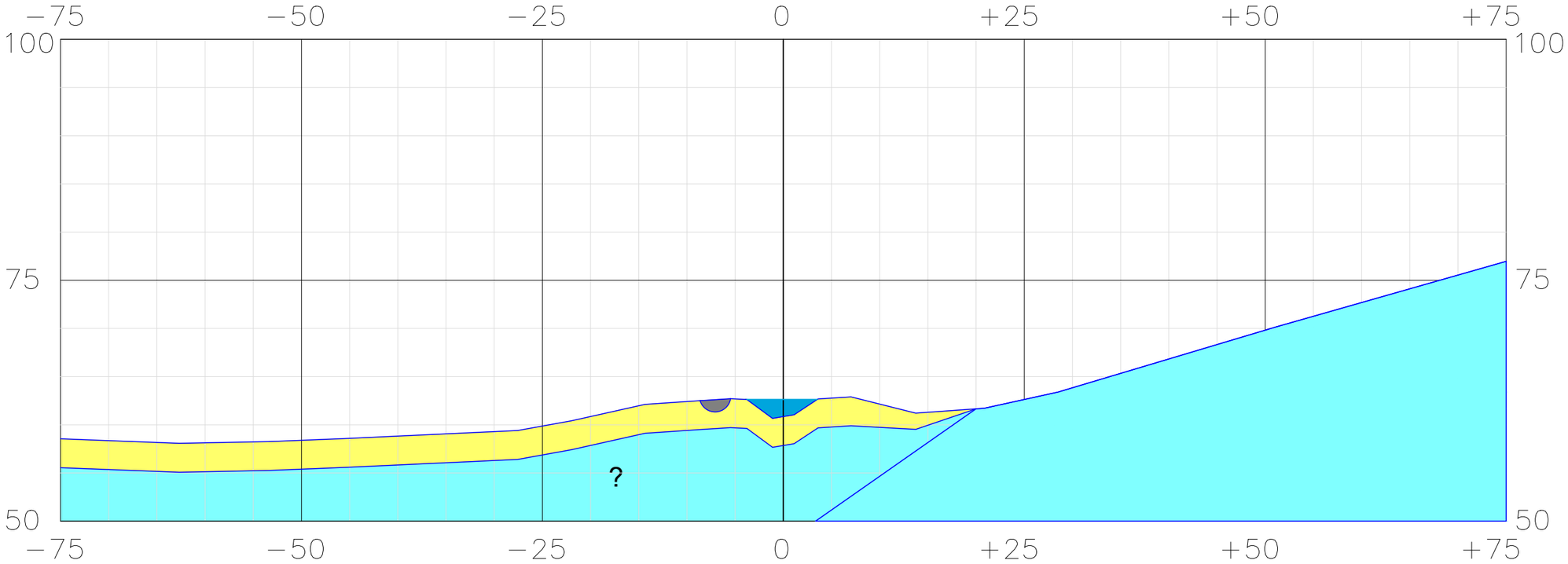
GEOLOGICAL SECTION 17+000



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 45
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

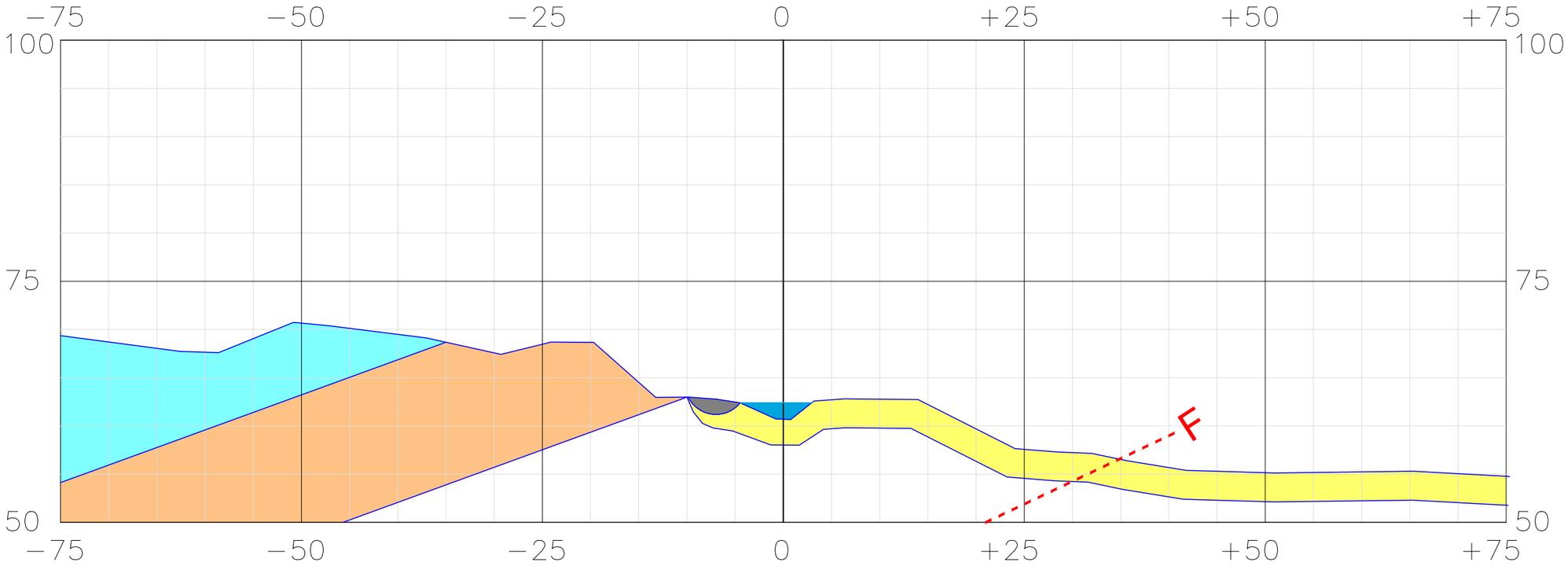
GEOLOGICAL SECTION 17+220



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		46
		DIP & STRIKE	FAULT INFERRED F		

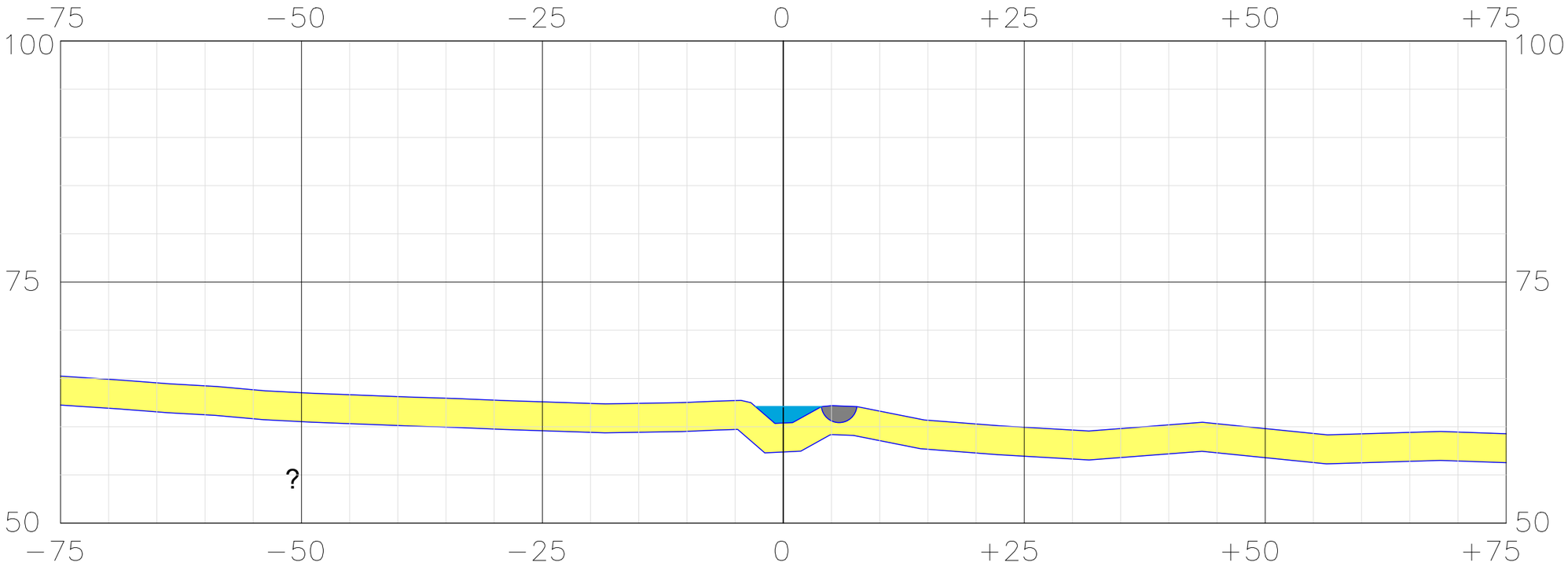
GEOLOGICAL SECTION 17+670



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
SURVEY TECH (PVT) LTD		SHALE	MUD STONE	UNIDENTIFIED ?	
		TEST PIT	HORIZONTAL BEDDING		SHEET NO 47
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

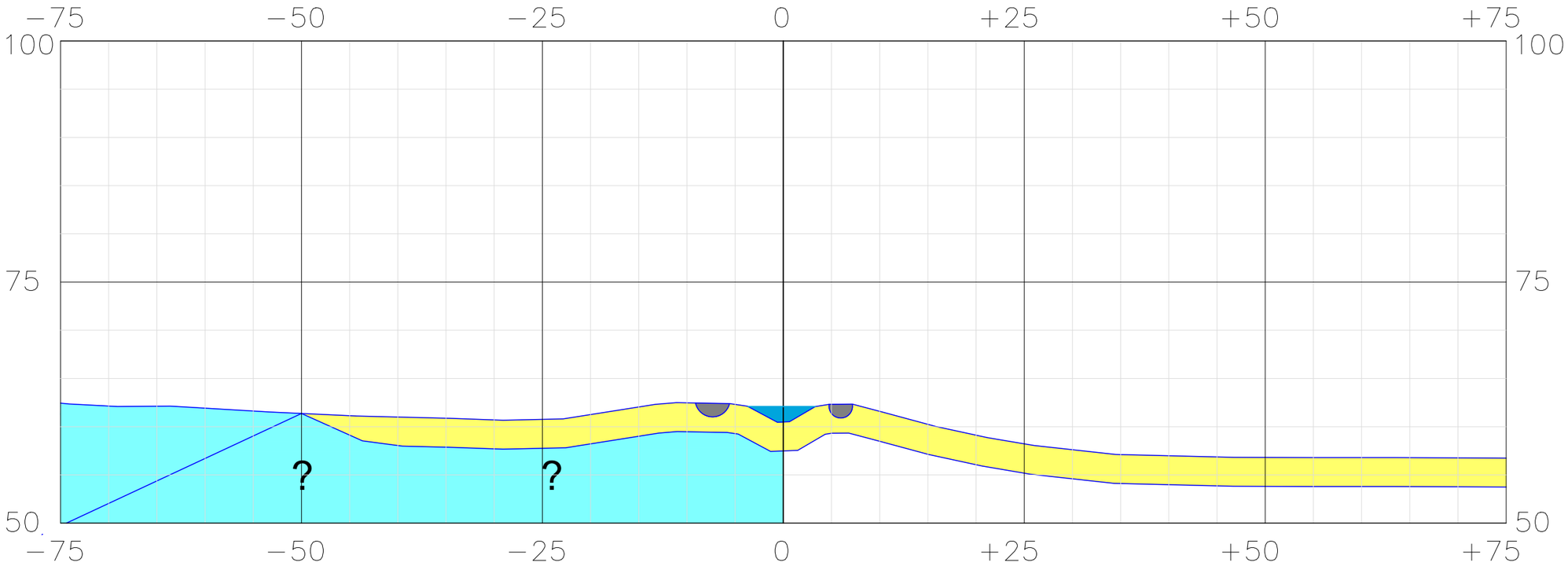
GEOLOGICAL SECTION 17+880



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		48
		DIP & STRIKE	FAULT INFERRED F		

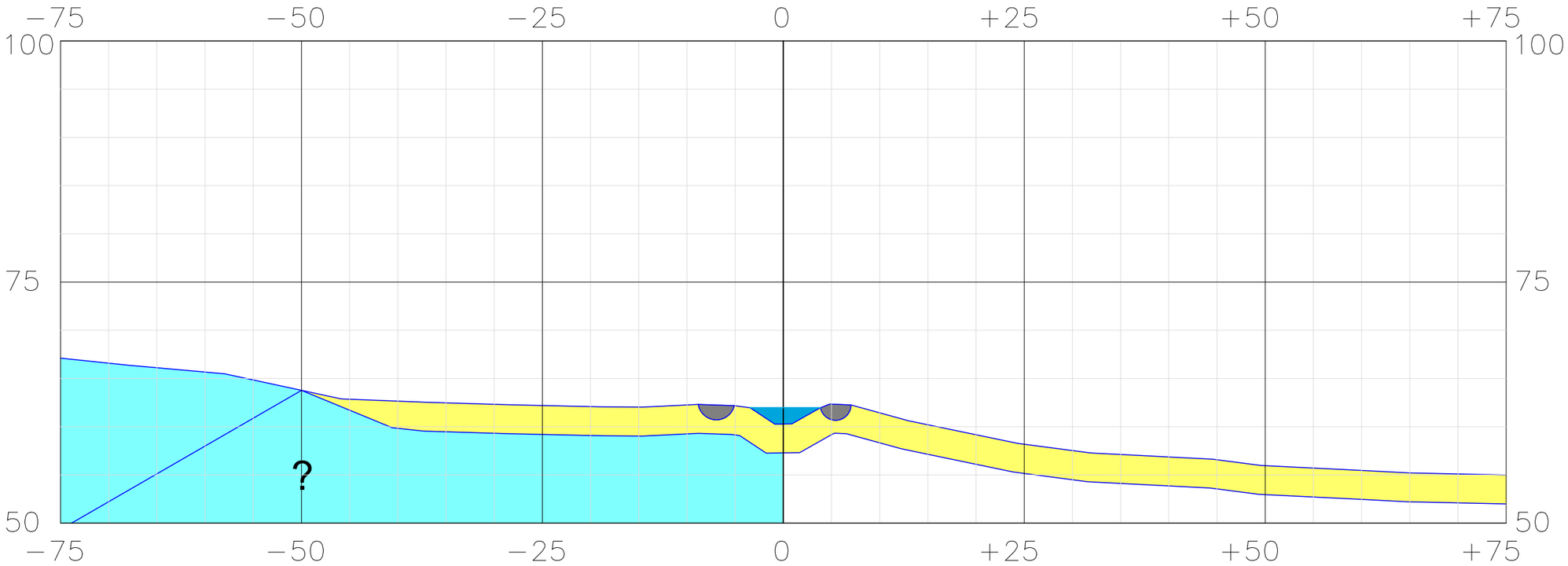
GEOLOGICAL SECTION 18+480



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		49
		DIP & STRIKE	FAULT INFERRED F		

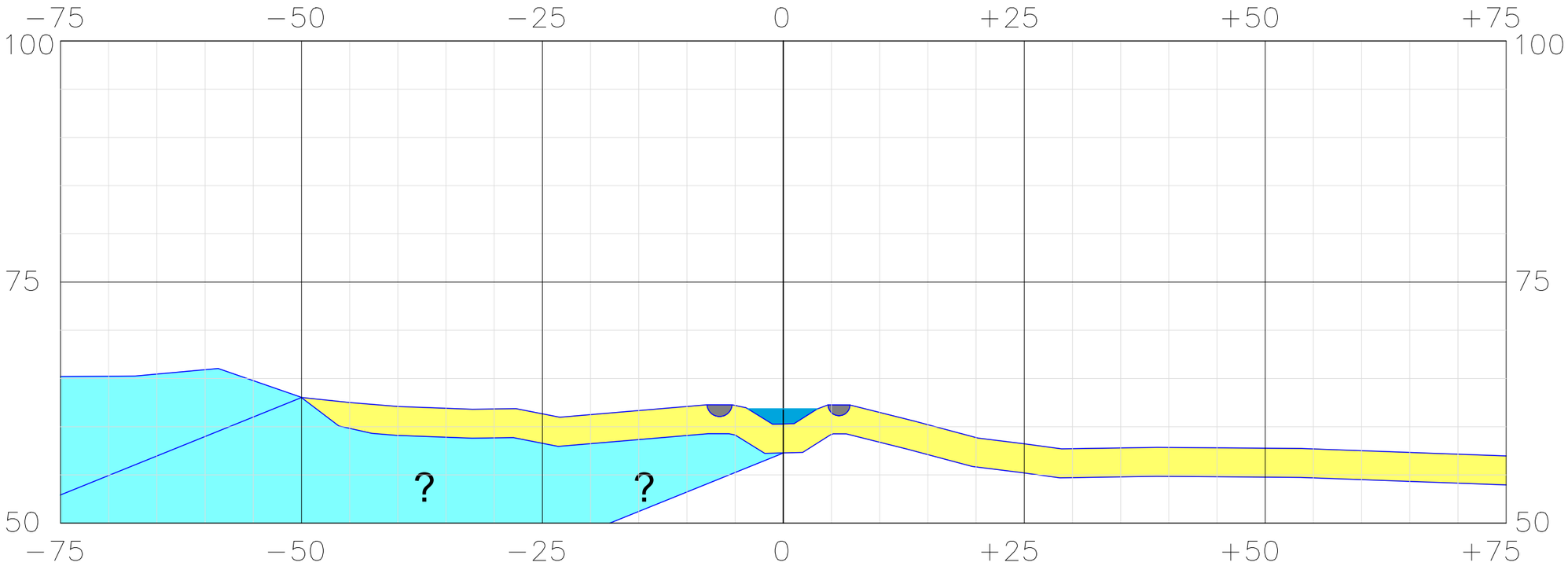
GEOLOGICAL SECTION 18+770



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		50
		DIP & STRIKE	FAULT INFERRED F		

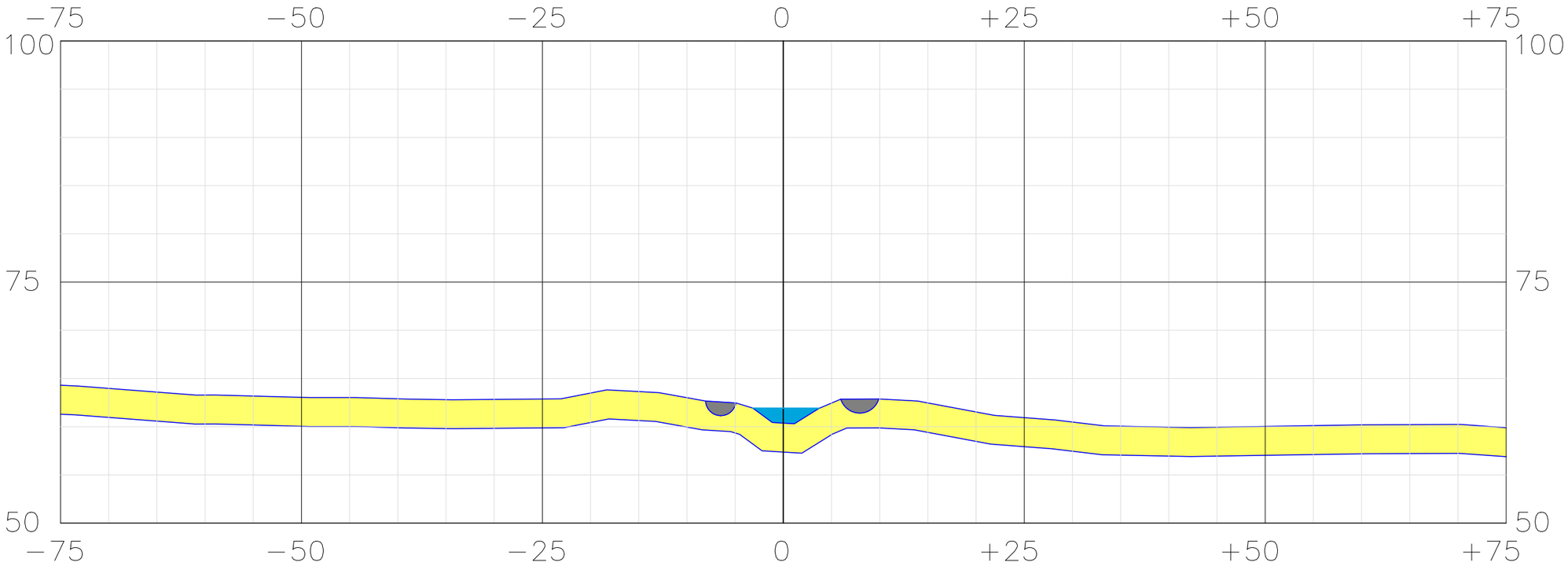
GEOLOGICAL SECTION 19+020



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:-
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	1:500
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE
		SHALE	MUD STONE	UNIDENTIFIED ?	A3
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO
		BORE HOLE	FAULT F		51
		DIP & STRIKE	FAULT INFERRED F		

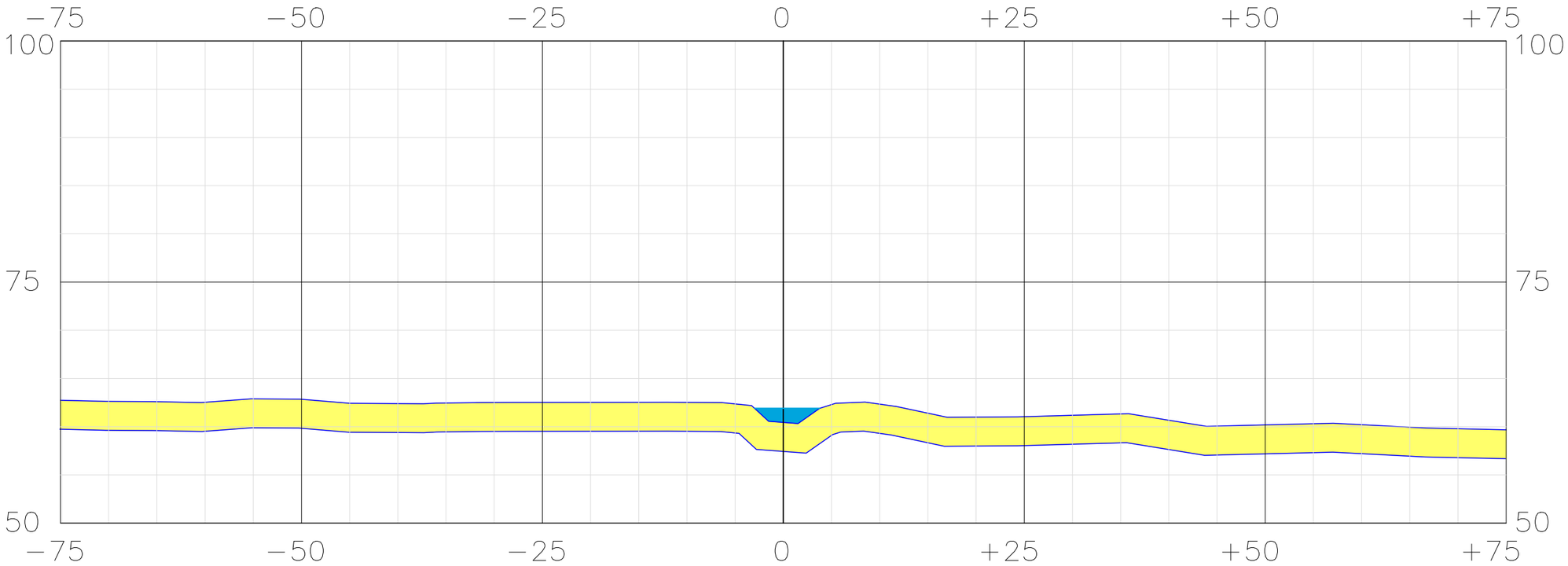
GEOLOGICAL SECTION 19+560



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 52
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

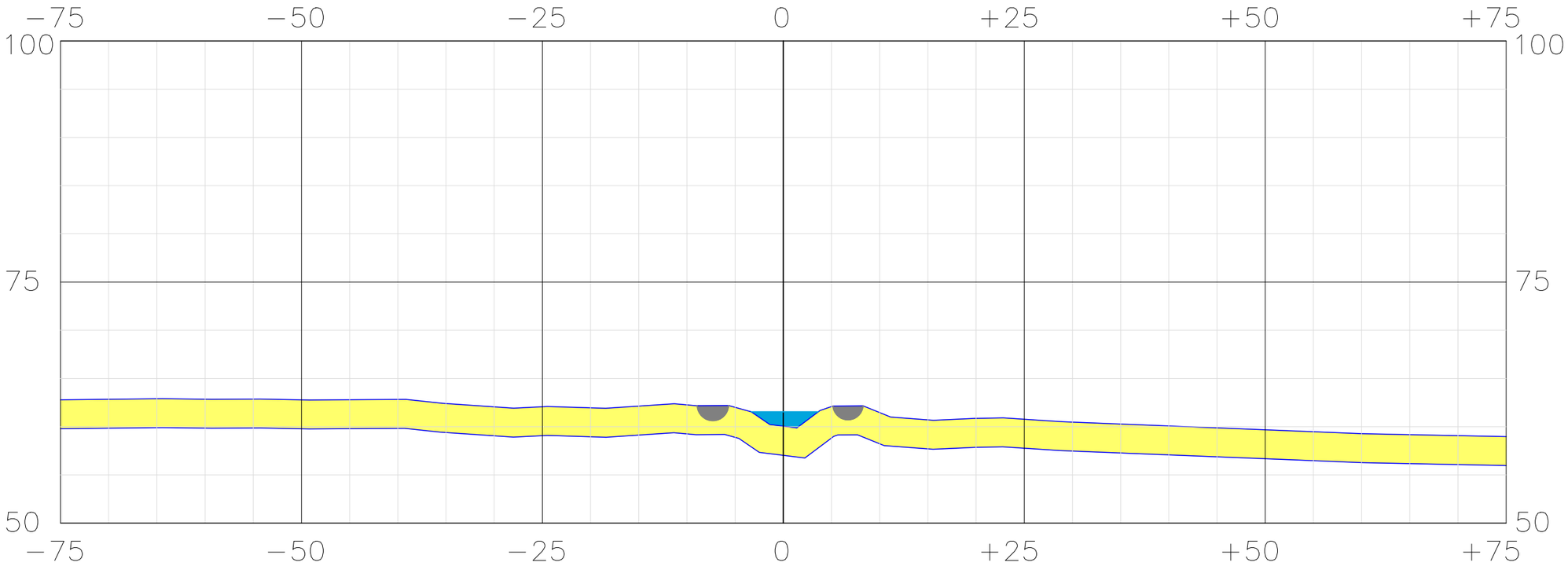
GEOLOGICAL SECTION 19+860



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 53
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

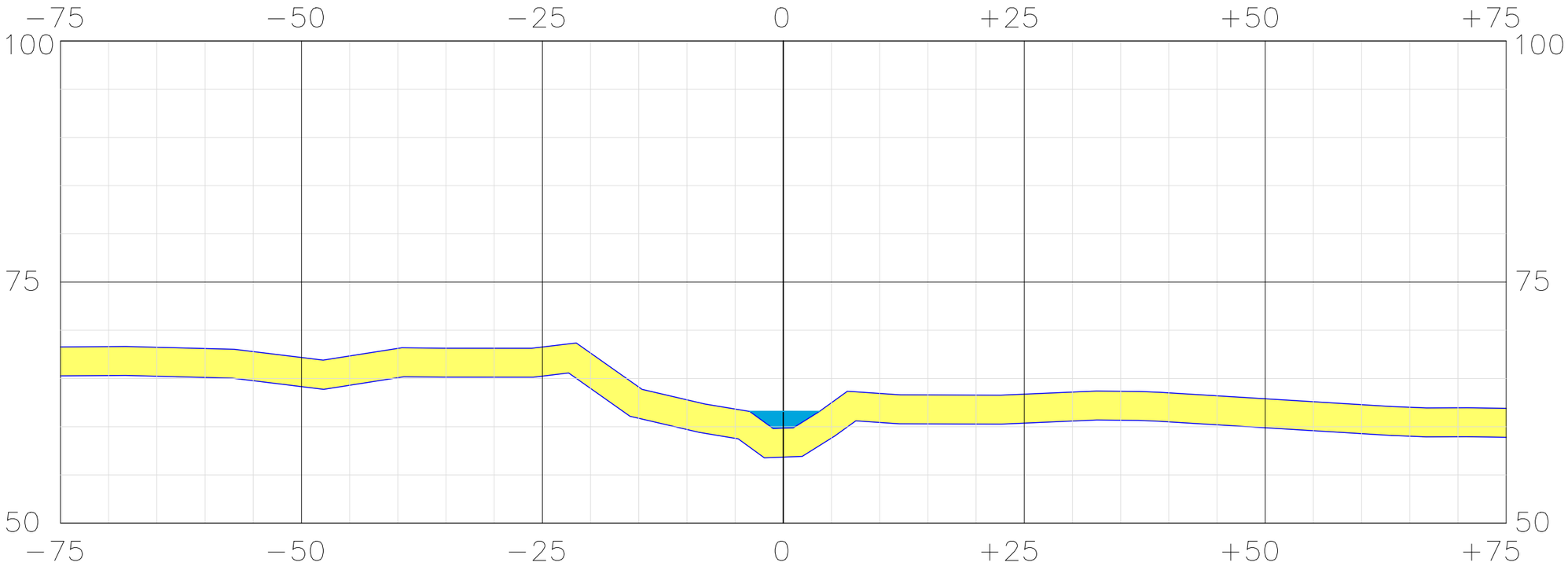
GEOLOGICAL SECTION 20+220



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 54
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

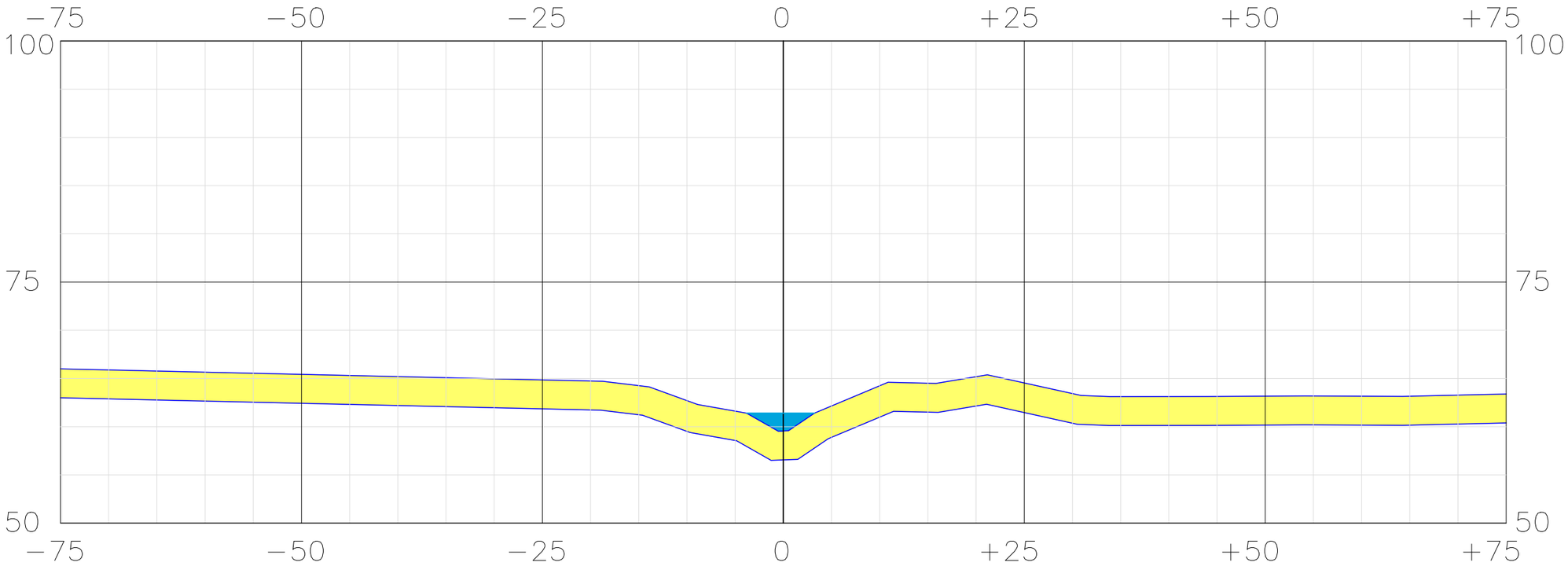
GEOLOGICAL SECTION 20+620



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 55
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

GEOLOGICAL SECTION 20+890



STRUCTURAL CROSS SECTION LOOKING SOUTH

HUB CANAL PROJECT	LEGENDS:-	PIEDMONT	CULTIVATED LAND	OVER BURDEN	SCALE:- 1:500
MAP TITTLE:- GEOLOGICAL MAPING		SAND STONE	GRAVELLY SOIL	QAL	
HALCROW PAKSITAN		CLAY STONE	LIMESTONE	QALI	SHEET SIZE A3
		SHALE	MUD STONE	UNIDENTIFIED ?	
SURVEY TECH (PVT) LTD		TEST PIT	HORIZONTAL BEDDING		SHEET NO 56
		BORE HOLE	FAULT F		
		DIP & STRIKE	FAULT INFERRED F		

ANNEXURE-C

TEST PIT DATA SHEETS

Test Pits Logs of the Karachi Canal

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
1	TP-00	304836.04	2787720.56	00+000	Clayey, Silty sand fine to medium grained including Cobble, pebble with concretion	Right bank Fill material
2	TP-01	304786.15	2787642.56	00+100	Clayey, Silty sand fine to medium grained including Cobble, pebble with concretion	Right bank Fill material
3	TP-02	304731.07	2787569.48	00+200	Fine to medium grained sand with Cobble and pebble	Right bank Fill material
4	TP-03	304675.37	2787492.82	00+300	Fine to medium grained Gravely soil, including boulders	Right bank Fill material
5	TP-04	304615.29	2787397.37	00+400	Fine to medium grained sand with minner clay, moist upto 15% , little plastic	Right bank Fill material
6	TP-05	304572.61	2787320.05	00+500	Fine to medium grained light brown sand with minner gravels	Right bank Fill material
7	TP-06	304525.72	2787233.66	00+600	Fine to medium grained light brown sand with minner gravels	Right bank Fill material
8	TP-07	304467.72	2787155.72	00+700	Gray to brownish gray fine to medium grained sand with minner clay and some gravels.	Right bank Fill material
9	TP-08	304423.93	2787058.29	00+800	Fine to medium grained silty sand	Right bank Fill material
10	TP-09	304381.11	2786969.49	00+900	Fine to medium grained Clayey, Silty sand including Cobble, pebble.	Right bank Fill material
11	TP-10	304315.70	2786908.39	01+000	Fine to medium grained Clayey, Silty sand including Cobble, pebble.	Right bank Fill material
12	TP-11	304263.22	2786815.41	01+100	Fine to medium grained, Silty sand. Contains 5 to 10% gravels.	Right bank Fill material
13	TP-12	304210.77	2786729.31	01+200	Fine to medium grained, Silty, moist sand also contains pebbles and cobble.	Right bank Fill material
14	TP-13	304169.72	2786660.20	01+300	Organic soil mainly composed of fine to medium grained silty sand.	Right bank Fill material
15	TP-14	304116.07	2786550.16	01+400	Light brown to brown fine to medium grained, clayey silty sand. Clay content is 30 to 35% present.	Right bank Fill material
16	TP-15	304089.86	2786453.03	01+500	Fine to medium grained Clayey, Silty sand including Cobble, pebble.	Right bank Fill material
17	TP-16	304095.55	2786357.17	01+600	Fine to medium grained Clayey, Silty sand including minor Cobble, pebble.	Right bank Fill material
18	TP-17	304092.19	2786250.98	01+700	Light brown to brown medium to coarse sand with minor clay and silt. Loosely compected, also contains plant roots and some gravels.	Right bank Fill material
19	TP-18	304114.77	2786154.49	01+800	Fine to medium grained, light gray to gray silty sand also contains grass roots.	Right bank Fill material
20	TP-19	304081.93	2786057.93	01+900	Fine to medium grained, silty sand with cobble pebble and boulders.	Right bank Fill material
21	TP-20	304097.14	2785955.45	02+000	Gray to brownish gray fine to medium grained silty sand, loosely compected.	Right bank Fill material
22	TP-21	304107.50	2785841.07	02+100	Light brown to brown clayey silty sand. Also contains gravel and pebbles, little bit gritty.	Right bank Fill material
23	TP-22	304153.50	2785755.75	02+200	Light brown to brown clayey silty sand. Also contains gravel and pebbles, little bit gritty.	Right bank Fill material
24	TP-23	304221.78	2785684.52	02+300	Fine to medium grained silty sand with minor gravels. 5 to 8% clasts of limestone and sand stone presents.	Right bank Fill material

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
25	TP-24	304213.93	2785598.31	02+400	Light brown to brown fine to medium grained, clayey silty sand also contain pebble and gravels.	Right bank Fill material
26	TP-25	304177.05	2785483.99	02+500	Light brown to brown fine to medium grained, clayey silty sand also contain pebble and gravels.	Right bank Fill material
27	TP-26	304160.20	2785408.36	02+600	Gray to brownish gray Clayey to silty sand. It also contains clasts of sand stone and limestone.	Right bank Fill material
28	TP-27	304119.43	2785295.61	02+700	Light gray to gray, fine to medium grained silty sand. It also contains clay lumps	Right bank Fill material
29	TP-28	304086.50	2785213.06	02+800	Light gray to gray, fine to medium grained silty sand. It also contains clay lumps	Right bank Fill material
30	TP-29	304047.68	2785127.92	02+900	Fine to medium grained, gray to dark gray silty sand.	Right bank Fill material
31	TP-30	304043.43	2785026.44	03+000	Gray to dark gray, fine to medium grained silty sand.	Right bank Fill material
32	TP-31	303998.86	2784944.15	03+100	Light brown to brownish medium to coarse grained silty sand, also includes pebbles and gravels.	Right bank Fill material
33	TP-32	303939.13	2784860.06	03+200	Light brown to brownish medium to coarse grained silty sand, also includes pebbles and gravels.	Right bank Fill material
34	TP-33	303889.15	2784762.15	03+300	Light brown to brown, medium to coarse grained sand including minor amount of silt.	Right bank Fill material
35	TP-34	303853.46	2784677.90	03+400	Light gray to gray, fine to medium grained silty sand with minor clasts of sandstone, limestone and plants roots presents.	Right bank Fill material
36	TP-35	303825.13	2784581.15	03+500	Light gray to gray, fine to medium grained silty sand with minor clasts of sandstone, limestone and plants roots presents.	Right bank Fill material
37	TP-36	303786.17	2784479.63	03+600	Light gray to gray, fine to medium grained sand, containing pebbles and gravels presents.	Right bank Fill material
38	TP-37	303783.86	2784382.27	03+700	Light gray to gray, loosely compected silty sand containing pebbles, gravel and plant roots.	Right bank Fill material
39	TP-38	303803.45	2784268.20	03+800	Fine to medium grained, sandy silt includes grass roots, also contains clay in minor amount.	Right bank Fill material
40	TP-39	303848.28	2784193.26	03+900	Light brown to brown silty sand also contains clasts of sandstone and limestone.	Right bank Fill material
41	TP-40	303888.55	2784096.54	04+000	Light brown to brown sandy silt, loosely complected also containing minor pebbles and cobbles.	Right bank Fill material
42	TP-41	303937.94	2784002.97	04+100	Light gray to brownish gray clayey silt, also containing clasts of sand stone and limestone.	Right bank Fill material
43	TP-42	303978.62	2783924.29	04+200	Light brown to brown Clayey sandy silt with minor concretion and plants roots.	Right bank Fill material
44	TP-43	304021.81	2783832.59	04+300	Light gray to brownish gray , fine to medium grained silty sand.	Right bank Fill material
45	TP-44	304061.47	2783731.46	04+400	Light gray to brownish gray, silty sand, little bit moist also containing cobbles and pebbles.	Right bank Fill material
46	TP-45	304095.80	2783654.12	04+500	Light gray to gray, fine to medium grained silty sand with minor clay. Loosely compected also containing cobbles and pabbles.	Right bank Fill material

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
47	TP-46	304085.48	2783560.85	04+600	Light gray to gray, fine to medium grained silty sand with minor clay. Loosely compected also containing cobbles and pabbles.	Right bank Fill material
48	TP-47	304057.71	2783463.03	04+700	Light gray to gray, fine to medium grained silty sand. Loosely compected and little moist	Right bank Fill material
49	TP-48	304034.26	2783368.04	04+800	Light brown to brown, fine to medium grained silty sand with minor clay and little moist, also includes minor cobbles, pebbles and concretions.	Right bank Fill material
50	TP-49	303991.22	2783271.78	04+900	Light brown to brown, fine to medium grained silty sand with minor clay and little moist, also includes minor cobbles, pebbles and concretions.	Right bank Fill material
51	TP-50	303948.26	2783194.96	05+000	Light brown to brown, fine to medium grained silty sand also containing gravels and pebbles.	Right bank Fill material
52	TP-51	303930.29	2783079.90	05+100	Light brown to brown, silty sand with minor clay. It is loosely compected at site.	Right bank Fill material
53	TP-52	303895.85	2783014.59	05+200	Light brown to brown, silty sand with minor clay. It is loosely compected at site, also includes grass roots.	Right bank Fill material
54	TP-53	303894.93	2782891.86	05+300	Light brown to brown, silty sand with minor clay. It is loosely compected at site, also includes grass roots.	Right bank Fill material
55	TP-54	303857.19	2782795.72	05+400	Light brown to brown, silty sand with minor clay. It is loosely compected at site.	Right bank Fill material
56	TP-55	303815.41	2782697.44	05+500	Light brown to brown, silty sand with minor clay. It is loosely compected at site.	Right bank Fill material
57	TP-56	303762.79	2782601.89	05+600	Loosely compected, silty sand containg clasts of sandstone and limestone with minor clay. Clasts are rounded to sub rounded.	Right bank Fill material
58	TP-57	303762.13	2782512.54	05+700	Fine to medium grained siltysand, also containing cobbles and pebbles.	Right bank Fill material
59	TP-58	303725.27	2782422.08	05+800	Light gray to gray, fine to medium grained sand with minor clay, also containing cobbles and pebbles.	Right bank Fill material
60	TP-59	303694.37	2782330.49	05+900	Light gray to gray, fine to medium grained sand with minor clay, also containing cobbles and pebbles.	Right bank Fill material
61	TP-60	303665.84	2782236.21	06+000	Fine to medium grained, siltysand.	Right bank Fill material
62	TP-61	303633.89	2782102.14	06+100	Light brown to brown, Clayey siltysand , also containing cobbles and pebbles of angular to sub-angular in shape.	Right bank Fill material
63	TP-62	303629.37	2782022.40	06+200	Light brown to brown, Clayey siltysand , also containing cobbles and pebbles of angular to sub-angular in shape.	Right bank Fill material
64	TP-63	303604.90	2781944.79	06+300	Light brown to brown, Clayey siltysand , also containing cobbles and pebbles of angular to sub-angular in shape.	Right bank Fill material
65	TP-64	303595.73	2781832.14	06+400	Fine to medium grained, Clayey siltysand also containing clasts of sand stone and limestone.	Right bank Fill material

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
66	TP-65	303558.19	2781743.05	06+500	Fine to medium grained, Clayey siltysand also containing clasts of sand stone and limestone.	Right bank Fill material
67	TP-66	303523.57	2781634.61	06+600	Light brown to brown, medium to coarse grained sand including minor cobbles and pebbles.	Right bank Fill material
68	TP-67	303510.21	2781555.13	06+700	Clayey Silty sand, containing to clasts of sandstone and limestone.	Right bank Fill material
69	TP-68	303468.77	2781445.96	06+800	Clayey Silty sand, containing to clasts of sandstone and limestone.	Right bank Fill material
70	TP-69	303435.22	2781375.39	06+900	Clayey Silty sand, containing to clasts of sandstone and limestone. Gravels are rounded to sub-rounded.	Right bank Fill material
71	TP-70	303431.63	2781271.17	07+000	Clayey Silty sand, containing to clasts of sandstone and limestone. Gravels are rounded to sub-rounded.	Right bank Fill material
72	TP-71	303412.96	2781187.36	07+100	Clayey Silty sand, containing to clasts of sandstone and limestone. Gravels are rounded to sub-rounded.	Right bank Fill material
73	TP-72	303397.77	2781081.64	07+200	Clayey Silty sand, containing to clasts of sandstone and limestone. Gravels are rounded to sub-rounded.	Right bank Fill material
74	TP-73	303372.11	2780968.34	07+300	Clayey Silty sand, containing to clasts of sandstone and limestone. Gravels are rounded to sub-rounded.	Right bank Fill material
75	TP-74	303354.72	2780860.07	07+400	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles.	Right bank Fill material
76	TP-75	303359.09	2780755.81	07+500	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles. It also includes rounded to sub-rounded gravels.	Right bank Fill material
77	TP-76	303384.57	2780619.96	07+600	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles. It also includes rounded to sub-rounded gravels.	Right bank Fill material
78	TP-77	303439.43	2780560.58	07+700	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles. It also includes rounded to sub-rounded gravels.	Right bank Fill material
79	TP-78	303423.45	2780493.18	07+800	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles. It also includes rounded to sub-rounded gravels.	Right bank Fill material
80	TP-79	303404.27	2780401.66	07+900	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles. It also includes rounded to sub-rounded gravels.	Right bank Fill material
81	TP-80	303405.87	2780298.01	08+000	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles. It also includes rounded to sub-rounded gravels. It is loosely compecgted at site.	Right bank Fill material

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
82	TP-81	303381.22	2780191.58	08+100	Light brown to brown, medium to coarse grained, siltysand with minor amount of pebbles and cobbles. It also includes rounded to sub-rounded gravels. It is loosely compecgted at site.	Right bank Fill material
83	TP-82	303360.63	2780110.43	08+200	Light brown to brown, fine to medium grained siltysand with minor clay also containing pebbles and cobbles and boulders.	Right bank Fill material
84	TP-83	303338.83	2780010.18	08+300	Light brown to brown, fine to medium grained siltysand with minor clay also containing pebbles and cobbles and boulders.	Right bank Fill material
85	TP-84	303314.38	2779892.00	08+400	Light brown to brown, fine to medium grained siltysand with minor clay also containing pebbles and cobbles and boulders.	Right bank Fill material
86	TP-85	303294.91	2779800.41	08+500	Light brown to brown, fine to medium grained siltysand with minor clay also containing pebbles and cobbles and boulders. It is little bit moist.	Right bank Fill material
87	TP-86	303280.20	2779702.63	08+600	Light brown to brownish silty sand with rock fragments sandstone and siltstone.	Right bank Fill material
88	TP-87	303256.51	2779610.15	08+700	Light brown to brownish silty sand with rock fragments sandstone and siltstone.	Right bank Fill material
89	TP-88	303217.38	2779516.18	08+800	Light brown to brownish silty sand with rock fragments sandstone and siltstone.	Right bank Fill material
90	TP-89	303205.54	2779442.45	08+900	Light gray to dark gray, fine to medium grained little bit moist sand.	Right bank Fill material
91	TP-90	303175.82	2779320.76	09+000	Light gray to dark gray siltysand with minor amount of pebbles and cobbles.	Right bank Fill material
92	TP-91	303146.07	2779222.41	09+100	Light gray to dark gray siltysand with minor amount of pebbles and cobbles.	Right bank Fill material
93	TP-92	303120.72	2779120.39	09+200	Light gray to dark gray siltysand with minor amount of pebbles and cobbles.	Right bank Fill material
94	TP-93	303106.17	2779029.58	09+300	Fine to medium grained siltysand with minor amount of cobbles and pebbles, loosely compected at site.	Bed rocks exposed at Toe.
95	TP-94	303078.50	2778957.65	09+400	Light gray to gray silty sand loosley compected at site.	Natural surface, diversion way
96	TP-95	303067.24	2778841.86	09+500	Light brown to brown, fine to medium grained clayey silty sand including pebbles and cobbles and boulders. It is slightly moists. Poorly sorted sand stone presents in vacinity.	Right bank Fill material
97	TP-96	303043.58	2778737.43	09+600	Light brown to brown, fine to medium grained clayey silty sand including pebbles and cobbles and boulders. It is slightly moists. Poorly sorted sand stone presents in vacinity.	Right bank Fill material
98	TP-97	303019.72	2778647.68	09+700	Light brown to brown, fine to medium grained clayey silty sand including pebbles and cobbles and boulders. It is slightly moists. Poorly sorted sand stone presents in vacinity.	Right bank Fill material

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
99	TP-98	302984.97	2778566.29	09+800	Light gray to gray, clayey siltysand with concretions, also includes pebbles cobbles and boulders of sandstone in irregular shapes exisit.	Right bank Fill material
100	TP-99	302963.59	2778460.95	09+900	Light gray to gray, clayey siltysand with concretions, also includes pebbles cobbles and boulders of sandstone in irregular shapes exisit.	Right bank Fill material
101	TP-100	302916.69	2778353.66	10+000	Light gray to gray fine to medium grained sand, including boulders of sandstone in irregular shapes. Loosely compected at site. The size of the boulders are 1 to 2 metrs in thickness.	Right bank Fill material
102	TP-101	302887.54	2778276.39	10+100	Light gray to gray, fine to medium grained siltysand with minor concretions also includes cobbles and pebbles.	Right bank Fill material
103	TP-102	302885.00	2778169.52	10+200	Light gray to gray, fine to medium grained clayeysand with minor concretions also includes cobbles and pebbles.	Right bank Fill material
104	TP-103	302853.80	2778083.19	10+300	Light gray to gray, fine to medium grained clayeysand with minor concretions also includes cobbles and pebbles. Loosely compected at sandstone beds.	Right bank Fill material
105	TP-104	302809.76	2777983.52	10+400	Light gray to gray, fine to medium grained clayeysand with minor concretions also includes cobbles and pebbles. Loosely compected at sandstone beds.	Right bank Fill material
106	TP-105	302783.36	2777881.45	10+500	Light brown to brown, fine to medium grained siltysand, it includes cobbles and pebbles in minor amount.	Right bank Fill material
107	TP-106	302766.66	2777755.68	10+600	Fine to medium grained, silty sand. Probably placed at sandstone, loosely compected at Natural surface.	Right bank Natural Surface
108	TP-107	302733.40	2777682.88	10+700	Fine to medium grained, silty sand. Probably placed at sandstone, loosely compected at Natural surface.	Right bank Fill material
109	TP-108	302699.75	2777621.70	10+800	Fine to medium grained, silty sand. Probably placed at sandstone, loosely compected at Natural surface.	Right bank Fill material
110	TP-109	302645.55	2777513.02	10+900	Light brown to brown, fine to medium grained siltysand, it is dry at place and it contain cobbles and pebbles in minor amount.	Right bank Fill material
111	TP-110	302643.32	2777418.50	11+000	Light gray to creamish gray fine to medium grained siltysand with minor cobbles and pebbles. It is loosely compected at site.	Right bank Fill material
112	TP-111	302663.40	2777319.33	11+100	Light brown to brown, fine to medium grained siltysand, little moist with minor concretion, it also includes cobbles and pebbles.	Right bank Natural Surface.

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
113	TP-112	302677.56	2777213.41	11+200	Light gray to gray, fine to medium grained, siltysand, even coarse grained sand also presents at places naturally. It is loosely compected at site. Minor amount of standstone boulders presents at surrounding.	Right bank Natural Surface.
114	TP-113	302686.29	2777110.07	11+300	Fine to medium grained, Clayey siltysand including cobbles pebbles and boulders of sandstone exist at site.	Right bank Natural Surface.
115	TP-114	302699.37	2777021.77	11+400	Fine to medium grained, siltysand with minor amount of cobbles and pebbles present at site.	Right bank Natural Surface.
116	TP-115	302699.15	2776916.16	11+500	Fine to medium grained, siltysand with minor amount of cobbles and pebbles present at site.	Right bank Fill material
117	TP-116	302710.95	2776800.96	11+600	Fine to medium grained, siltysand with minor amount of cobbles and pebbles present at site.	Right bank Fill material
118	TP-117	302721.44	2776703.54	11+700	Fine to medium grained, siltysand with minor clay includied cobble, pebble and boulders at sandstone. The shape of the boulders are irregular.	Right bank Natural Surface
119	TP-118	302681.23	2776624.49	11+800	Fine to medium grained siltysand loosely compected at surface. It includeds cobbles, pebbles.	Right bank Natural Surface
120	TP-119	302628.96	2776541.13	11+900	Light gray to gray, fine to medium grained, siltysand with cobbles and pebbles.	Right bank Natural Surface
121	TP-120	302694.56	2776439.08	12+000	Fine to medium grained, siltysand including cobbles pebbles presents.	Right bank Natural Surface
122	TP-121	302712.34	2776374.43	12+100	Fine to medium grained, siltysand including cobbles pebbles presents.	Right bank Natural Surface
123	TP-122	302710.07	2776261.23	12+200	Fine to medium grained, siltysand including cobbles pebbles presents.	Right bank Natural Surface
124	TP-123	302710.39	2776181.00	12+300	Fine to medium grained, siltysand including cobbles pebbles presents.	Right bank Natural Surface
125	TP-124	302692.30	2776084.46	12+400	Light gray to gray, fine to medium graind, siltysand alongwith cobbles and pebbles. Clay content in minor amount also reflects.	Right bank Fill material
126	TP-125	302667.73	2775977.16	12+500	Light gray to gray, fine to medium graind, siltysand alongwith cobbles and pebbles. Clay content in minor amount also reflects.	Right bank Natural Surface
127	TP-126	302613.80	2775901.07	12+600	Light brown to brown fine to medium grained siltysand.	Right bank Fill material
128	TP-127	302563.31	2775808.50	12+700	Light brown to brown fine to medium grained siltysand.	Right bank Fill material
129	TP-128	302550.70	2775729.37	12+800	Light brown to brown fine to medium grained siltysand.	Right bank Fill material
130	TP-129	302535.46	2775643.60	12+900	Light brown to brown fine to medium grained siltysand.	Right bank Fill material
131	TP-130	302515.75	2775534.05	13+000	Light brown to brown fine to medium grained siltysand.	Right bank Fill material
132	TP-131	302482.17	2775449.04	13+100	Light brown to brown, fine to medium grained siltysand. The amount of cobbles and pebbles are decreasing towords looking down stream.	Right bank Fill material
133	TP-132	302445.76	2775338.54	13+200	Light brown to brown, fine to medium grained, clayey siltysand. It is loosely compected along the canal line.	Right bank Natural Surface

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
134	TP-133	302403.29	2775259.57	13+300	Light brown to brown, fine to medium grained, clayey siltysand. It is loosely compected along the canal line.	Right bank Natural Surface
135	TP-134	302367.61	2775169.33	13+400	Light brown to brown, fine to medium grained, clayey siltysand. It is loosely compected along the canal line.	Right bank Natural Surface
136	TP-135	302304.13	2775112.35	13+500	Light brown to brown, fine to medium grained, clayey siltysand. It is loosely compected along the canal line.	Right bank Natural Surface
137	TP-136	302226.37	2775045.17	13+600	Fine to medium grained, light brown to brown, siltysand with concretion of limestone and sandstone presents.	Right bank Natural Surface
138	TP-137	302185.21	2774952.77	13+700	Light brown to dark brown, fine to medium grained siltysand, it also includes pebbles and cobbles.	Right bank Natural Surface
139	TP-138	302113.47	2774906.90	13+800	Light brown to dark brown, fine to medium grained siltysand. it also includes clasts of sandstone and limestone.	Right bank Natural Surface
140	TP-139	301998.82	2774860.56	13+900	Light brown to dark brown, fine to medium grained siltysand. it also includes clasts of sandstone and limestone.	Right bank Natural Surface
141	TP-140	301929.32	2774820.73	14+000	Light brown to dark brown, fine to medium grained siltysand. it also includes clasts of sandstone and limestone.	Right bank Natural Surface
142	TP-141	301841.83	2774753.63	14+100	Light brown to dark brown, fine to medium grained siltysand. it also includes clasts of sandstone and limestone.	Right bank Natural Surface
143	TP-142	301820.41	2774646.08	14+200	Light gray to dark gray siltysand, highly moist.	Right bank Natural Surface
144	TP-143	301813.49	2774542.80	14+300	Light gray to dark gray siltysand, highly moist.	Right bank Natural Surface
145	TP-144	301798.81	2774459.77	14+400	Light gray to dark gray siltysand, highly moist.	Right bank Natural Surface
146	TP-145	301788.10	2774346.44	14+500	Gray to dark gray, coarse grained siltysand, also includes rounded to sub rounded clasts of sandstone and limestone presents.	Right bank Natural Surface
147	TP-146	301781.12	2774265.26	14+600	Fine to medium grained siltysand.	Right bank Natural Surface
148	TP-147	301775.49	2774148.14	14+700	Gray to dark gray, coarse grained siltysand, also includes rounded to sub rounded clasts of sandstone and limestone presents.	Right bank Fill material
149	TP-148	301761.66	2774050.56	14+800	Gray to dark gray, coarse grained siltysand, also includes rounded to sub rounded clasts of sandstone and limestone presents.	Right bank Fill material
150	TP-149	301699.85	2773967.78	14+900	Light brown to dark brown, clayey siltysand, lumps of clay also presents.	Right bank Fill material
151	TP-150	301644.32	2773901.50	15+000	Light brown to brown, fine to medium grained, siltysand.	Right bank Fill material
152	TP-151	301571.98	2773822.58	15+100	Light brown to brown, fine to medium grained, siltysand.	Right bank Fill material
153	TP-152	301527.94	2773747.48	15+200	Light brown to brown, fine to medium grained, siltysand.	Right bank Fill material
154	TP-153	301467.24	2773633.58	15+300	Light brown to dark brown, fine to medium grained, siltysand. It is dry nature.	Right bank Natural Surface

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
155	TP-154	301430.03	2773532.97	15+400	Light brown to dark brown, fine to medium grained, siltysand. It is dry nature.	Right bank Natural Surface
156	TP-156	301361.55	2773372.21	15+500	Light brown to dark brown, fine to medium grained, siltysand. It is dry nature.	Right bank Natural Surface
157	TP-155	301391.82	2773447.03	15+600	Light brown to dark brown, fine to medium grained, siltysand. It is dry nature.	Right bank Natural Surface
158	TP-157	301307.01	2773273.03	15+700	Light brown to dark brown, fine to medium grained, siltysand. It is dry nature.	Right bank Natural Surface
159	TP-158	301276.21	2773181.18	15+800	Light brown to brown, fine to medium grained, siltysand with minor amount of clay and loosely compected at surface.	Right bank Fill material
160	TP-159	301239.11	2773104.75	15+900	Light brown to brown, fine to medium grained, siltysand with minor amount of clay and loosely compected at surface.	Right bank Fill material
161	TP-160	301242.81	2772981.81	16+000	Light brown to dark brown, fine to medium grained, siltysand.	Left bank Fill material
162	TP-161	301238.20	2772893.90	16+100	Light brown to dark brown, fine to medium grained, siltysand.	Left bank Fill material
163	TP-162	301232.53	2772790.26	16+200	Light brown to dark brown, fine to medium grained, siltysand.	Left bank Fill material
164	TP-163	301226.51	2772686.02	16+300	Light brown to dark brown, fine to medium grained, siltysand.	Left bank Fill material
165	TP-164	301222.38	2772588.23	16+400	Light brown to dark brown, fine to medium grained, siltysand.	Left bank Fill material
166	TP-165	301193.70	2772497.42	16+500	Light brown to dark brown, siltysand with minor amount of clay.	Left bank Fill material
167	TP-166	301146.24	2772403.74	16+600	Light brown to dark brown, siltysand with minor amount of clay.	Left bank Fill material
168	TP-167	301107.54	2772322.97	16+700	Light brown to dark brown, siltysand with minor amount of clay. Rocks fragments also encountered.	Left bank Natural surface
169	TP-168	301047.98	2772224.28	16+800	Light brown to dark brown, siltysand with minor amount of clay. Rocks fragments also encountered.	Left bank Natural surface
170	TP-169	301019.12	2772165.24	16+900	Fine to medium grained, siltysand with minor clay. It is little moist at places, it also includes concretions.	Left bank Fill material
171	TP-170	301001.75	2772037.27	17+000	Fine to medium grained, siltysand with minor clay. It is little moist at places, it also includes concretions.	Left bank Fill material
172	TP-171	300987.18	2771933.99	17+100	Light brown to dark brown, fine to medium grained siltysand.	Left bank Natural surface
173	TP-172	300977.96	2771842.62	17+200	Light brown to dark brown, fine to medium grained siltysand. Cobbles and pebbles of limestone also presents.	Left bank Natural surface
174	TP-173	300975.55	2771740.99	17+300	Light brown to dark brown, fine to medium grained siltysand. Cobbles and pebbles of limestone also presents.	Left bank Fill material
175	TP-174	300972.30	2771634.86	17+400	Light brown to dark brown, fine to medium grained siltysand. Cobbles and pebbles of limestone also presents.	Left bank Fill material
176	TP-175	301024.98	2771532.47	17+500	Light brown to dark brown, fine to medium grained siltysand.	Left bank Fill material

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
177	TP-176	300897.37	2771491.05	17+600	Light brown to dark brown, fine to medium grained siltysand.	Left bank Fill material
178	TP-177	300818.79	2771451.36	17+700	Light brown to dark brown, fine to medium grained siltysand. Fault zone filled with bedding of sandy limestone at surface.	Left bank Natural surface
179	TP-178	300729.11	2771399.89	17+800	Light brown to brown, fine to medium grained, siltysand with little clay, also moist.	Left bank Fill material
180	TP-179	300677.97	2771332.20	17+900	Light brown to brown, fine to medium grained, siltysand with little clay, also moist. It is loosely compected at site.	Left bank Fill material
181	TP-180	300634.43	2771221.73	18+000	Light brown to brown, fine to medium grained, siltysand with little clay, also moist. It is loosely compected at site.	Left bank Fill material
182	TP-181	300607.33	2771145.11	18+100	Light brown to brown, fine to medium grained, siltysand with little clay, also includes cobbles and pebbles in minor amount. It is loosely compected at site.	Left bank Fill material
183	TP-182	300582.55	2771061.80	18+200	Light brown to brown, fine to medium grained, siltysand with little clay, also includes cobbles and pebbles in minor amount. It is loosely compected at site and grass roots also presents.	Left bank Fill material
184	TP-183	300548.94	2770949.17	18+300	Light brown to brown, fine to medium grained, siltysand with little clay, also includes cobbles and pebbles in minor amount. It is loosely compected at site and grass roots also presents.	Left bank Fill material
185	TP-184	300487.45	2770852.78	18+400	Light brown to brown, fine to medium grained, siltysand with little clay, also includes cobbles and pebbles in minor amount. It is loosely compected at site and grass roots also presents.	Left bank Fill material
186	TP-185	300452.13	2770774.60	18+500	Light brown to brown, fine to medium grained, siltysand with little clay, also includes cobbles and pebbles in minor amount. It is loosely compected at site and grass roots also presents.	Left bank Fill material
187	TP-186	300441.41	2770686.99	18+600	Light brown to brown, fine to medium grained, siltysand with little clay, also includes cobbles and pebbles in minor amount. It is loosely compected at site and grass roots also presents.	Left bank Fill material
188	TP-187	300429.39	2770586.66	18+700	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface.	Left bank Fill material
189	TP-188	300438.99	2770485.52	18+800	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface.	Left bank Fill material
190	TP-189	300448.95	2770367.52	18+900	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface.	Left bank Fill material

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
191	TP-190	300461.76	2770282.53	19+000	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface.	Left bank Fill material
192	TP-191	300509.42	2770195.78	19+100	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface.	Left bank Natural surface
193	TP-192	300563.81	2770128.75	19+200	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface.	Left bank Natural surface
194	TP-193	300599.47	2770038.69	19+300	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Fill material
195	TP-194	300643.22	2769926.40	19+400	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
196	TP-195	300675.72	2769844.38	19+500	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
197	TP-196	300706.01	2769750.79	19+600	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
198	TP-197	300732.88	2769647.22	19+700	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
199	TP-198	300688.09	2769545.46	19+800	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
200	TP-199	300622.75	2769473.59	19+900	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface

Sr #	Test Pit #	Coordinates		RD	Description	REMARKS
		Easting	Northing			
201	TP-200	300535.38	2769422.15	20+000	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
202	TP-201	300459.32	2769364.21	20+100	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
203	TP-202	300377.31	2769302.40	20+200	Light brown to brown, fine to medium grained, siltysand with minor concretion. Rocks pieces also encourntered at surroundings. It is loosely compected at surface. Clay contents also present in minor amount.	Left bank Natural surface
204	TP-203	300310.14	2769236.23	20+300	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface.	Left bank Natural surface
205	TP-204	300238.68	2769152.88	20+400	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface.	Left bank Natural surface
206	TP-205	300195.16	2769081.64	20+500	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface.	Left bank Natural surface
207	TP-206	300192.88	2768987.95	20+600	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface.	Left bank Natural surface
208	TP-207	300205.67	2768882.04	20+700	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface.	Left bank Natural surface
209	TP-208	300211.92	2768786.96	20+800	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface. It is highly moist.	Left bank Natural surface
210	TP-209	300225.81	2768683.72	20+900	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface. It is highly moist.	Left bank Natural surface
211	TP-210	300242.15	2768579.12	21+000	Light brown to brown, fine to medium grained siltysand with minor clay. It includes cobbles and pebbles in minor amount. Loosely compected at surface. It is highly moist.	Left bank Natural surface

ANNEXURE-D

PROJECT PHOTOGRAPHS

PROJECT PHOTOGRAPHS

TEST PIT
26
PROJECT

TEST PIT
104
PROJECT

SURVEY TECH (PVT) LTD
ENGINEERS, CONTRACTORS, GEOLOGIST & PROFESSIONAL SURVEYORS

REPORT

GEOTECHNICAL INVESTIGATION

AT
Karachi

PROJECT
Rehabilitation of Karachi Water Canal

CLIENT:

HPK
Halcrow Pakistan (Pvt) Ltd

October, 2020

H-129,Block-II,Sector C-I, Township, Lahore-Pakistan. ☎+92-42-35465005, Fax: 042- 35465005
E-mail: surveytech2@gmail.com URL: www.surveytechpak.com

TABLE OF CONTENT

Sr. #	Description	Page #
1.	**NTRODUCTION**	**01**
1.1	General	01
1.2	Description of the Project Components	01
1.3	Objectives of Investigations	02
1.4	Scope of Work	02
1.5	General Site Conditions, Climate	02
1.6	Format of the Report	03
2.	**GEOLOGY AND SEISMICITY OF THE AREA**	**04**
2.1	General	04
2.2	Geology	04
2.3	Seismicity	04
3.	**FIELD GEOTECHNICAL ACTIVITIES**	**05**
3.1	Investigation Program	05
3.2	Drilling of Boreholes	05
3.3	Standard Penetration Tests (SPTs)	06
3.4	Disturbed Sampling	06
3.5	Core Drilling and Sampling	06
3.6	Groundwater Table	06
4.	**LABORATORY TESTING**	**07**
4.1	General	**07**
4.2	Discussion of Salient Test Results	07
	4.2.1 Classification Tests and Atterberg Limits	07
	4.2.2 Specific Gravity	08
	4.2.3 Strength Tests on Soil Samples	08
	4.2.4 Strength Tests on Rock Samples	08
	4.2.5 Chemical Tests on Soil	08
5.	**SITE GEOTECHNICS**	**10**
5.1	Lithology and Stratigraphy	10
5.2	In-Situ Compactness	10
5.3	Shear Strength	10
5.4	Settlement Potential	10
5.5	Groundwater	10
5.6	Chemical Aggressivity	11

6.	**CONSIDERATIONS FOR DESIGN AND CONSTRUCTION OF FOUNDATIONS**	**12**
6.1	General	12
6.2	Design Criteria	12
6.3	Excavations/Earth Work	12
6.4	Coefficients of Lateral Earth Pressure	12
6.5	Type of Cement	13
6.6	Fill Placement and Compaction	13
7.	**CONCLUSIONS AND RECOMMENDATIONS**	**14**

ANNEXURE

Annexure-I	Zoning Map of Sindh
Annexure-II	Borehole Logs
Annexure-III	Summary of Laboratory Test Results
Annexure-IV	Laboratory Test Result
Annexure -V	Field Photographs

1. Introduction

1.1 General

Hub dam is a large water storage reservoir, constructed on Hub River for supply of Municipal, Industrial and Irrigation water to Karachi - Sindh and Lasbella district in Balochistan. The Hub Canal System consists of Main Canal, Karachi Water Supply Canal, Lasbella Canal and a Bund Murad Minor.

In order to carry out the rehabilitation of the canal system, it was essential to carry out Geotechnical studies of the project. The task was delegated to M/S SURVEY TECH, Lahore, Pakistan. The field investigations and laboratory testing for determination of the subsoil conditions were carefully planned by experienced geotechnical engineers of GeoScience Associates. The field investigations were carried out under the full-time supervision of an experienced geologist of GeoScience Associates in the months of October 2020.

This report provides detail of the geotechnical activities carried out at the site, the characteristics of subsurface materials and the particulars of field and laboratory tests. The necessary recommendations are also provided in the report. Similarly remedial measures needed are also discussed.

1.2 Description of the Project Components

The canal system lies towards north of Karachi, situated at a distance of 56 km. The canal runs through many curves and dense forest, crosses over number of natural Nullahs with 16 Aqueducts, about 14 Siphons, 03 Village road bridges and 03 Village pedestrian crossings. There is one fall structure on this canal also.

The Main Canal discharges from the dam and bifurcates into two branches after flowing about 8 km at Head Regulator. At Head Regulator the water supplies to Sindh and Balochistan are controlled by manually operated vertical gates. Whereas, supply to Bund Murad Minor is controlled through Lasbella Canal about 1 km from Head Regulator. At Head Regulator one branch is known as Karachi Water Supply Canal.

The Karachi Water Supply Canal is about 21.2 km long open lined channel. The uninterrupted water is supplied through this canal, terminates at Karachi Water and Sewerage Board – KW&SB Pumping Station near Manghopir-Karachi.

1.3 Objectives of Investigations

The geotechnical investigations were undertaken to meet the following objectives:

i. To delineate the major subsoil types spread over the site area.
ii. To evaluate the geotechnical design parameters for project works.
iii. To spell-out the geotechnical evaluation of the foundations.

1.4 Scope of Work

The following geotechnical investigations program was developed to fulfill the above-mentioned objectives:

i. Drilling of sixteen (16) boreholes varying from 5 to 15 m depth, through straight rotary drilling.
ii. Carrying out Standard Penetration Tests (SPTs) or CPT in the boreholes at 1.0 m intervals generally up to maximum drilled depth of 15 m.
iii. Collection of undisturbed soil samples from the boreholes.
iv. Collection of water samples from boreholes, if encountered.
v. Laboratory testing of selected soil samples for the evaluation of classification, moisture content, density, strength and chemical characteristics.
vi. Analysis of field and laboratory data and determination of design parameters including soil parameters, appropriate foundation depth required, allowable bearing pressure, foundation settlement etc.
vii. Compilation of a Geotechnical Investigation Evaluation report.

1.5 General Site Conditions and Climate

The project lies in the area with topography of slight undulating with a range of low cliffs in the vicinity. The topsoil mainly consists of windblown deposit in the form of silty, fine to coarse sand/clayey silt.

Located near the coast, the project area has an arid climate with low average precipitation levels (approx. 250 mm per annum), the bulk of which occurs during the July–August monsoon season. Winters are warm and dry, while the summers are hot and humid; the proximity to the sea maintains humidity levels at a near-constant high

and cool sea breezes relieve the heat of the summer months. December through February is dry and pleasant as compared to the warm summers that dominate through the late spring (March) to the pre-monsoon season (June).

1.6 Format of the Report

This report provides detail of all the geotechnical investigations conducted for the accomplishment of the objectives mentioned in Section 1.2 above. Geology and Seismicity of the area has been outlined in Section 2. The details of field investigations and laboratory testing are discussed in Sections 3 and 4, respectively. The site-specific geotechnics, as evaluated on the basis of these studies, are elaborated in Section 5. Section 6 covers the considerations for design and construction. Conclusions and recommendations are given at the end of the report in Section 7.

2. GEOLOGY AND SEISMICITY OF THE AREA

2.1 General

The project area is connected with road from Karachi main city through two different routes. The topography is slight undulating with a range of low cliffs in the locality.

2.2 Geology

The main geological unit around the site is Miocene to Pliocene age Gaj/Manchhar/Nari Formation comprising mainly marine shale and friable to hard limestone with sandstone, shale, clay beds & conglomerates in the top most part. The rocks dominantly comprising interbedded sandstone, siltstone, mudstone and shale. Thin beds of limestone are also present in small stretch. In addition, thin veins of secondary gypsum are also present within the rocks. The overburden comprises silty sand with thin layer of slightly consolidated gravel.

2.3 Seismicity

The area does not possess many and strong earthquake generating source in close proximity but distant seismic sources are strong and active, as frequent moderate level of shakings were felt from earthquake occurring in far flung areas like Hindukush region.

The project area lies in the Zone 2B according to the earthquake zoning of Pakistan. The probability of earthquake is low with an intensity range of V to VI according to MMI scale. The corresponding PGA is 0.16g to 0.24g. A map showing the seismicity of Sindh (Fig. 2.1) has been placed in Annexure-I.

3. FIELD GEOTECHNICAL ACTIVITIES

3.1 Investigation Program

In order to evaluate the geotechnical conditions for the rehabilitation of canal project, sixteen (16) boreholes of 5 to 15 m depth were planned at the selected locations in the light of project requirements.

3.2 Drilling of Boreholes

The exact locations of all the boreholes were marked on the ground in the presence of client's representative. The boreholes were drilled by straight rotary method using bentonite as drilling fluid. Location of the boreholes is shown in Fig. 3.1. Summary of the boreholes with details is as under;

BH. No.	Depth (m)	No. of SPT	No. of Core Run	Core Recovery (%)	Rock Quality Deignation (%)
1	5	Nil	6	65-95	45-85
2	5	Nil	6	87-95	52-85
3	5	Nil	5	87-95	52-85
4	15	Nil	14	25-66	0-18
5	5	5	Nil	Nil	Nil
6	5	5	Nil	Nil	Nil
7	5	3	2	40-50	10-12
8	5	5	Nil	Nil	Nil
9	5	2	3	35-45	0-12
10	5	2	3	25-35	5-10
11	5	5	Nil	Nil	Nil
12	5	5	Nil	Nil	Nil
13	7	4		35-40	12-15
14	7	Nil		22-70	5-26
15	7	2		50-100	12-77
16	7.5	3		32-68	0-15

Field borehole logs were developed on the basis of the materials encountered at the site and later confirmed on the basis of the laboratory test results. The boreholes

were backfilled using the in-situ soil after completing the investigation. The finalized logs are appended to this report in Annexure-II.

3.3 Standard Penetration Tests (SPTs)

SPT is performed to determine the stiffness of the soil in terms of penetration resistance (N value). In this test, a standard spoon sampler (also known as split barrel) of about 500 mm diameter is driven into the ground by a drop hammer weighing about 140 lbs and falling through a distance of 76 cm. The sampler is driven 15 cm into the soil at a testing depth and number of blows (N) required to drive it a further 30 cm is then recorded. N, in general, is known as the SPT resistance of the soil.

A total of 41 SPTs were performed according to the latest ASTM D-1586, generally at 1 m depth interval in the boreholes. The SPT blow counts were recorded for 45 cm total penetration of split barrel sampler. The data obtained from these tests was utilized to assess the in-situ compactness of the subsurface materials. The number of blows (N values) have been shown on the respective borehole log sheets (Annexure-II) and also graphically in separate diagrams (Fig 3.2).

3.4 Disturbed Sampling

The SPT samples (disturbed samples) obtained from the overburden soils in the boreholes were properly labeled and preserved in polythene bags and plastic jars.

3.5 Core Drilling and Sampling

As hard shale was encountered in most of the boreholes therefore core drilling was carried out at these locations. Fifty seven (57) m of core drilling was carried out in all the boreholes. The material encountered in the core was mainly hard shale and mudstone. Core recovery ranged between 22 and 100% while RQD was calculated between 0 and 85%.

3.6 Groundwater Table

Water was encountered in only one borehole (BH-4) during soil investigation in the month of October 2020. The average depth in the borehole was 1.6 m. However, this could not be actual groundwater table at that location.

4. LABORATORY TESTING

4.1 General

Samples collected from the boreholes and test pits were subjected to some or all of the following tests as per latest ASTM, BS or equivalent standards in Civil Engineering Department, UET, Lahore and Soilcon Testing Laboratories, Lahore:

- Sieve Analysis and Hydrometer Analysis (ASTM D – 421, 422 & BS 1377 Part 2)
- Atterberg Limits (ASTM D – 4318 & BS 1377 Part 2)
- Point Load Index Test on rock samples (ASTM D5731 - 08)
- Uniaxial Compression (ASTM D – 7012)
- Specific Gravity (ASTM C127 – 07)
- Direct Shear (ASTM D – 3080)
- Sulphate / Chloride / pH / Organic matter content (BS 1377 Part 3)

The summary of laboratory tests results for soil samples is appended to this report as Annexure-III while lab test result sheets are provided in Annexure-IV.

4.2 Discussion of Salient Test Results

The results of various tests are discussed below:

4.2.1 Classification Tests and Atterberg Limits

A total of twenty six (26) grain size analyses were performed on various soil samples. The soils classified as granular soils contain gravels from 0 to 53% while sand was ranging from 22 to 87%. The amount of fines (silt and clay) found in cohesive sample were 50 to 93%.

Nine (9) samples of soils were also tested for the determination of Atterberg Limits to know the consistency of the soil. It includes the Liquid Limit and Plastic Limit of the soil samples. Among the samples, four (4) samples were found to be non-plastic. In remaining samples, the Liquid Limit (LL) found to be between 22 to 41% while their plasticity indices (PI) ranged from 6 to 17%.

The classification test results indicate that the cohesive soils mostly comprise CL-ML / CL while the granular soils belong to SM-SC / SP group according to Unified Soil Classification System (USCS).

4.2.2 Specific Gravity

Thirteen (13) rock samples were tested for the determination of specific gravity (relative density). The range of specific gravity was from 2.52 to 2.64.

4.2.3 Strength Tests on Soil Samples

To estimate the shear strength of the soil, direct shear tests were performed on the selected samples. In direct shear test, shearing force is applied at constant rate of strain until shearing failure occurs. Thus in this test, the sample is made to fail on a pre-determined horizontal shear plane.

Two (2) direct shear tests were performed on the selected soil samples. The result shows zero cohesion in both the tested samples while angle of internal friction was from 32.2 and 34.4 degrees.

4.2.4 Strength Tests on Rock Samples

Uniaxial compression test and point load strength index tests were carried on selected rock core samples to determine the strength of intact core samples. In uniaxial test, the specimens are loaded axially up to failure or any other prescribed level whereby the specimen is deformed. Whereas point load testing is used to determine rock strength indexes in geotechnical practice. It involves the compressing of a rock sample between conical steel platens until failure occurs.

Eight (8) core pieces were tested to determine the uniaxial compressive strength and point load strength index. The UCS ranged from 6.44 to 14.85 MPa and PLSI varied from 0.02 to 3.6 MPa.

4.2.5 Chemical Tests of Soil

The chemical tests are performed to check the acidity of the soil and the quantities of aggressive materials in the ground, such as sulphates, chlorides and organic materials which may attack buried concrete or metal.

Seven (7) chemical tests were carried out on the selected soil samples. The soluble sulphate content at the tested locations ranged from 0.006 to 0.020%, the chloride content varied from 0.002% to 0.036% and the organic matter varied from 0.298 to 0.549%.

5. SITE GEOTECHNICS

5.1 Lithology and Stratigraphy

The subsurface materials as identified are mostly intermixed at various depths. However, the geotechnical investigations have revealed the presence of the following main lithological units at project areas:

(a) Yellowish Brown, Medium to coarse grained Limestone.

(b) Yellowish Brown, hard Limestone.

(c) Grayish brown hard shale with sandstone interlayer somewhere

(d) Light brown loose to medium silty sandy clay

(e) Light brown medium dense sand with gravel

(f) Dark Brown medium dense Coarse sand with gravel

5.2 In-Situ Compactness

The in-situ compactness as inferred from SPT "N" values indicate a loose to medium dense / dense material. The N values are ranging from 1 to 41 However, the in-situ compactness is highly variable vertically and also location wise.

5.3 Shear Strength

This strength data shows that the soil consistency is medium. The angle of internal friction of sandy samples is in the range of 32 to 34 degrees which appears to be adequate for medium dense inorganic silt / silty sand.

5.4 Settlement Potential

The soils at site are medium compressible and expected to undergo moderate settlements under the expected structural loads at most of the locations. The compressibility of the ground is variable, vertically as well as laterally.

5.5 Groundwater

Groundwater table was not encountered in the boreholes except at one discrete location.

5.6 Chemical Aggressivity

A study of salt concentration determined in the soil samples at a few locations indicates that the soluble sulphates, chloride and organic matters are present in low percentage.

6. CONSIDERATIONS FOR DESIGN AND CONSTRUCTION

6.1 General

The considerations for the designs and construction of various foundation types have been made keeping in mind the topography of the area, limitations of geotechnical investigations, expected types of structures and the subsoil characteristics. A safe and an economical design of foundations has to be ensured.

6.2 Design Criteria

The foundations of all the structures should meet the following minimum design criteria.

i. These should be safe against shear failure of the supporting ground.
ii. These should not settle excessively under the service loads. A limit of 25mm has been put on the total settlement of any individual square/strip type spread foundation. The total settlement of mats should be considered as 50mm.
iii. The angular distortion between two adjacent foundations should not exceed 1/500.
iv. The foundations of various structures must stay safe under tensile, lateral moment and vibrational loadings.

6.3 Excavations/Earth Work

Generally excavations for shallow work would be made in the firm silty / sandy stratum. It is estimated that steep temporary excavations with light equipment would be possible in, probably without any support system. For guidance, the temporary excavation lines may be kept close to vertical, or as determined by trials at site.

6.4 Coefficients of Lateral Earth Pressure

It is recommended to use granular material as the backfill material behind the retaining structures wherever required. The backfill material should be compacted to at least 90% Modified Proctor density.

The static lateral earth pressure coefficients for active (K_a), at rest (K_o) and passive (K_p) conditions, using granular material as backfill having ø = 30° are recommended as follows:

$K_a = 0.33$
$K_o = 0.50$
$K_p = 3.00$

The coefficient of friction between concrete and soil should be 0.35.

6.5 Type of Cement

The subsoils at the site contain soluble sulphates in lower quantities, therefore, it is recommended to use Ordinary Portland Cement (OPC) or other suitable type in concrete construction work according to requirement.

6.6 Fill Placement and Compaction

For the placement and compaction of engineered fill, granular material should be used. The material should be well graded and should not have fraction greater than 3 inches. The maximum fine fractions should not exceed from 8%.

The embankment foundation must be stable. The embankments and canal slopes consists of a series of compacted layers of soil. The construction of each layer or lift along with compaction characteristics must be approved by the Engineer. Compaction Control Tests should be performed frequently.

7. CONCLUSIONS AND RECOMMENDATIONS

i. The subsurface materials as identified are mostly intermixed at various depths. However, the geotechnical investigations have revealed the presence of the following main lithological units at project areas:

   (a) Yellowish Brown, Medium to coarse grained Limestone.

   (b) Yellowish Brown, hard Limestone.

   (c) Grayish brown hard shale with sandstone interlayer somewhere

   (d) Light brown loose to medium silty sandy clay

   (e) Light brown medium dense sand with gravel

   (f) Dark Brown medium dense Coarse sand with gravel

ii. Groundwater table was not encountered in the boreholes except at one discrete location.

iii. The soils at site are medium compressible and expected to undergo moderate settlements under the expected structural loads at most of the locations.

iv. It is recommended to use Ordinary Portland Cement (OPC) or other suitable type in concrete construction work according to requirement.

v. It is recommended to adopt peak ground acceleration (PGA) of 0.20g for the design of the structures.

vi. The concrete aggregates to be used for the project, must be screened for alkali-silica reaction (ASR).

vii. For the placement and compaction of engineered fill, granular material should be used.

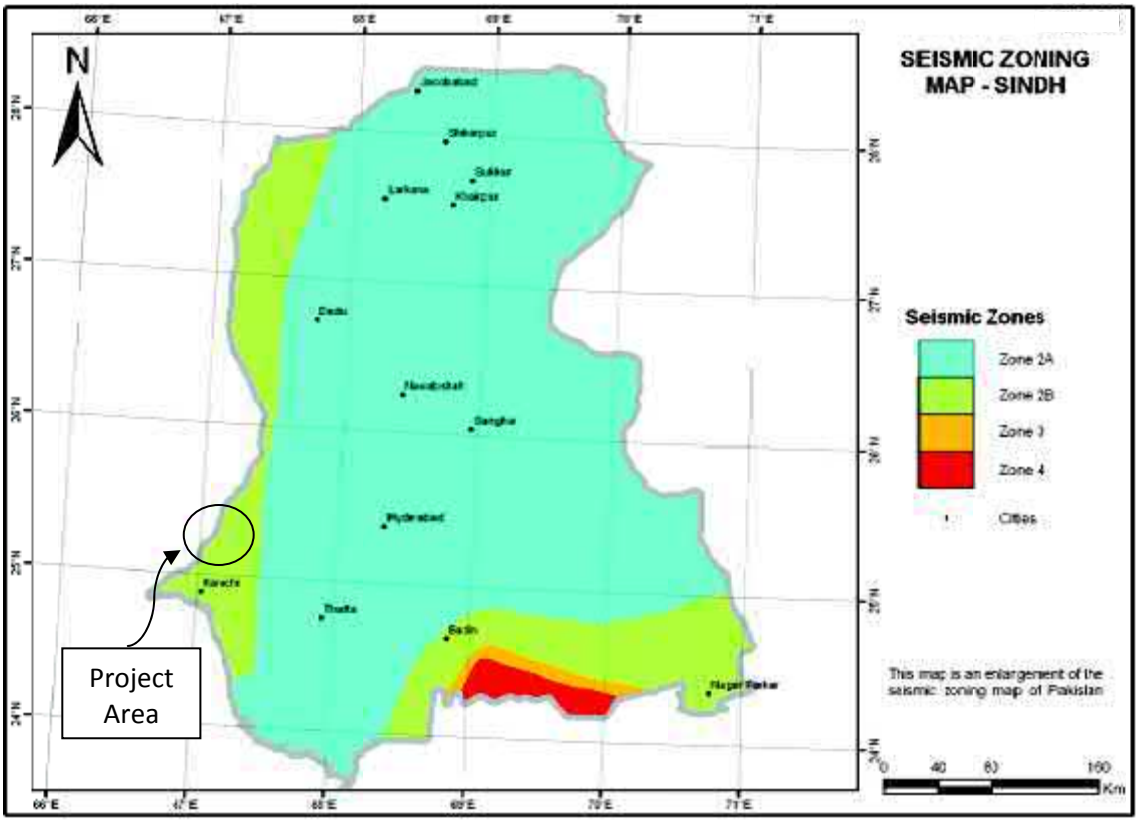
viii. Compaction Control Tests should be performed frequently

ANNEXURES

Annexure I

Zoning Map of the Sindh

Seismic Zoning Map of Sindh

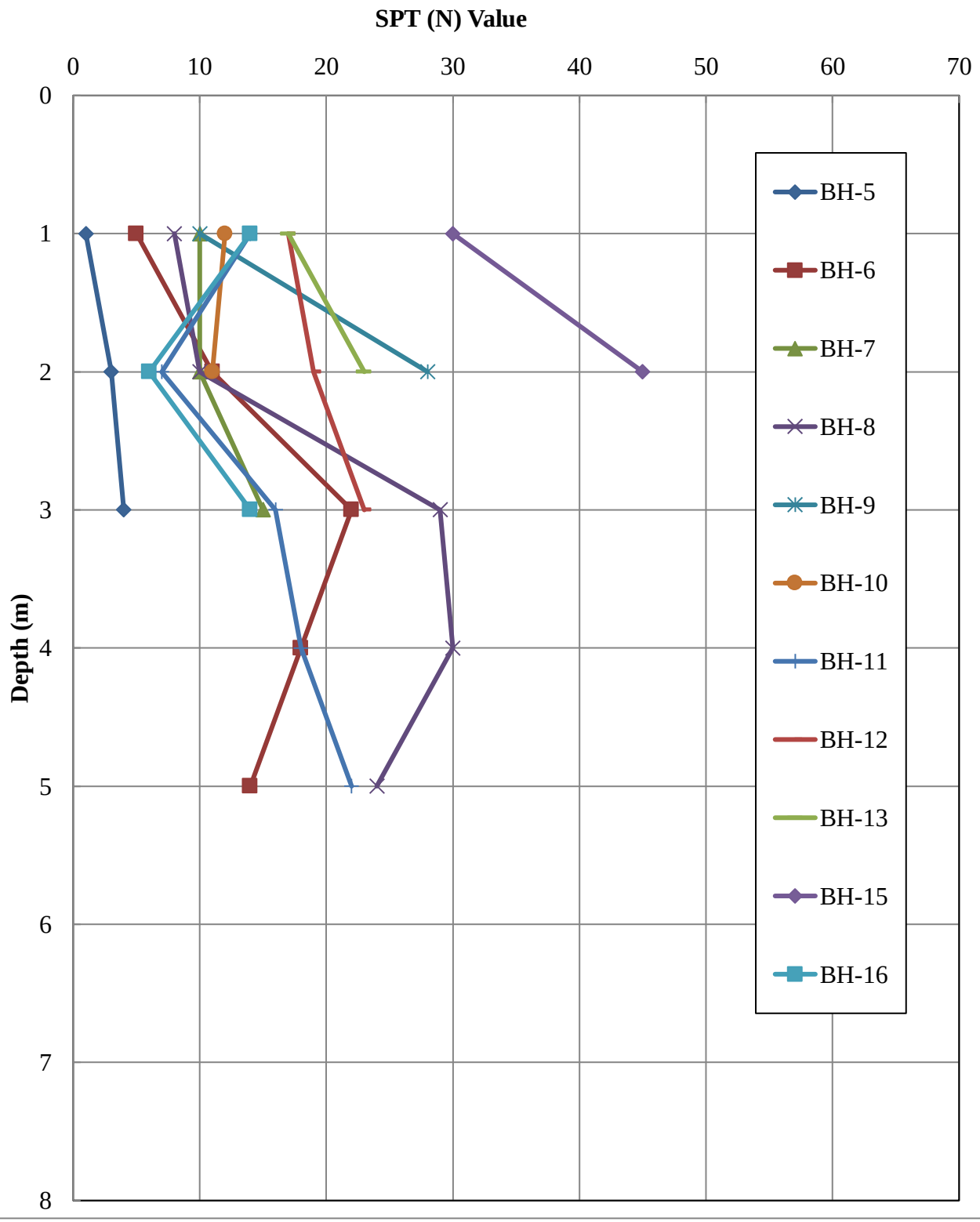


Source: Building Code of Pakistan – Seismic Provision 2007

Annexure-II

Borehole Logs

Project: Geotechnical Investigations for Rehabilitation of Hub Canal Karachi



Bore Hole No. 01
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 300800, N 2766435	Client's Rep.	
Location/Area	FILTRATION PLANT	Type of Boring	Straight Rotary	Date Started	09.10.2020
Ground Water Depth	Not Encountered	Drilling Fluid	Bentonite	Date Completed	09.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
0.-0.60		1		Yellowish Brown, Medium to coarse grained Limestone.									87	52		
0.60-1.40		2		Yellowish Brown, Medium to coarse grained Limestone.									88	57		
1.40-2.40		3		Yellowish Brown, Medium to coarse grained Limestone.									95	55		
2.40-3.40		4		Yellowish Brown, Medium to coarse grained Limestone.									90	85		
3.40-4.0		5		Yellowish Brown, Medium to coarse grained Limestone.									90	85		
4.0-5.0		6		Grayish brown shale									65	45		

NFP: No further penetration R: Refusal

Bore Hole No. 02
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 300745, N 2766225	Client's Rep.	
Location/Area	FILTRATION PLANT	Type of Boring	Straight Rotary	Date Started	10.10.2020
Ground Water Depth	Not Encountered	Drilling Fluid	Bentonite	Date Completed	10.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
0.-0.60		1		Yellowish Brown, Medium to coarse grained Limestone.									87	52		
0.60-1.40		2		Yellowish Brown, Medium to coarse grained Limestone.									88	57		
1.40-2.40		3		Yellowish Brown, Medium to coarse grained Limestone.									95	55		
2.40-3.40		4		Yellowish Brown, Medium to coarse grained Limestone.									90	85		
3.40-5.0		5		Yellowish Brown, Medium to coarse grained Limestone.									90	85		

NFP: No further penetration R: Refusal

Bore Hole No. 03
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 300236 , N 2767287	Client's Rep.	
Location/Area	RISING MAINS	Type of Boring	Straight Rotary	Date Started	12.10.2020
Ground Water Depth	Not Encountered	Drilling Fluid	Bentonite	Date Completed	12.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
0.-0.60		1		Grayish brown shale									87	52		
0.60-1.40		2		Grayish brown shale									88	57		
1.40-2.40		3		Grayish brown shale									95	55		
2.40-3.40		4		Grayish brown shale									90	85		
3.40-5.0		5		Grayish brown shale									90	85		

NFP: No further penetration R: Refusal

Bore Hole No. 04
Sheet. 01 of 02

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 300245, N 2768433	Client's Rep.	
Location/Area	PUMPING STATION	Type of Boring	Straight Rotary	Date Started	13.10.2020
Ground Water Depth	1.6 M	Drilling Fluid	Bentonite	Date Completed	14.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
0-1.0		1		CONCRETE + GRAVEL FILLING									40	NIL		
1.0-2.0	1.0	2		Grayish brown hard shale			26						30	NIL		
2.0-3.0		3		Grayish brown sandstone									33	17		
3.0-4.0		4		Grayish brown sandstone									43	10		
4.0-5.0		5		Grayish brown sandstone									28	0		
5.0-6.0		6		Grayish brown sandstone									25	0		
6.0-7.0		7		Grayish brown shale with sandstone interlayer									25	0		
7.0-8.0		8		Grayish brown shale with sandstone interlayer									25	0		

NFP: No further penetration R: Refusal

Bore Hole No. 04
Sheet. 02 of 02

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 300245, N 2768433	Client's Rep.	
Location/Area	PUMPING STATION	Type of Boring	Straight Rotary	Date Started	13.10.2020
Ground Water Depth	1.6 M	Drilling Fluid	Bentonite	Date Completed	14.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
8-9.0		9		Grayish brown shale									40	NIL		
9.0-10.0		10		Grayish brown shale			26						30	NIL		
10.0-11.0		11		Grayish brown shale									54	17		
11.0-12.0		12		Grayish brown shale									66	18		
12.0-13.0		13		Grayish brown shale with sandstone interlayer									40	0		
13.0-14.0		14		Grayish brown shale with sandstone interlayer									35	0		
14.0-15.0		15		Grayish brown shale with sandstone interlayer									43	0		

NFP: No further penetration R: Refusal

Bore Hole No. 05
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 300699, N 2769708	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	15.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	15.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Light brown loose silty sandy clay			1	0	0	0	0	1			32	
2.0	2.0			Light brown loose silty sandy clay			1	1	0	1	1	3			34	
3.0	3.0			Light brown loose silty sandy clay			1	1	1	1	1	4			32	
4.0	4.0			LIght brown hard clay /shale			9	14	25	R					20	
5.0	5.0			LIght brown hard clay /shale			12	13	30	R					25	

NFP: No further penetration R: Refusal

Bore Hole No. 06
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 301401, N 2773442	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	17.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	17.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Light brown loose sand			2	1	1	1	2	5			32	
2.0	2.0			Light brown medium dense sand			4	2	2	3	4	11			34	
3.0	3.0			Light brown medium dense sand			6	5	5	6	6	22			32	
4.0	4.0			Light brown medium dense sand			8	5	6	4	3	18			34	
5.0	5.0			Dark brown medium dense clayey sand			6	4	3	3	4	14			35	

NFP: No further penetration R: Refusal

Bore Hole No. 07
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 302401, N 2775242	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	17.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	17.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Light brown medium dense sand			4	3	2	3	2	10			32	
2.0	2.0			Light brown medium dense sand			6	2	3	2	3	10			34	
3.0	3.0			Light brown medium dense sand			8	4	3	3	5	15			32	
4.0		1		Greyish brown sandstone									40	10		
5.0		2		Greyish brown sandstone									50	12		

NFP: No further penetration R: Refusal

Bore Hole No. 08
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 302663 , N 2777466	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	18.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	18.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Light brown medium dense sand			3	2	2	2	2	8			32	
2.0	2.0			Light brown medium dense sand			6	3	3	2	2	10			34	
3.0	3.0			Light brown dense coarse sand with gravel			5	7	10	7	5	29			32	
4.0	4.0			Light brown dense coarse sand with gravel			6	8	10	6	6	30			30	
5.0	5.0			Dark brown medium dense clayey sand			5	3	4	7	10	24			34	

NFP: No further penetration R: Refusal

Bore Hole No. 09
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 303275 , N 2779647	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	18.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	18.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Light brown medium dense sand			3	2	2	3	3	10			32	
2.0	2.0			Light brown medium dense sand			4	6	5	10	7	28			34	
3.0		1		Brownish gray shale with interlayer sanstone									35	nil		
4.0		2		Brownish gray shale with interlayer sanstone									40	nil		
5.0		3		Brownish gray shale with interlayer sanstone									45	12		

NFP: No further penetration R: Refusal

SUBSURFACE EXPLORATION LOG

Bore Hole No. 10
Sheet. 01 of 01

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 303540 , N 2781668	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	19.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	19.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Light brown medium dense sand with gravel			5	2	3	3	4	12			32	
2.0	2.0			Light brown medium dense sand			3	1	2	3	5	11			34	
3.0		1		Brownish gray shale with interlayer limestone									25	8		
4.0		2		Brownish gray shale with interlayer limestone									30	5		
5.0		3		Brownish gray shale with interlayer limestone									35	10		

NFP: No further penetration R: Refusal

Bore Hole No. 11
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 303790 , N 2784410	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	19.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	19.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Light brown medium dense Coarse sand with silt			4	3	4	4	3	14			32	
2.0	2.0			Light brown medium dense clayey sand with silt			4	3	2	1	1	7			34	
3.0	3.0			Light brown medium dense clayey sand with silt			5	2	3	4	7	16			30	
4.0	4.0			Light brown medium dense Coarse sand with gravel			5	2	4	5	7	18			28	
5.0	5.0			Light brown medium dense Coarse sand with gravel			4	3	7	8	4	22			26	

NFP: No further penetration R: Refusal

Bore Hole No. 12
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 304127 , N 2786542	Client's Rep.	
Location/Area	CANAL	Type of Boring	Straight Rotary	Date Started	20.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	20.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Dark Brown medium dense Coarse sand with gravel			7	4	4	4	5	17			35	
2.0	2.0			Dark Brown medium dense Coarse sand with gravel			4	3	3	5	8	19			30	
3.0	3.0			Dark Brown medium dense Coarse sand with gravel			4	4	9	8	7	23			34	
4.0	4.0			Dark Brown hard shale			10	12	13	25	R				35	
5.0	5.0			Dark Brown hard shale			32	21	35	R					22	

NFP: No further penetration R: Refusal

Bore Hole No. 13
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 300970 ,N 2771546	Client's Rep.	
Location/Area	AQUEDUCT # 11	Type of Boring	Straight Rotary	Date Started	16.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	16.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Dark Brown medium dense Coarse sand with gravel			5	6	4	3	4	17			35	
2.0	2.0			Dark Brown medium dense Coarse sand with gravel			7	5	6	5	7	23			30	
3.0	3.0			Grayish brown shale			10	9	11	25	R				34	
4.0	4.0			Grayish brown shale			9	10	13	25	R				35	
5.5		1		Dark gray mudstone									40	15		
6.5		2		Dark gray mudstone									35	12		
7.5		3		Dark gray mudstone									35	12		

NFP: No further penetration R: Refusal

SUBSURFACE EXPLORATION LOG

Bore Hole No. 14
Sheet. 01 of 01

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 303806 , N 2782627	Client's Rep.	
Location/Area	AQUEDUCT # 08	Type of Boring	Straight Rotary	Date Started	22.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	22.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0		1		Yellowish Brown, hard Limestone.									50	26		
2.0		2		Yellowish Brown, hard Limestone with shale									22	5		
3.0		3		Yellowish Brown, hard Limestone.									50	10		
4.0		4		Yellowish Brown, hard Limestone.									60	10		
5.0		5		Yellowish Brown, hard Limestone.									70	10		
6.0		6		Yellowish Brown, hard Limestone.									50	12		
7.0		7		Yellowish Brown, hard Limestone.									50	10		

NFP: No further penetration R: Refusal

Bore Hole No. 15
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 304225 , N 2785563	Client's Rep.	
Location/Area	AQUEDUCT # 05	Type of Boring	Straight Rotary	Date Started	19.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	20.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Grayish brown hard shale			5	6	7	8	9	30			34	
2.0	2.0			Grayish brown hard shale			10	12	11	13	12	45			30	
3.0		1		Grayish brown hard shale with sandstone									50	12		
4.0		2		Dark gray mudstone									100	51		
5.0		3		Dark gray mudstone									90	77		
6.0		4		Dark gray mudstone									100	14		
7.0		5		Dark gray mudstone									75	13		

NFP: No further penetration R: Refusal

Bore Hole No. 16
Sheet. 01 of 01

SUBSURFACE EXPLORATION LOG

FIELD DATA

Client	HALCROW PAKISTAN	Ground Elevation		Geologist/Engr.	Junaid Khursheed
Project	KARACHI WATER CANAL	Coordinates	E 304566 , N 2787270	Client's Rep.	
Location/Area	AQUEDUCT # 02	Type of Boring	Straight Rotary	Date Started	21.10.2020
Ground Water Depth		Drilling Fluid	Bentonite	Date Completed	21.10.2020

Depth (m)	SPT/CPT	Run	Thickness of Layer	DESCRIPTION OF MATERIALS	Soil Classification		SPT No. of Blows						CR %	RQD %	Sample Length (cm)	Remarks/Date/Time
					USCS Symbol	Legend	6"	3"	3"	3"	3"	N				
1.0	1.0			Dark brown medium dense sand with gravel			2	2	3	4	5	14			32	
2.0	2.0			Dark brown loose Coarse sand with clay			1	1	1	2	2	6			28	
3.0	3.0			Brownish gray medium dense sand			4	2	1	5	6	14			26	
4.5		1		Grayish sandstone									32	nil		
5.5		2		Grayish sandstone with sahle									60	15		
6.5		3		Grayish sandstone with sahle									65	14		
7.5		4		Grayish sandstone with sahle									68	12		

NFP: No further penetration R: Refusal

Annexure-III

Summary of Laboratory Test Results

Summary of Test Results

Project: Geotechnical Investigations for Rehabilitation of Karachi Water Canal

BH No.	Sample No.	Depth (m)	Sp. Gravity	Grain Size Analysis				Atterberg Limits			Soil Type	Direct shear Test		UCT	PLSIT (Rock)	Chemical Test of Soil		
				Gravel	Sand	Silt	Clay	LL	PL	PI	USCS	C	Φ	q_u	Sulphate Contents	Chloride Contents	Organic Mattrers	
				(%)	(%)	(%)	(%)	(%)	(%)	(%)		(kPa)	(deg)	(Mpa)	(MPa)	(%)	(%)	(%)
1	RUN-2	0.60-1.40	2.56											14.85				
	RUN-3	1.40-2.40	2.6											11.96				
2	RUN-2	0.60-1.40	2.58												3.6			
	RUN-4	2.40-3.40												14.35				
4	SPT-1	2.00																
	RUN-4	3.0-4.0	2.62											10.19				
	RUN-12	11.0-12.0													0.02			
5	SPT-1	1.00		0	63	37		Non Plastic			SM-SC					0.011	0.002	0.301
	UDS-1	2.00																
	SPT-4	4.00			80	20		Non Plastic			SM-SC							
6	SPT-1	1.50		32	45	23					SM-SC							
	SPT-3	3.00		0	87	13					SM-SC					0.012	0.002	0.298
	SPT-5	5.00		6	44	50		Non Plastic			ML							
7	SPT-1	1.00		3	75	22					SM-SC							
	SPT-3	3.00		0	81	19					SM-SC	0	33.2			0.02	0.002	0.359
	RUN-1	3-4.00	2.54												0.18			
8	SPT-1	1.00		8	89	3					SP							
	SPT-3	3.00		20	67	3					SP	0	34.4			0.009	0.002	0.549
	SPT-5	5.00		14	55	31		Non Plastic			SM-SC							
9	SPT-1	2.00		2	80	18					SM-SC							
	RUN-1	3.0-4.0	2.59	13	43	44		22	16	6	CL-ML							
	RUN-3	4-5.0		53	22	25					GM-GC							
10	SPT-1	1.00		11	56	33					SM-SC							
	RUN-1	2.45-3.0	2.58												0.15			
	RUN-3	3.0-4.0	2.64												2.41			
11	SPT-1	1.00		9	65	26					SM-SC							
	SPT-2	2.00		5	72	23					SM-SC					0.007	0.003	0.317
	SPT-4	4.00		10	70	20					SM-SC							
12	SPT-1	1.00		25	59	16					SM-SC							
	SPT-3	3.00		8	79	13					SM-SC							
	SPT-5	5.00		15	31	64		32	20	12	CL							
13	SPT-1	2.00		8	76	16					SM-SC					0.012	0.036	0.425
	SPT-3	3.00		3	4	93		41	24	17	CL							
	RUN-3	6.50-7.00													0.2			
14	RUN-1	0-1	2.56												3.22			
	RUN-4	3.0-4.0	2.52											9.76				
15	SPT-1	1.00		2	38	60		25	17	8	CL							
	SPT-2	2.00		0	45	55		24	17	7	CL-ML					0.006	0.004	0.435
	RUN-2	3.0-4.0												6.44				
	RUN-5	6.0-7.0												7.5				
16	SPT-1	1.00		31	17	52					SM-SC							
	SPT-3	3.00		3	68	29					SM-SC							
	RUN-1	3.00-4.00	2.62												0.1			
	RUN-3	5.00-6.00	2.6											8.04				

Annexure-IV

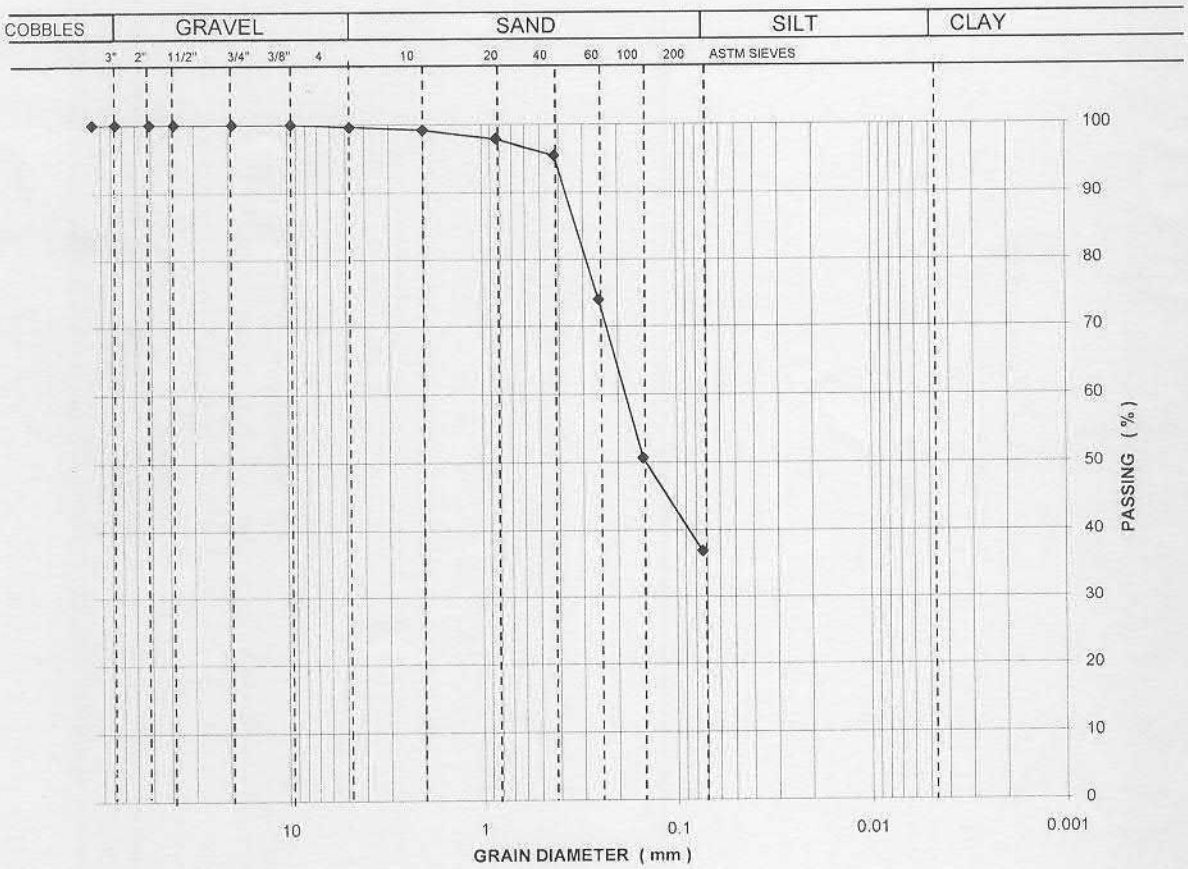
Laboratory Test Results

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-5	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	100	99	95	51	37

LAB. REF.	74/2020

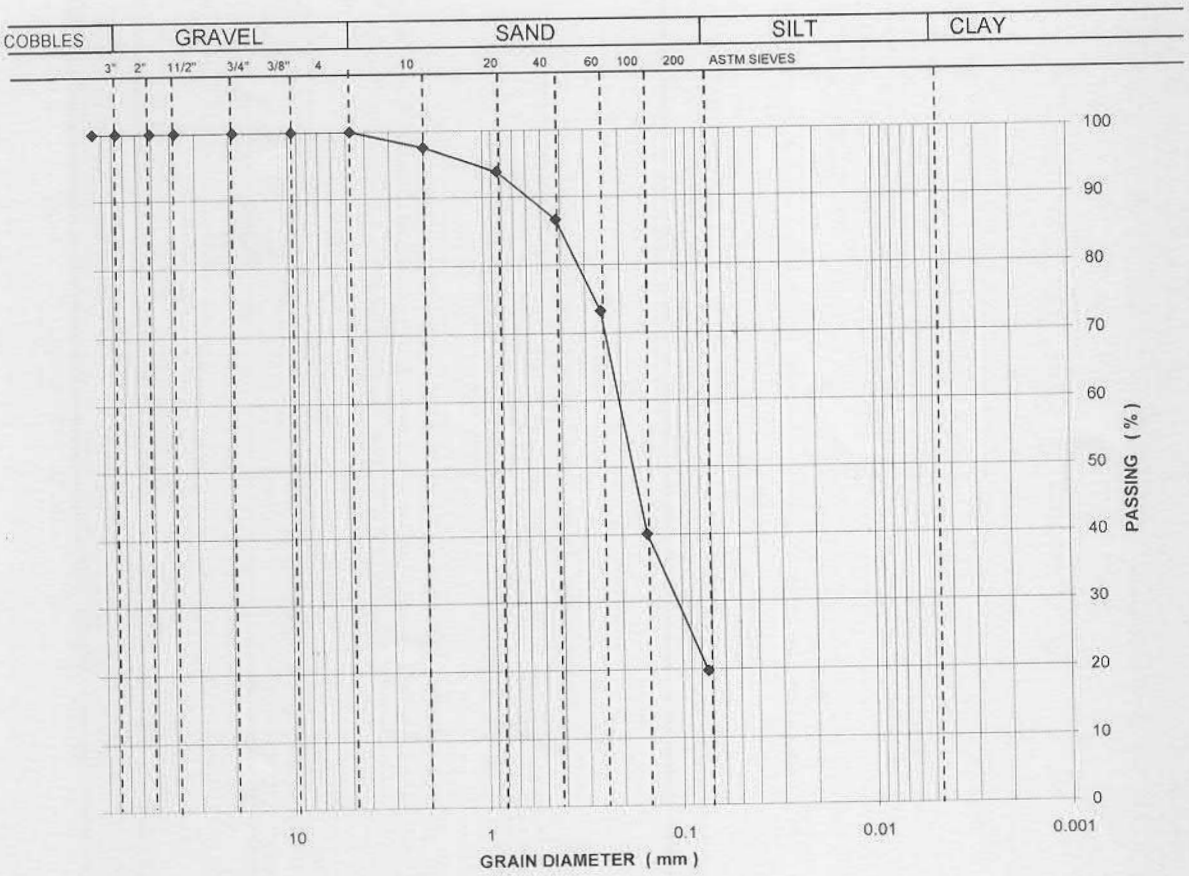
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-5	SAMPLE	SPT-4
TYPE	DISTURBED	DEPTH(m)	4.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	100	98	87	40	20

LAB. REF.	74/2020

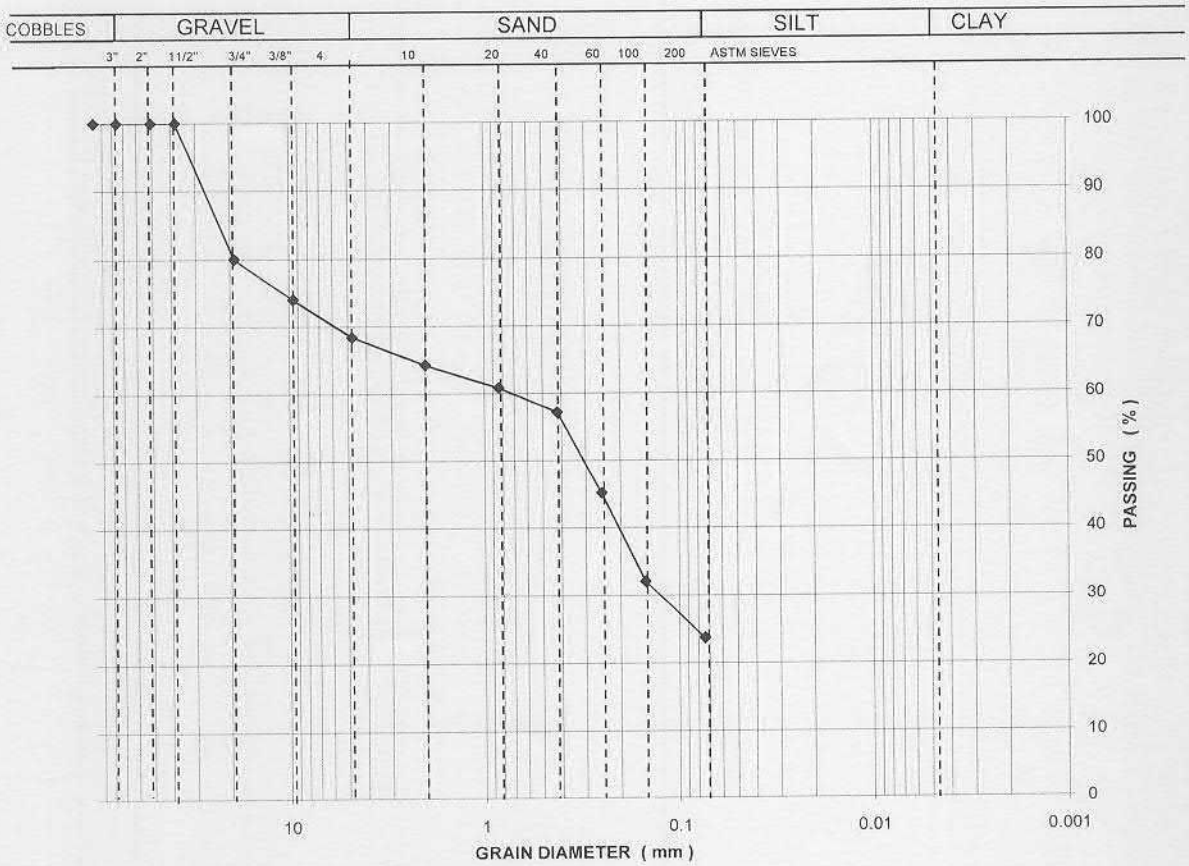
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-6	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.50
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	80	74	68	64	57	32	24

LAB. REF.	74/2020

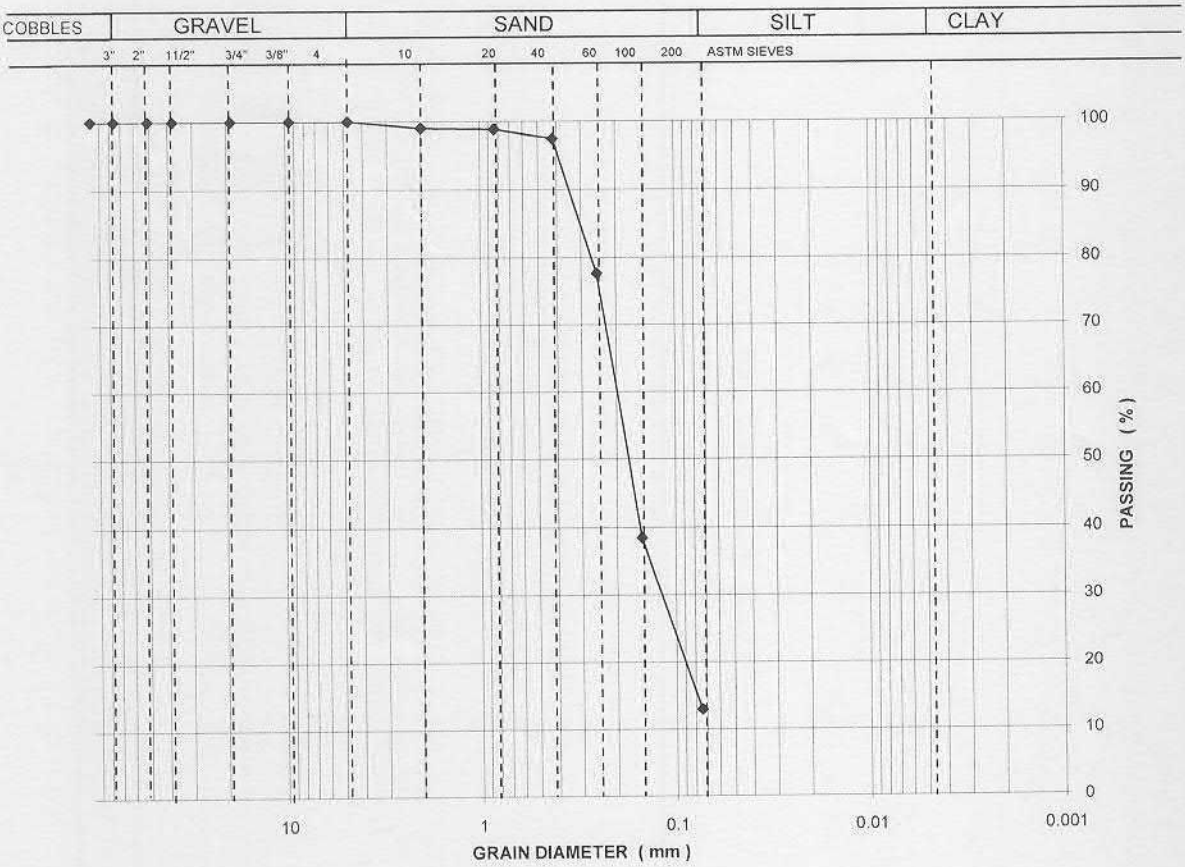
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-6	SAMPLE	SPT-3
TYPE	DISTURBED	DEPTH(m)	3.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	100	99	97	38	13

LAB. REF.	74/2020

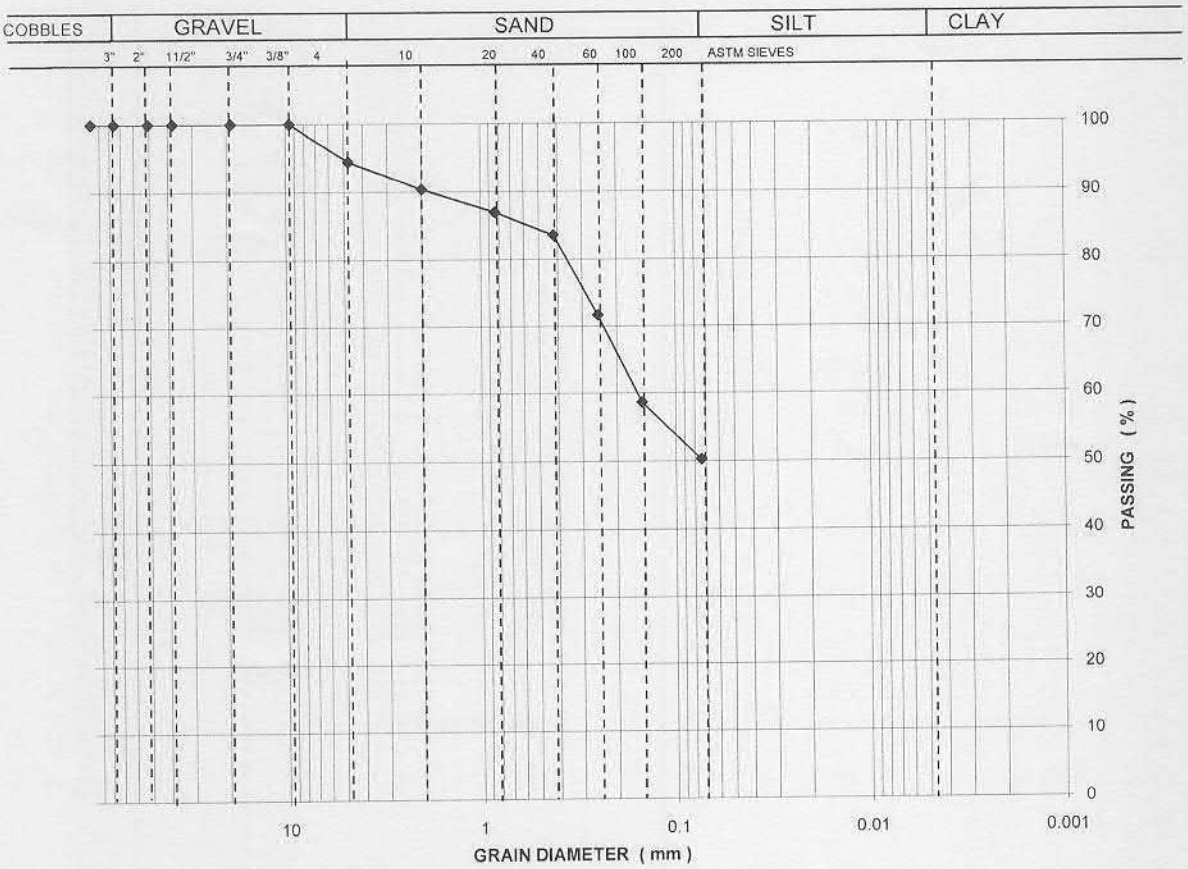
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-6	SAMPLE	SPT-5
TYPE	DISTURBED	DEPTH(m)	5.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	94	90	84	59	50

LAB. REF.	74/2020

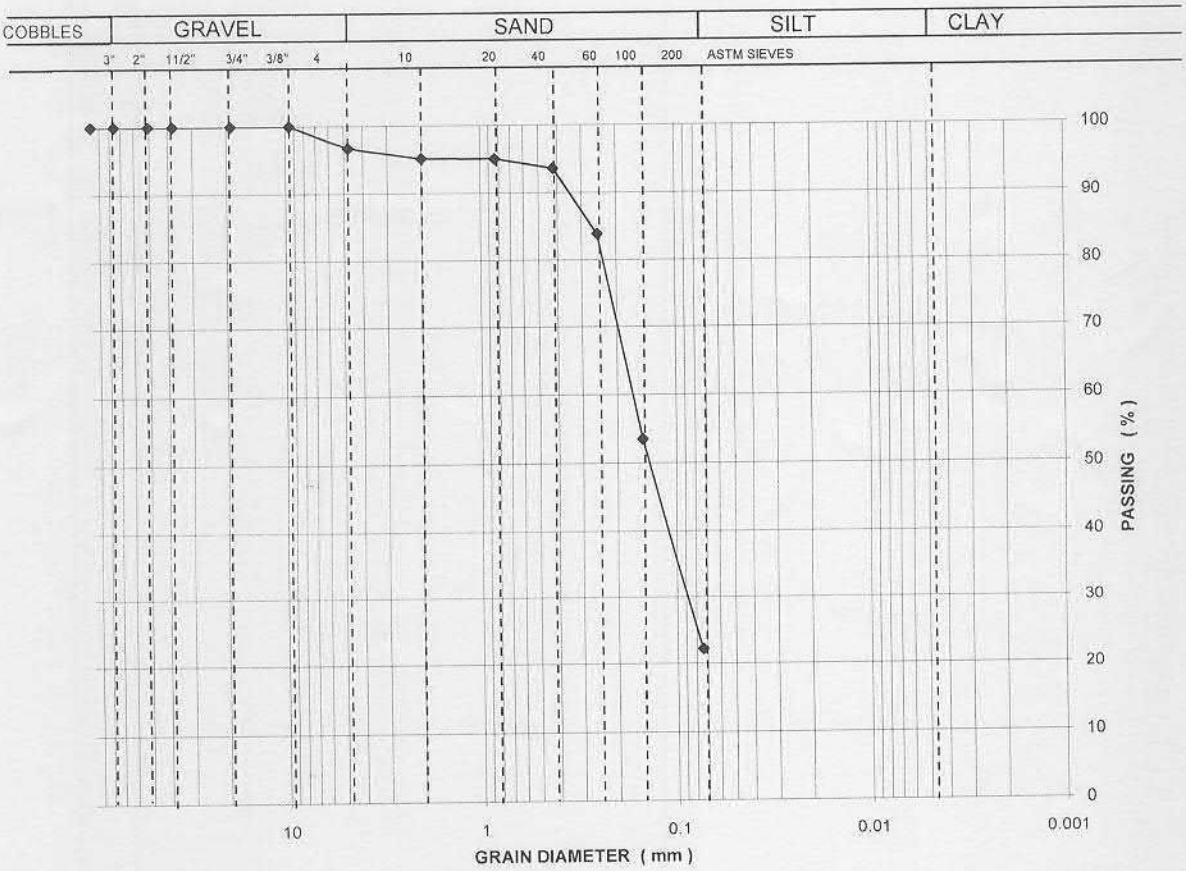
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-7	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	97	95	94	54	22

LAB. REF.	74/2020

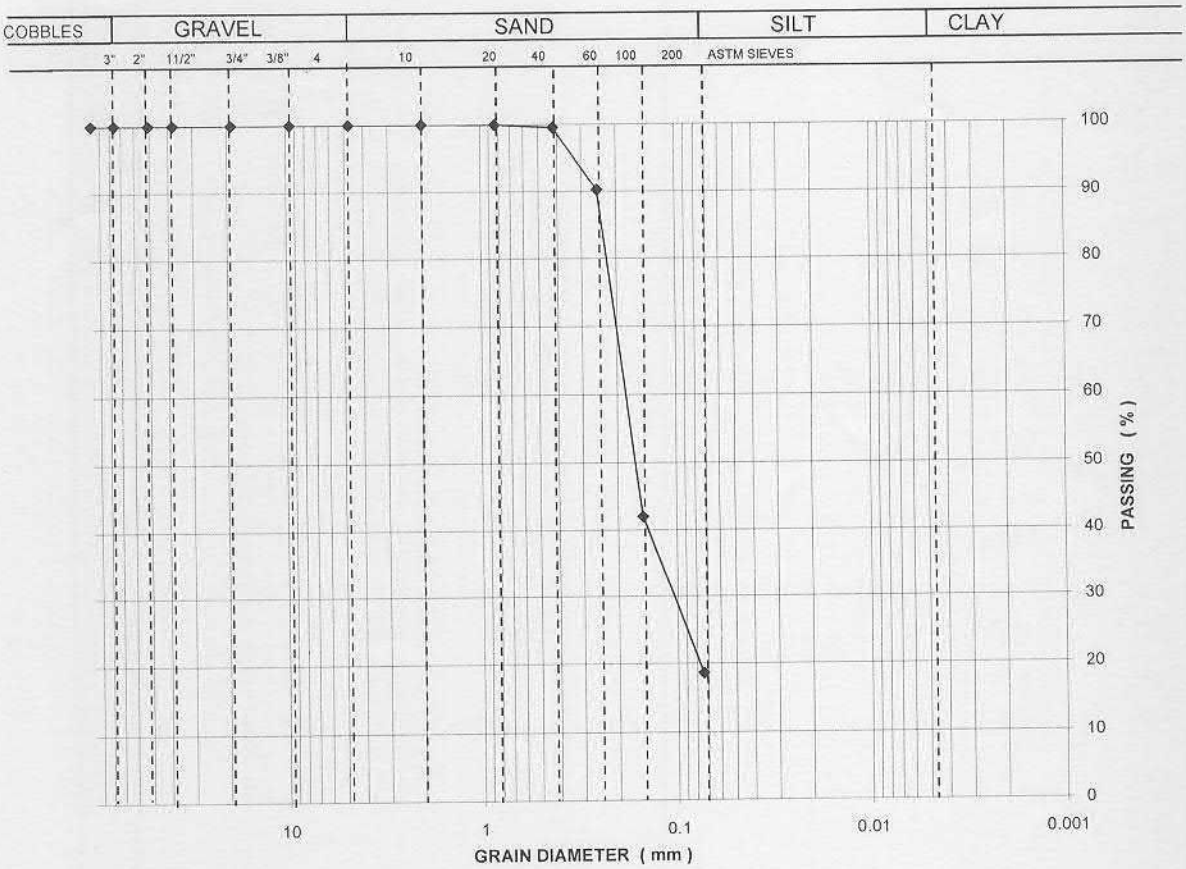
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-7	SAMPLE	SPT-3
TYPE	DISTURBED	DEPTH(m)	3.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	100	100	100	42	19

LAB. REF.	74/2020

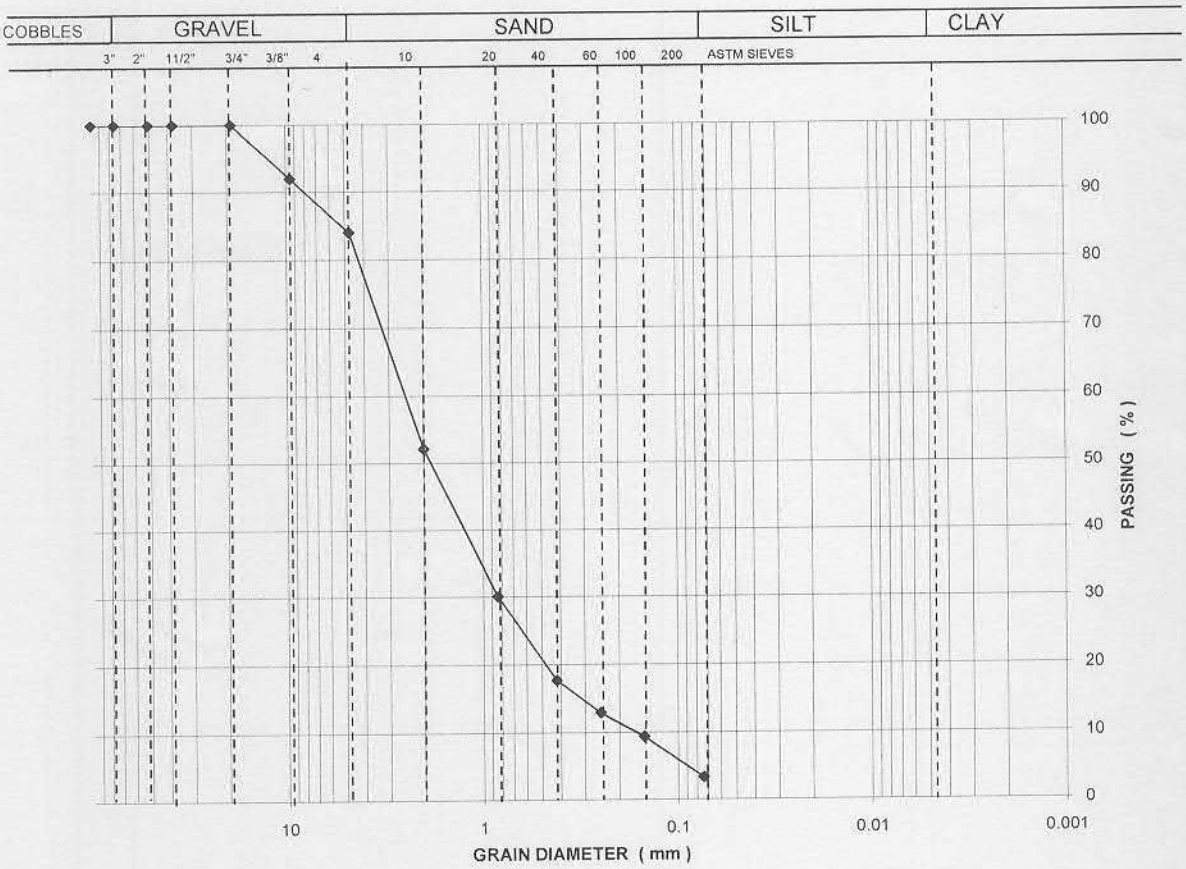
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-8	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	92	84	52	18	9	3

LAB. REF.	74/2020

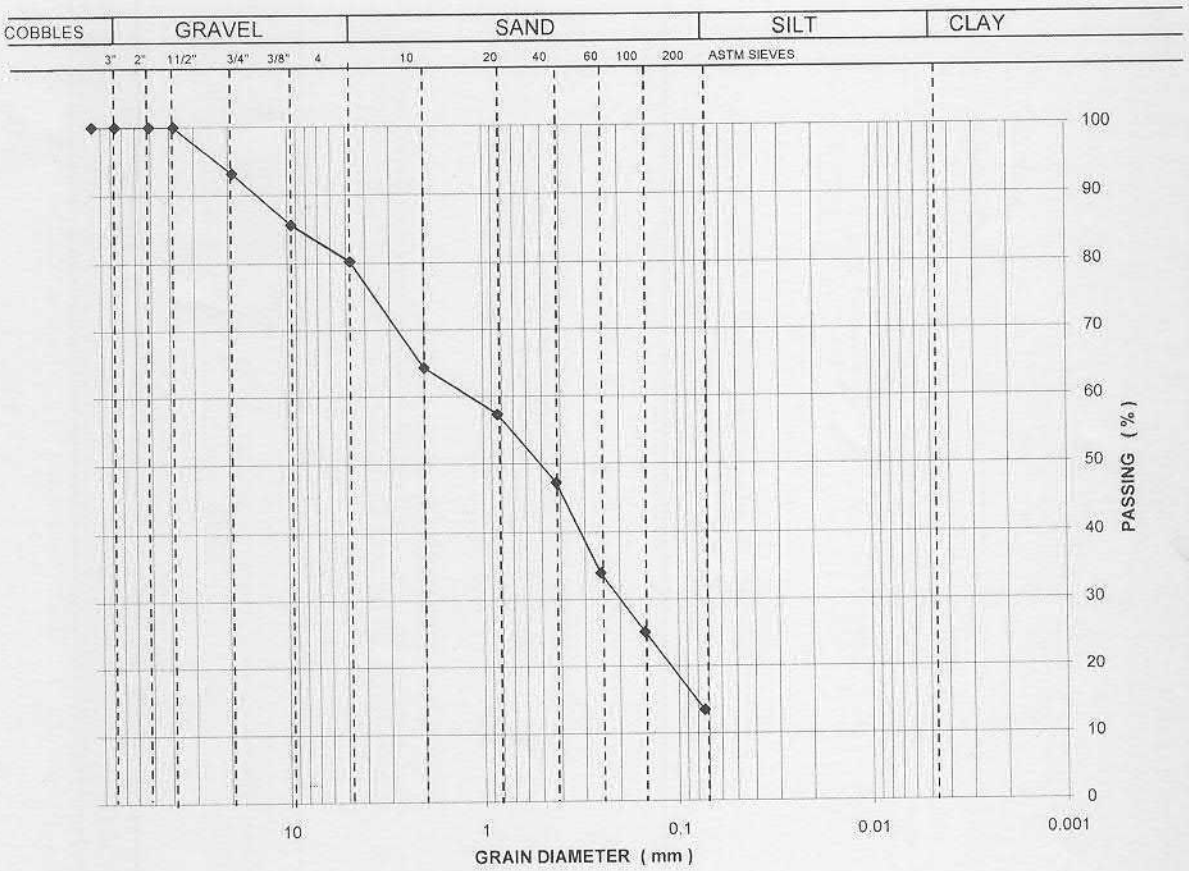
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-8	SAMPLE	SPT-3
TYPE	DISTURBED	DEPTH(m)	3.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	93	86	80	64	47	25	13

LAB. REF.	74/2020

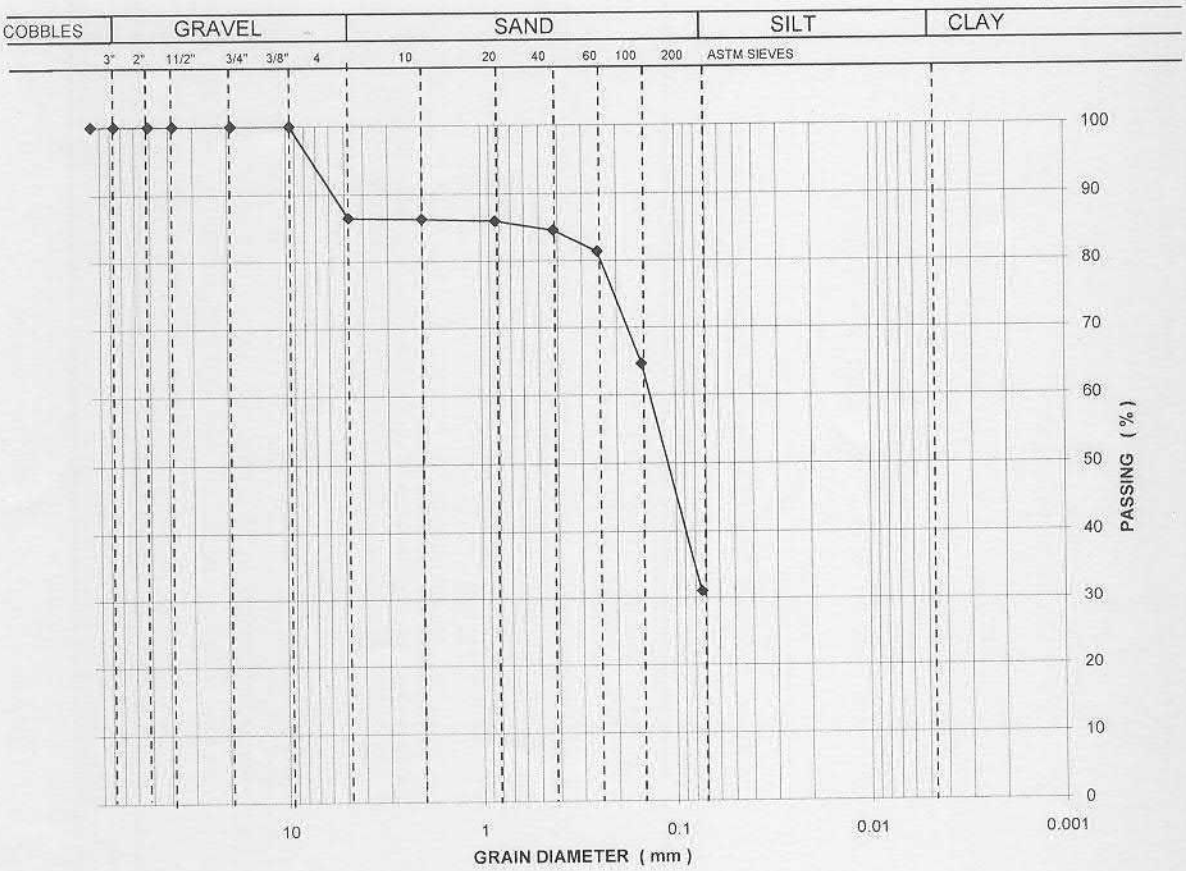
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-8	SAMPLE	SPT-5
TYPE	DISTURBED	DEPTH(m)	5.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	86	86	85	65	31

LAB. REF.	74/2020

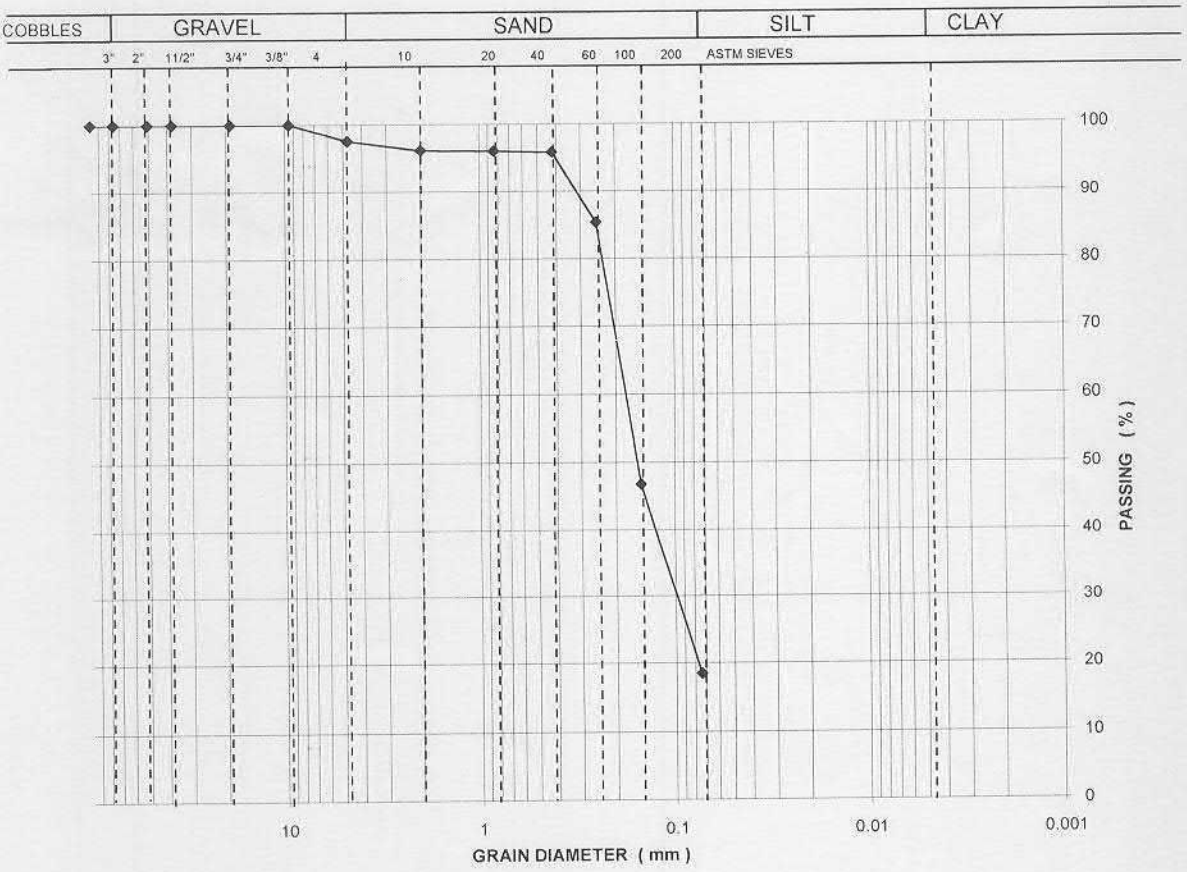
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-9	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	2.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	98	96	96	47	18

LAB. REF.	74/2020

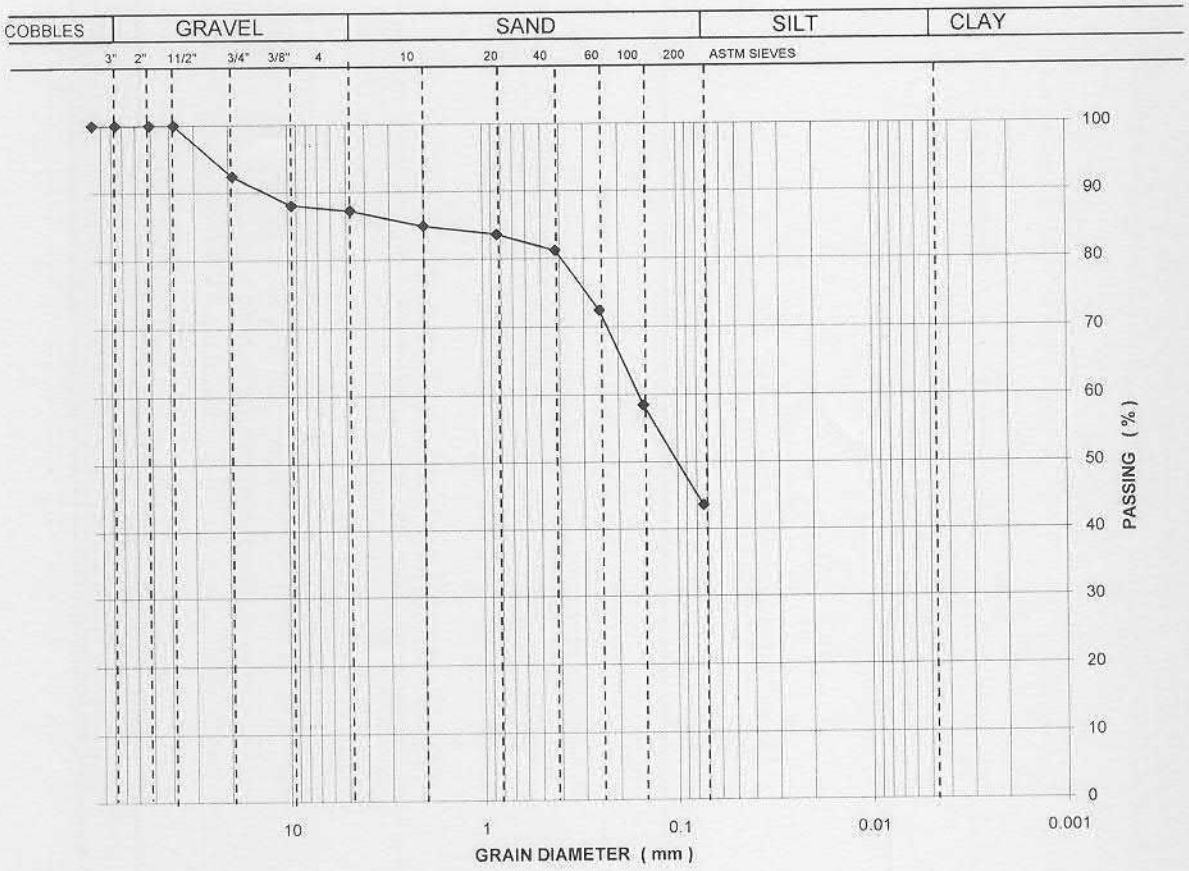
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-9	SAMPLE	RUN-1
TYPE	DISTURBED	DEPTH(m)	3.00-4.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	92	88	87	85	81	58	44

LAB. REF.	74/2020

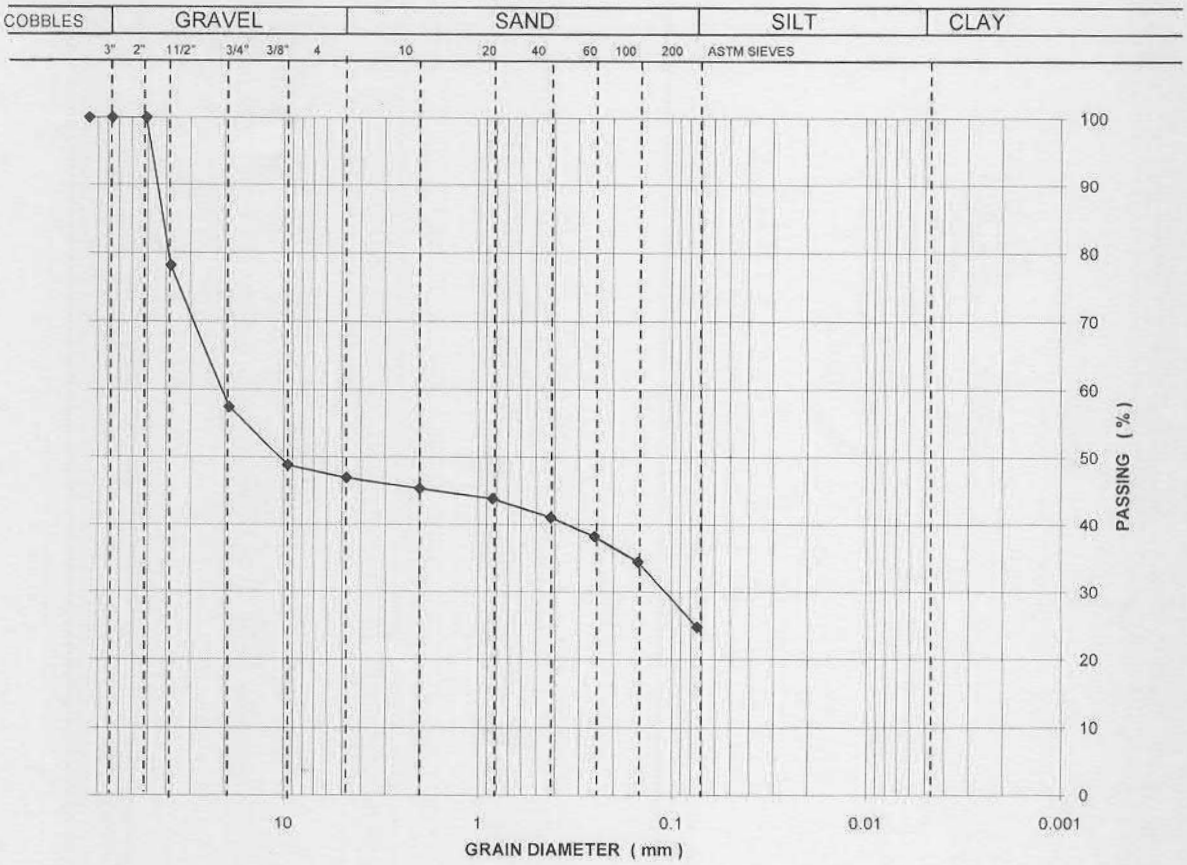
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-9	SAMPLE	RUN-3
TYPE	DISTURBED	DEPTH(m)	4.50
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	78	57	49	47	45	41	34	25

LAB. REF.	74/2020

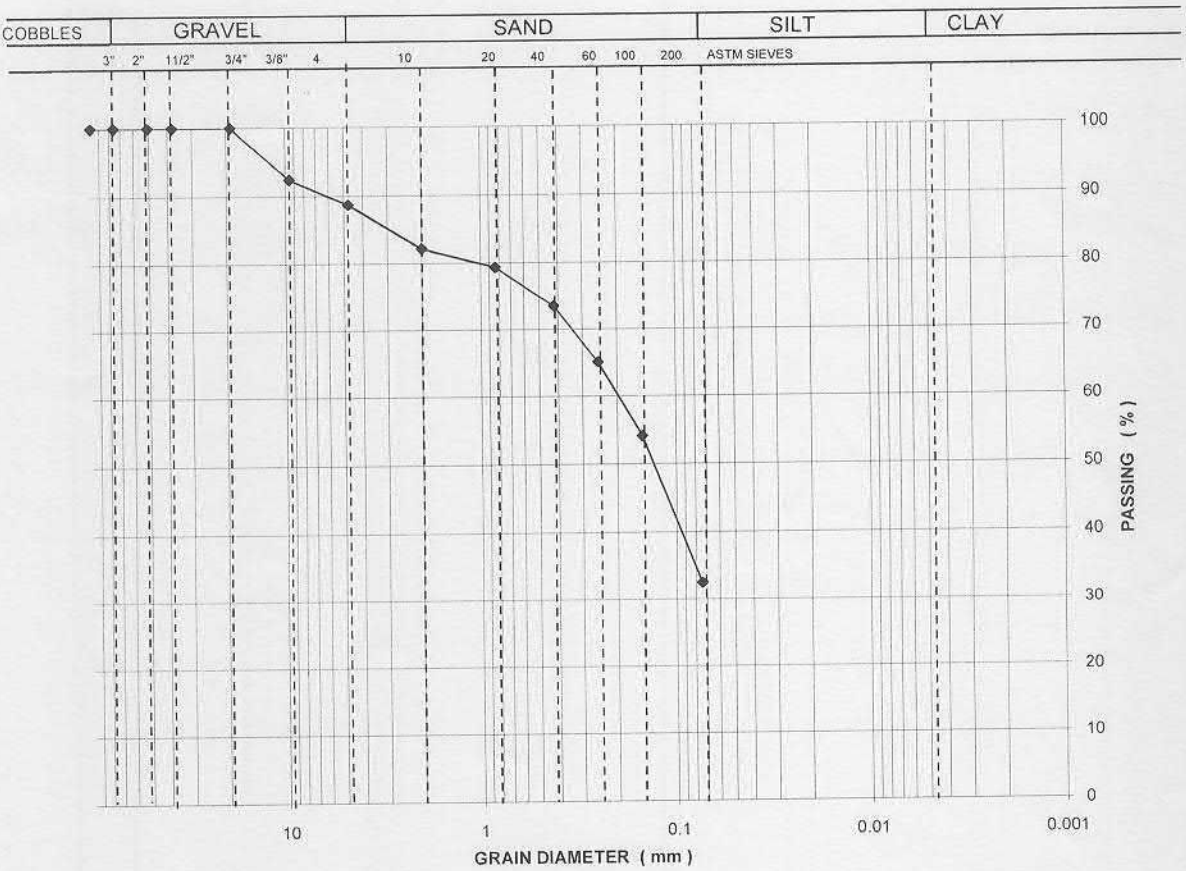
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-10	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	92	89	82	73	54	33

LAB. REF.	74/2020

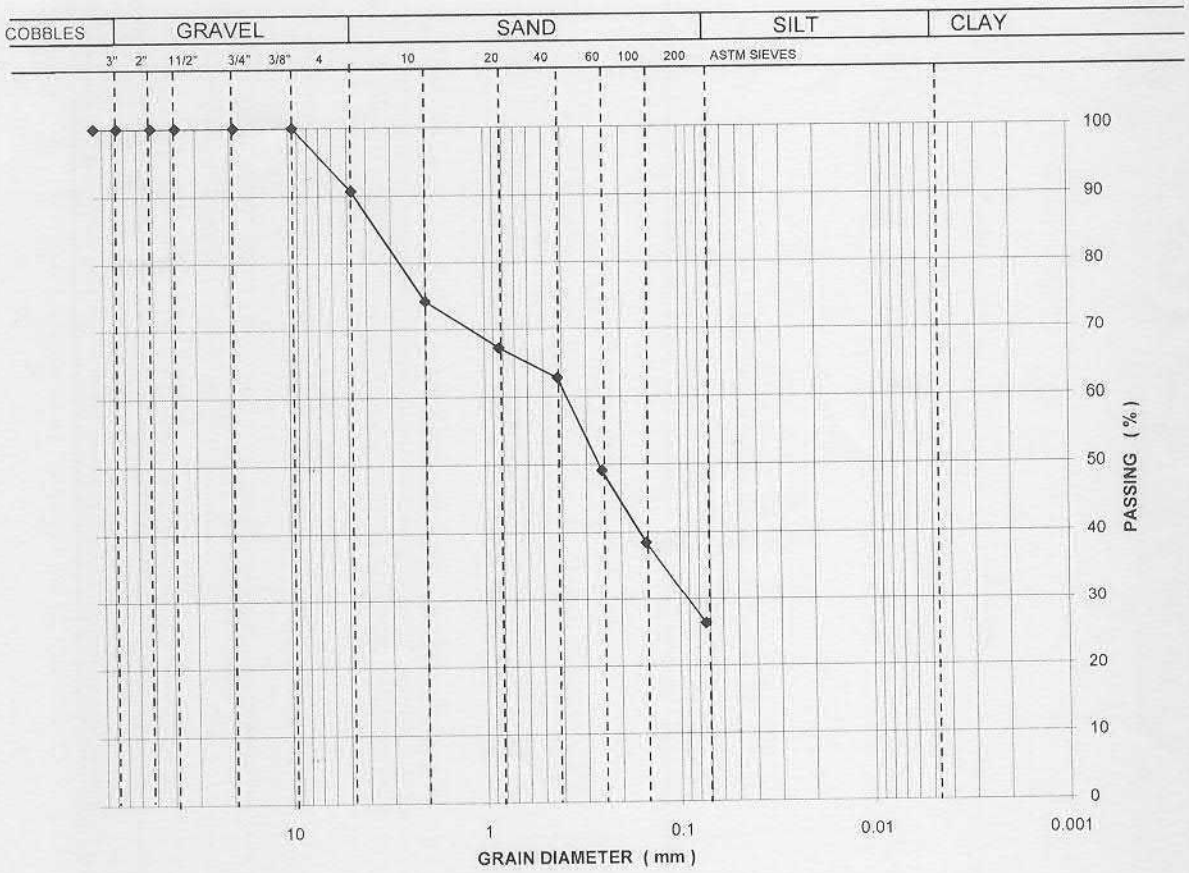
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-11	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	91	74	63	38	26

LAB. REF.	74/2020

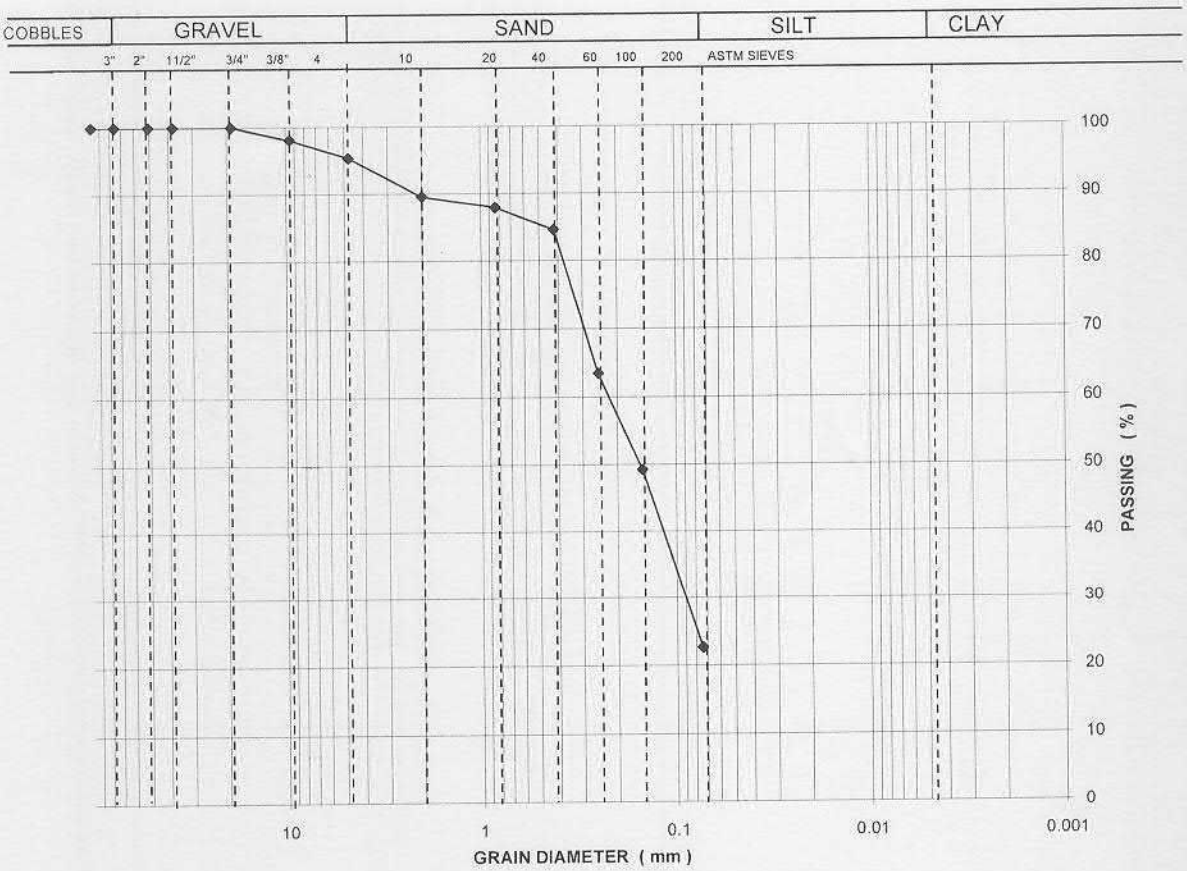
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-11	SAMPLE	SPT-2
TYPE	DISTURBED	DEPTH(m)	2.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	98	95	90	85	49	23

LAB. REF.	74/2020

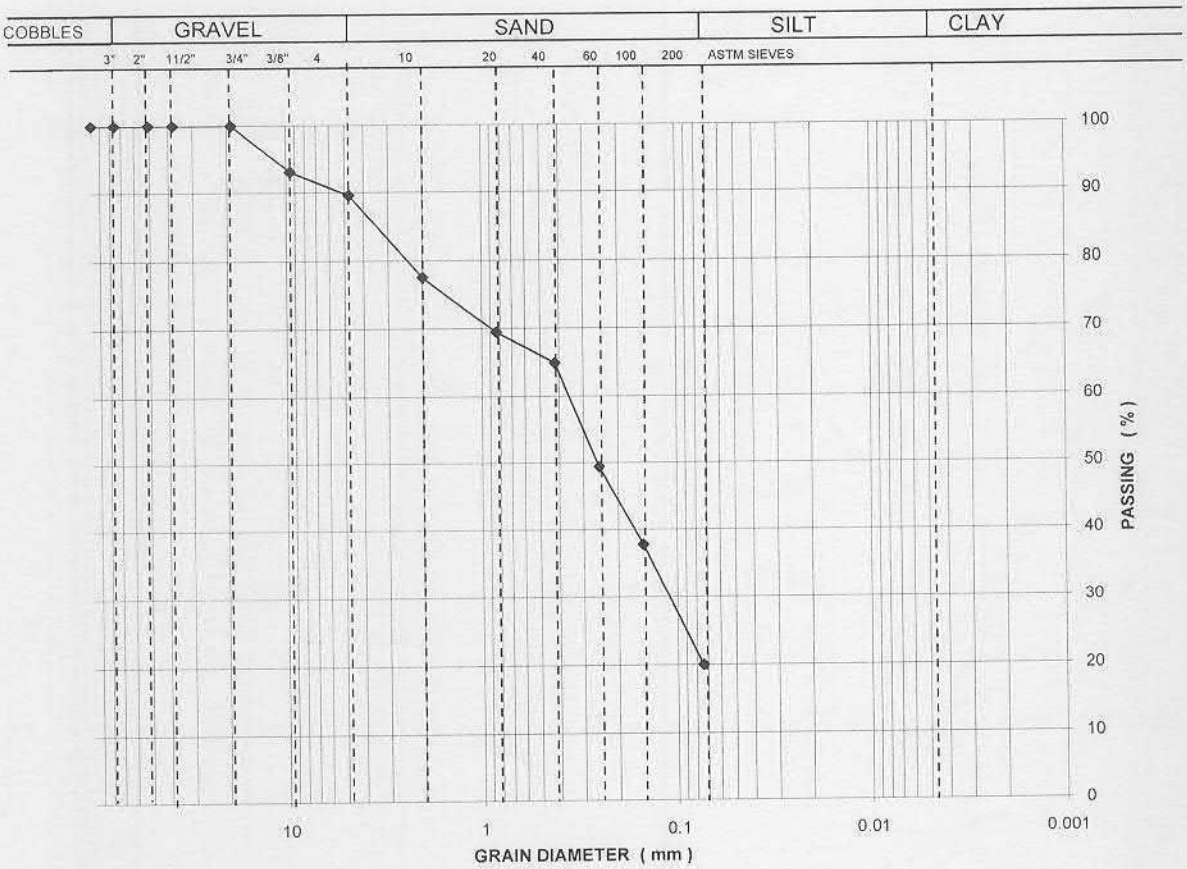
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-11	SAMPLE	SPT-4
TYPE	DISTURBED	DEPTH(m)	4.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	93	90	78	65	38	20

LAB. REF.	74/2020

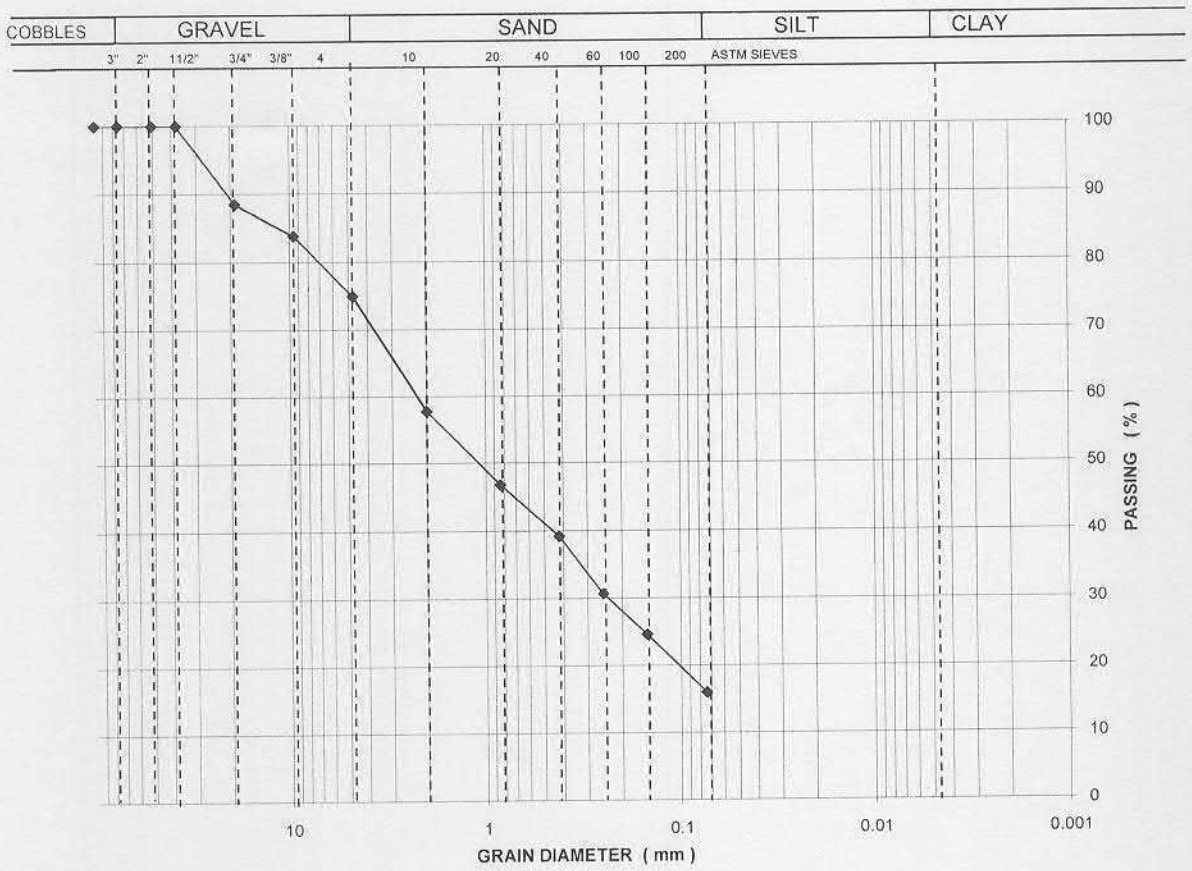
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-12	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	89	84	75	58	39	25	16

LAB. REF.	74/2020

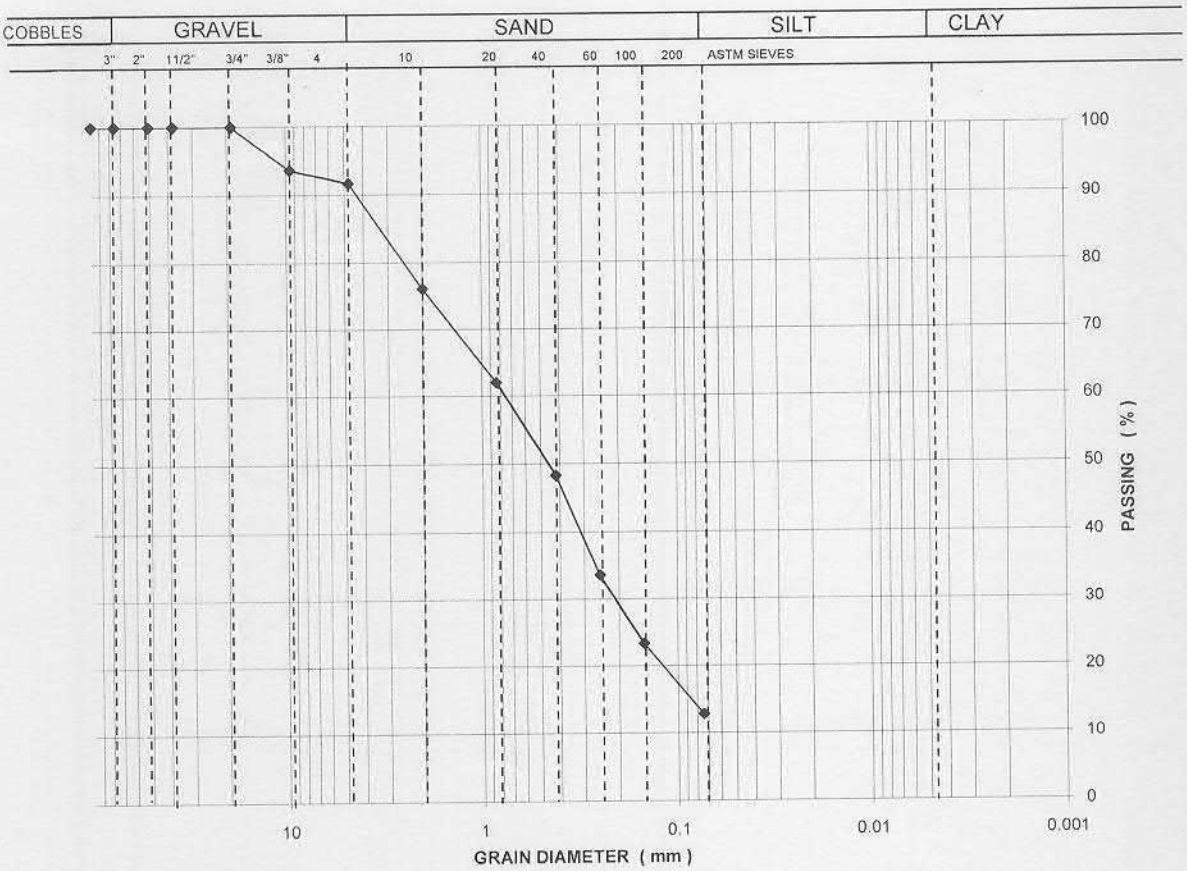
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-12	SAMPLE	SPT-3
TYPE	DISTURBED	DEPTH(m)	3.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	94	92	76	48	23	13

LAB. REF.	74/2020

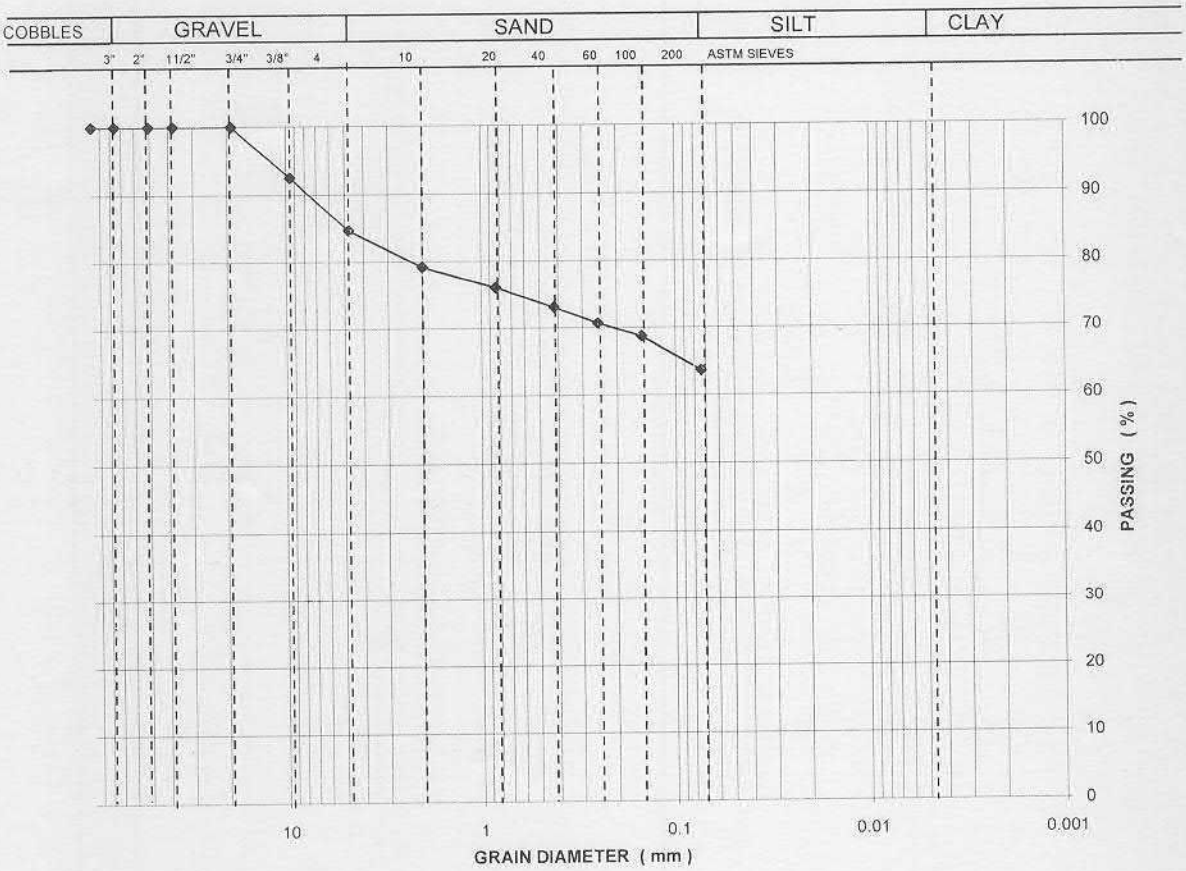
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-12	SAMPLE	SPT-5
TYPE	DISTURBED	DEPTH(m)	5.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	93	85	79	73	69	64

LAB. REF.	74/2020

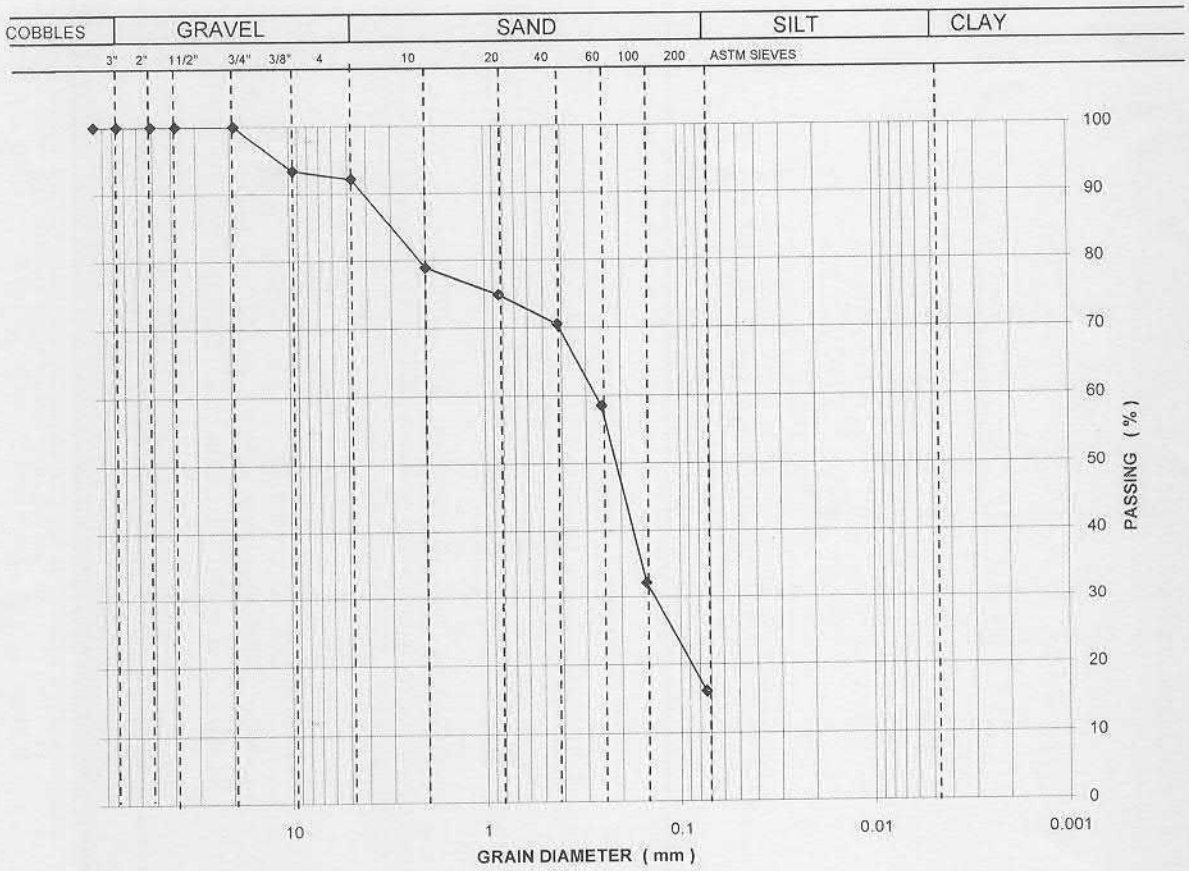
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-13	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	2.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	93	92	79	70	32	16

LAB. REF.	74/2020

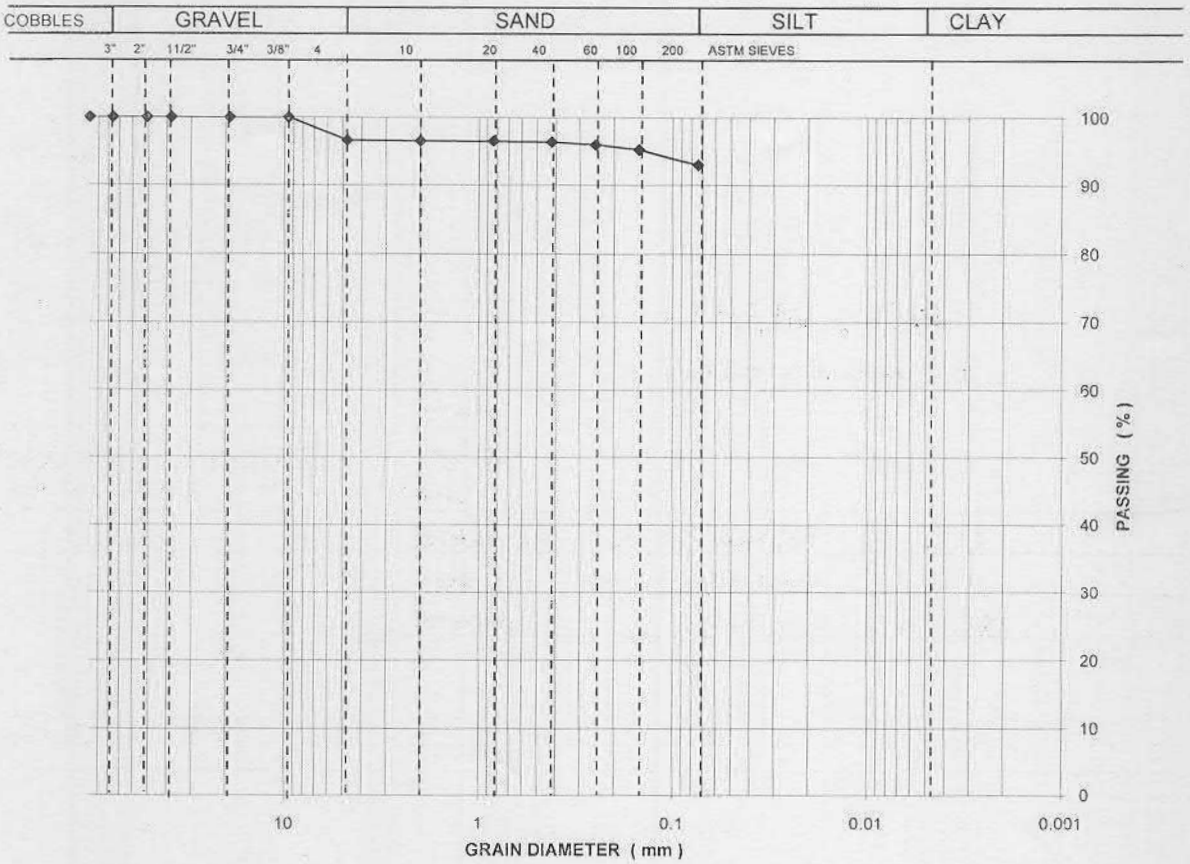
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-13	SAMPLE	SPT-3
TYPE	DISTURBED	DEPTH(m)	3.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	97	97	96	95	93

LAB. REF.	74/2020

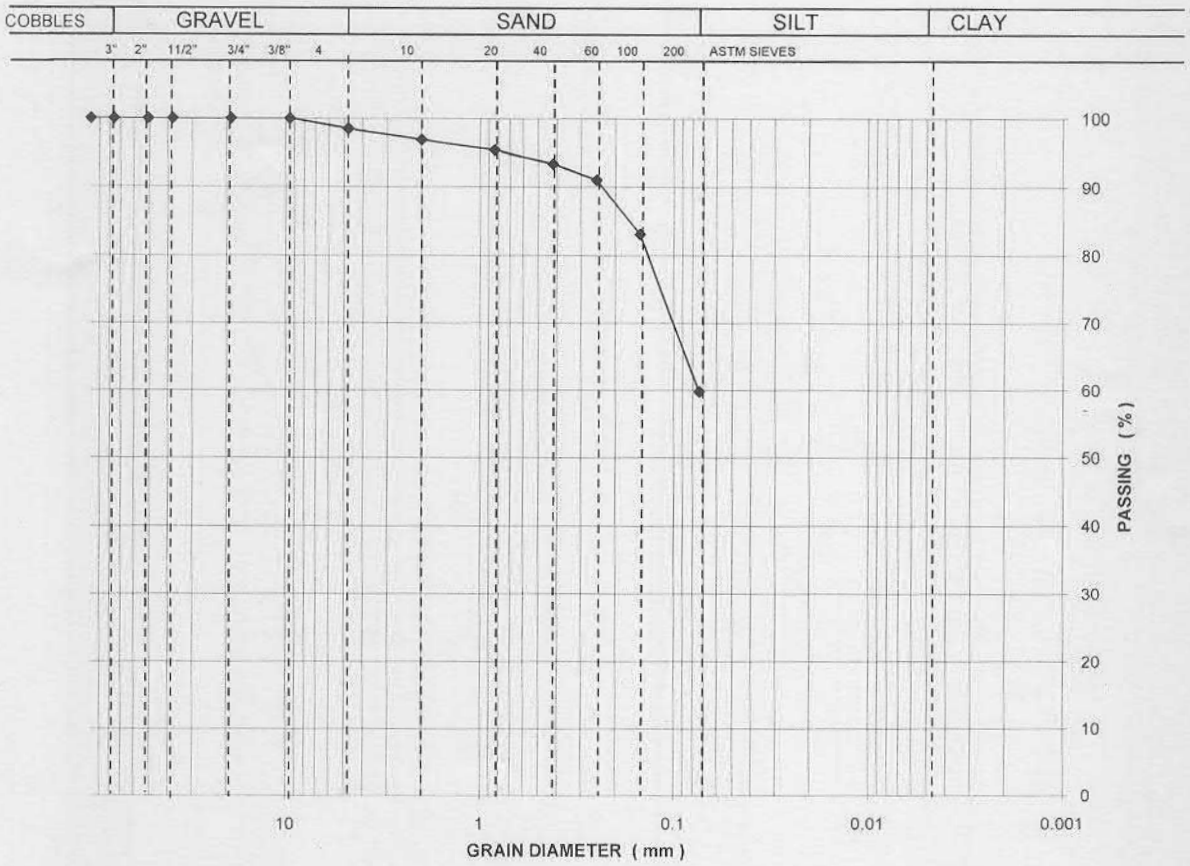
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-15	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	98	97	93	83	60

LAB. REF.	74/2020

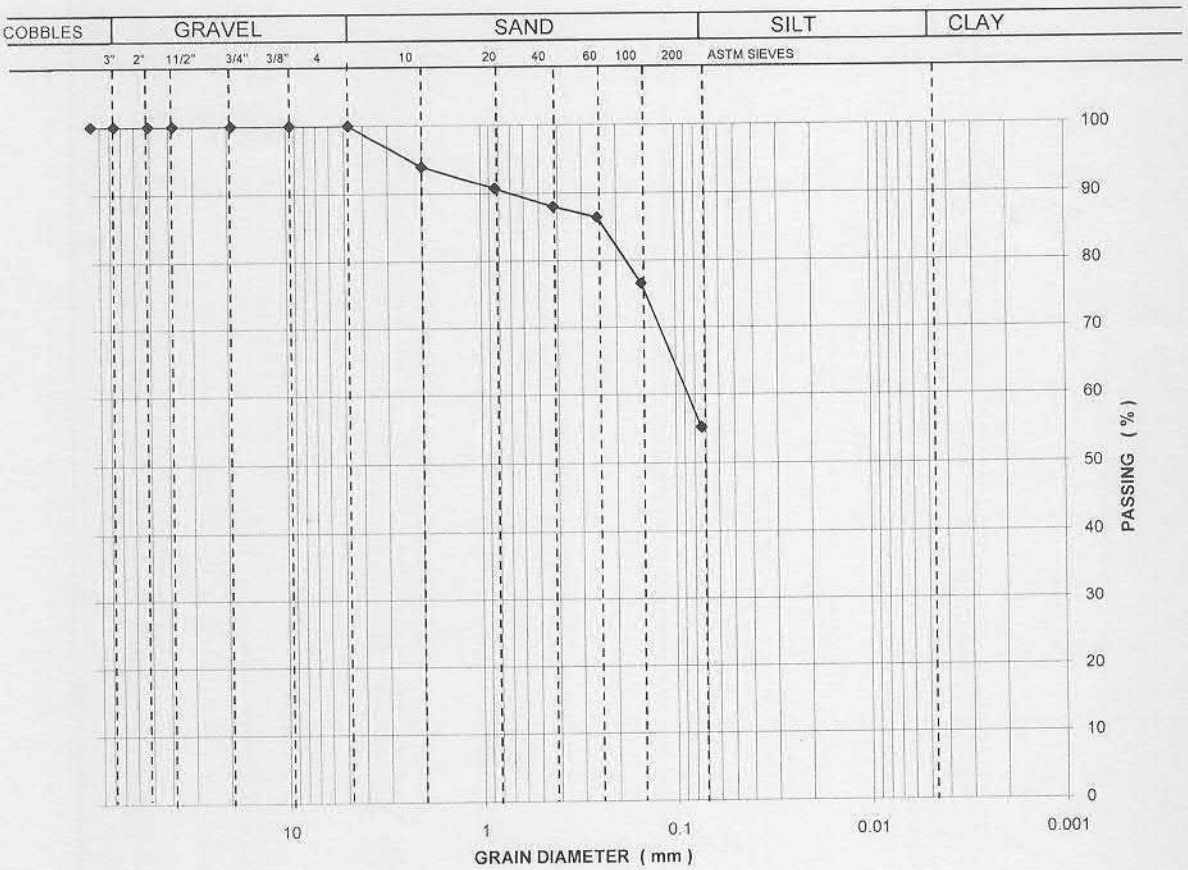
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-15	SAMPLE	SPT-2
TYPE	DISTURBED	DEPTH(m)	2.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	100	94	88	77	55

LAB. REF.	74/2020

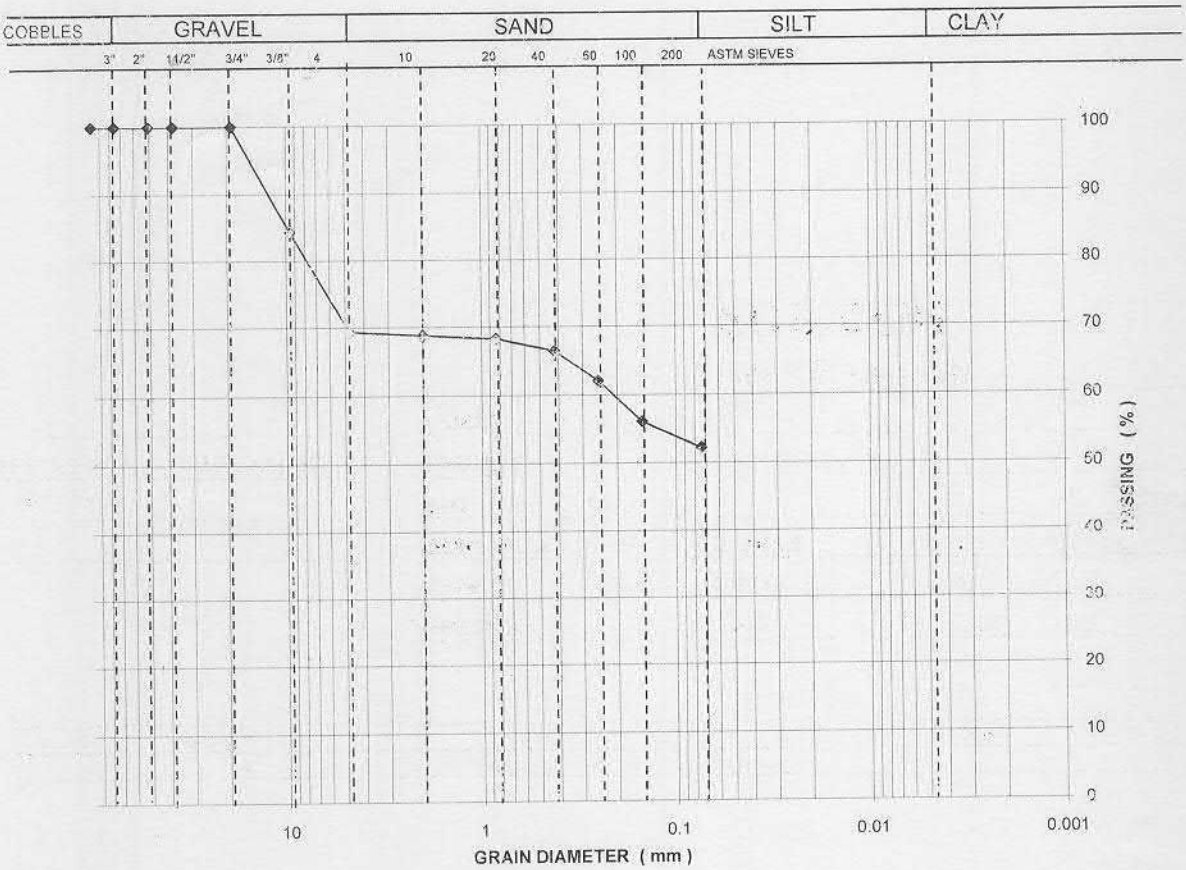
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-16	SAMPLE	SPT-1
TYPE	DISTURBED	DEPTH(m)	1.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	84	69	69	66	56	52

LAB. REF.	74/2020

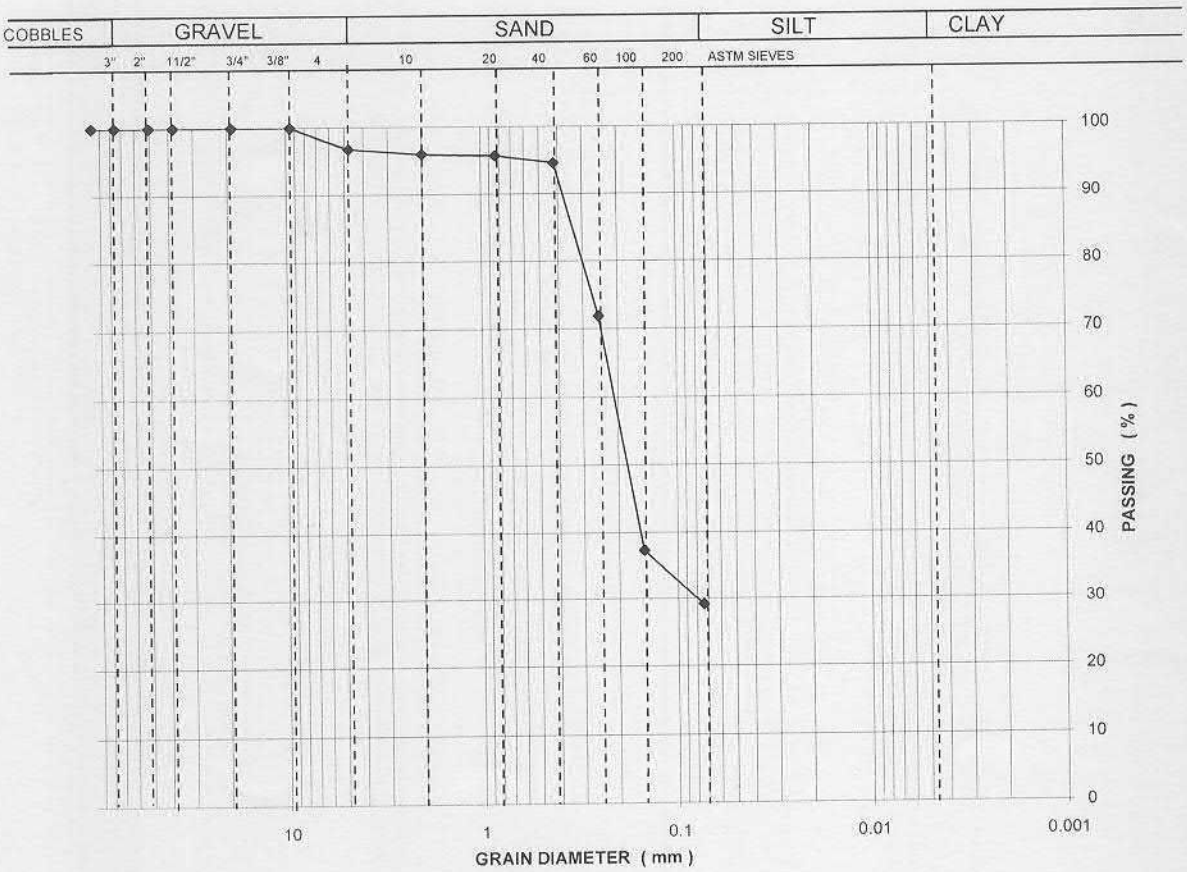
REMARKS :

SOILCON

GRAIN SIZE ANALYSIS

TESTED BY	CHECKED BY
IKRAM ULLAH	MAHMOOD

CLIENT	HALCROW PAJISTAN		
PROJECT	KARACHI WATER CANAL		
SITE	KARACHI		
BORE HOLE	BH-16	SAMPLE	SPT-3
TYPE	DISTURBED	DEPTH(m)	3.00
SPECIMEN	1	DATE	09.11.2020



SIEVE NO.	3"	2"	1"1/2	3/4"	3/8"	4	10	40	100	200
PASSING (%)	100	100	100	100	100	97	96	95	37	29

LAB. REF.	74/2020

REMARKS :

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-5	SAMPLE	SPT-1	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	1.00	DATE	06.11.2020

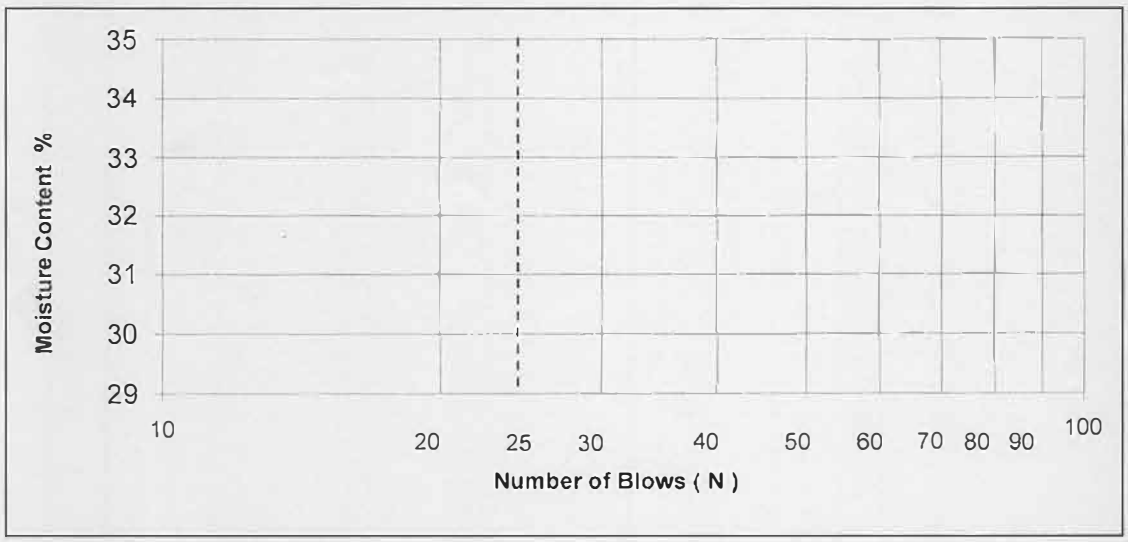
LIQUID LIMIT

Number of Blows N					
Moisture Content %					

PLASTIC LIMIT

Moisture Content %			

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	NON-PLASTIC	



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-5	SAMPLE	SPT-4	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	4.00	DATE	06.11.2020

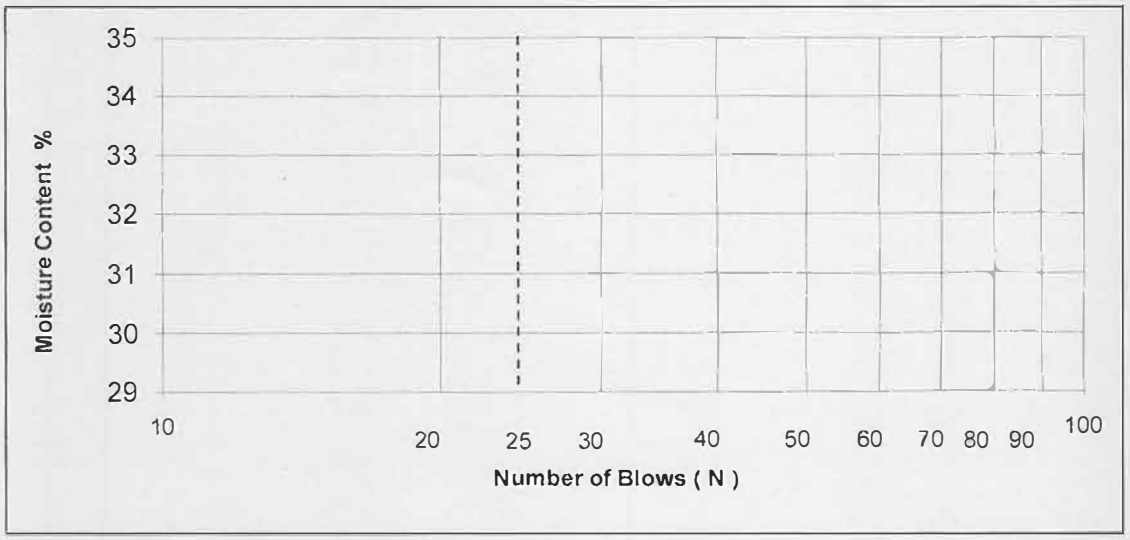
LIQUID LIMIT

Number of Blows N	11	Further readings are not possible
Moisture Content %	24.48	

PLASTIC LIMIT

Moisture Content %			

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-6	SAMPLE	SPT-5	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	5.00	DATE	06.11.2020

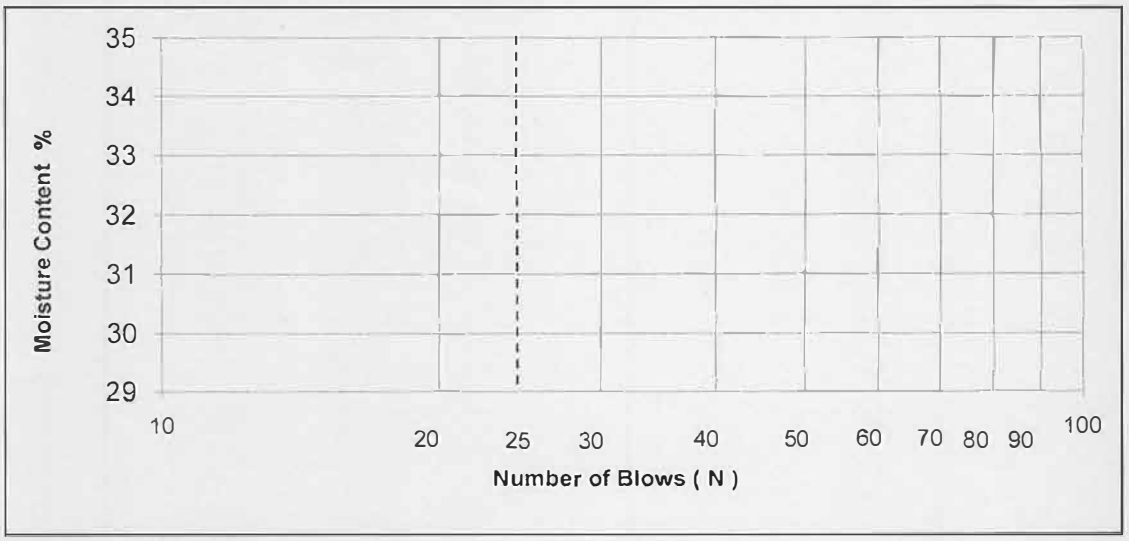
LIQUID LIMIT

Number of Blows N	9	Further readings are not possible
Moisture Content %	23.50	

PLASTIC LIMIT

Moisture Content %			

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-8	SAMPLE	SPT-5	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	5.00	DATE	06.11.2020

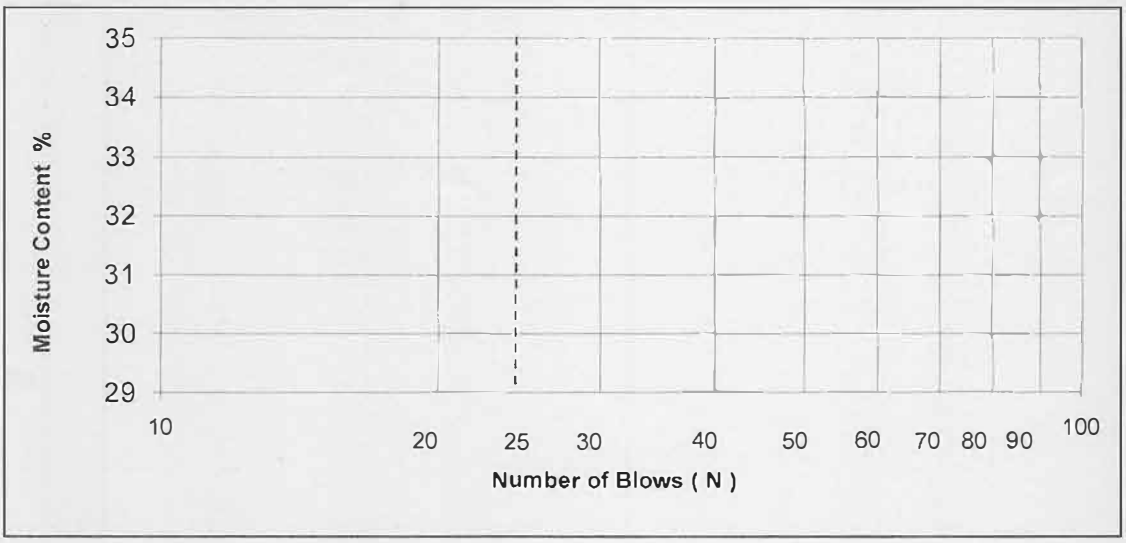
LIQUID LIMIT

Number of Blows N	9	Further readings are not possible
Moisture Content %	24.13	

PLASTIC LIMIT

Moisture Content %			

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-9	SAMPLE	RUN-1	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	3.00-4.00	DATE	06.11.2020

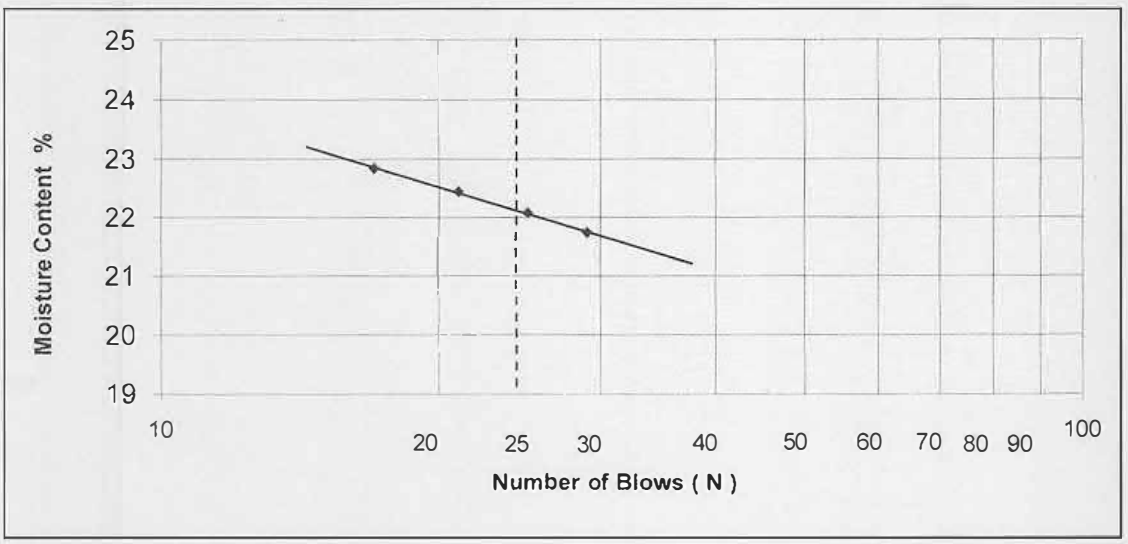
LIQUID LIMIT

Number of Blows N	17	21	25	29	
Moisture Content %	22.84	22.45	22.08	21.74	

PLASTIC LIMIT

Moisture Content %	15.98	16.03	16.06

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
22	16	6



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-12	SAMPLE	SPT-5	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	3.00-3.36	DATE	06.11.2020

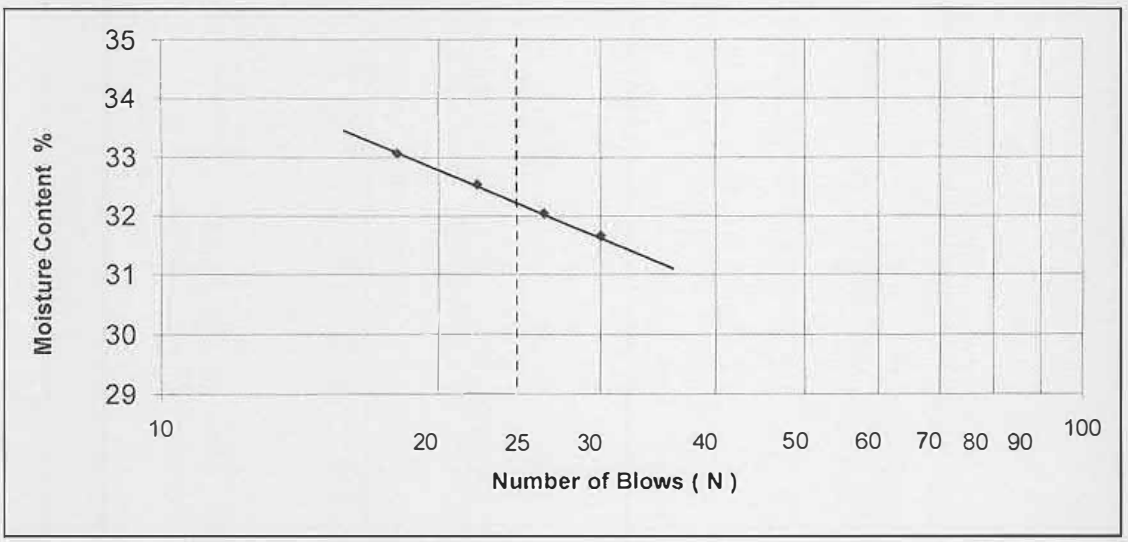
LIQUID LIMIT

Number of Blows N	18	22	26	30	
Moisture Content %	33.07	32.54	32.05	31.66	

PLASTIC LIMIT

Moisture Content %	20.05	20.09	20.12

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
32	20	12



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-13	SAMPLE	SPT-3	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	3.00	DATE	06.11.2020

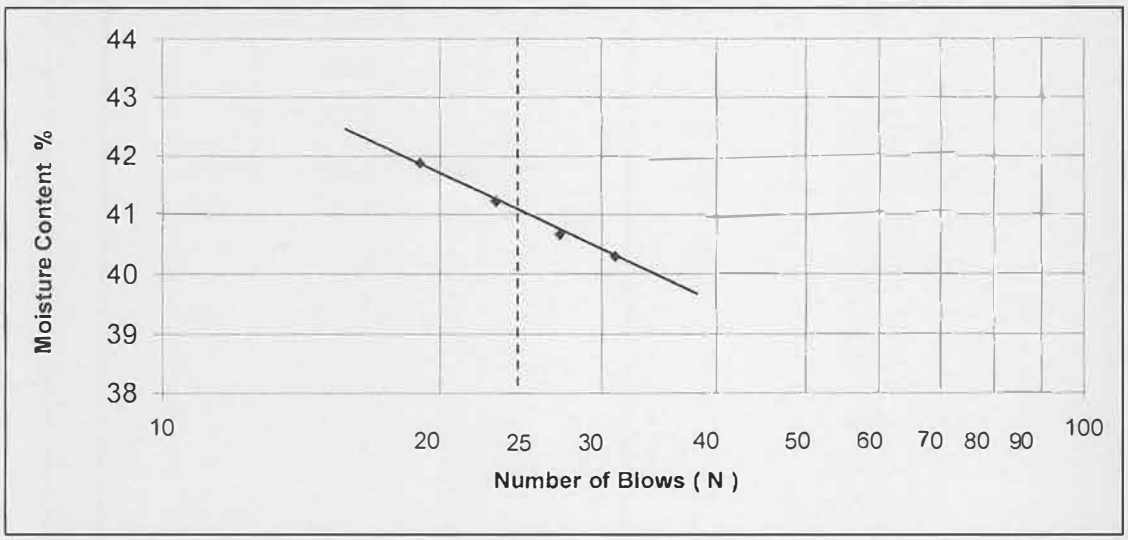
LIQUID LIMIT

Number of Blows N	19	23	27	31	
Moisture Content %	41.88	41.22	40.67	40.3	

PLASTIC LIMIT

Moisture Content %	24.03	24.06	24.10

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
41	24	17



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-15	SAMPLE	SPT-01	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	1.00-1.45	DATE	06.11.2020

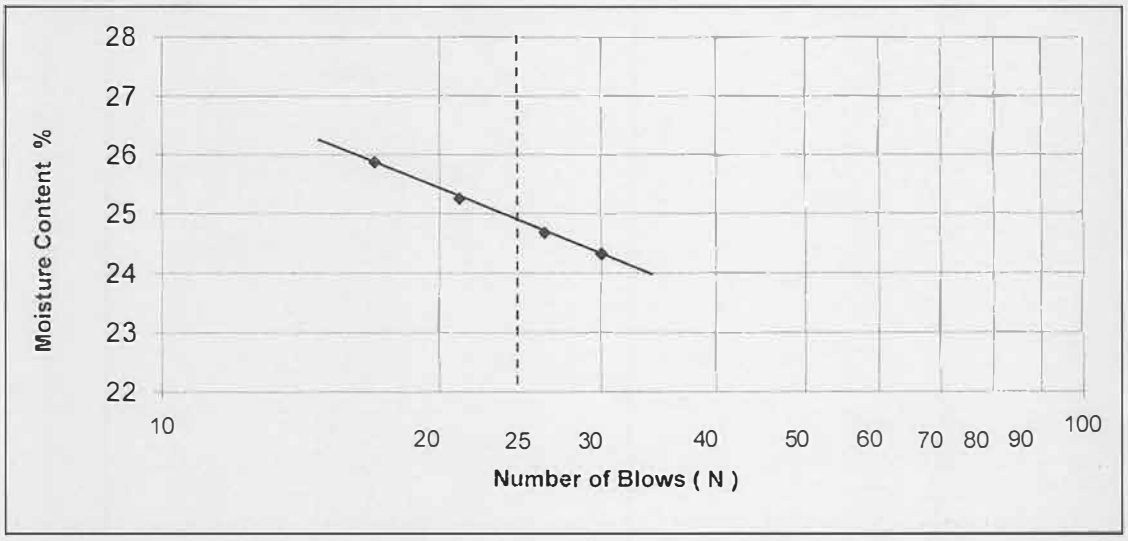
LIQUID LIMIT

Number of Blows N	17	21	26	30	
Moisture Content %	25.87	25.25	24.68	24.32	

PLASTIC LIMIT

Moisture Content %	16.91	16.94	16.98

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
25	17	8



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

SOILCON

LIQUID & PLASTIC LIMIT

(ASTM D - 4318)

PROJECT	KARACHI WATER CANAL				
LOCATION					
CLIENT	HALCROW PAKISTAN				
BOREHOLE	BH-15	SAMPLE	SPT-2	TYPE	DISTURBED
LAB. REF.	74/2020	DEPTH m	2.00	DATE	06.11.2020

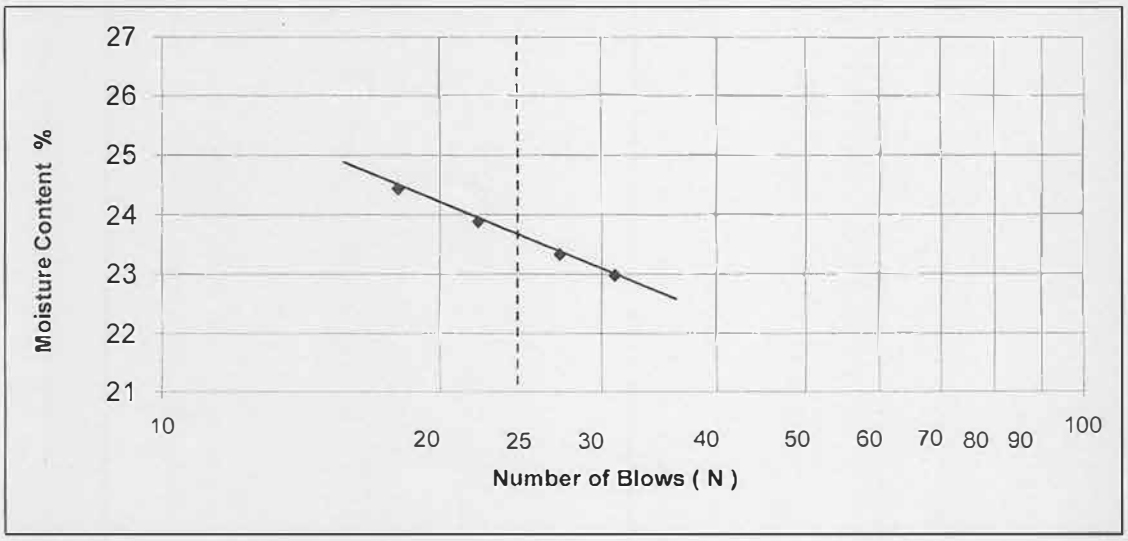
LIQUID LIMIT

Number of Blows N	18	22	27	31	
Moisture Content %	24.43	23.89	23.33	22.98	

PLASTIC LIMIT

Moisture Content %	16.77	16.81	16.83

LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
24	17	7



TESTED BY	CHECKED BY
MAHMOOD	IKRAM

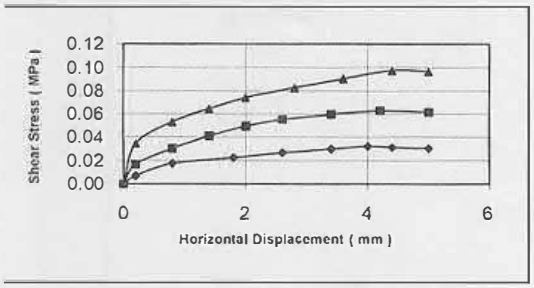
SOILCON

DIRECT SHEAR TEST ASTM - D3080

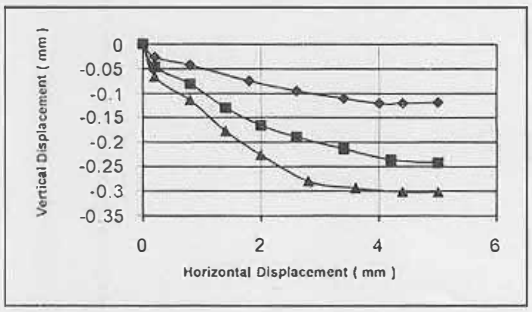
Operator	Checked by
Nisar Ahmad	Mahmood

CLIENT	HALCROW PAKISTAN		
PROJECT	KARACHI WATER CANAL		
SITE			
BORE HOLE	BH-7	SAMPLE	SPT-3
SPECIMEN	1-2-3	TYPE	DISTURBED
DEPTH (m)	3.00	DATE	09.11.2020

Initial Values		Values at beginning of shear cycle					Failure Values		
Dry density	m.c.	Def.rate	Normal stress	Height	Vertical Displacement	tc	Shear Stress	Horizontal Displacement	Vertical Displacement
g/cm³	%	mm/min	Mpa	mm	mm	hrs	MPa	mm	mm
1.343	13.89	0.020	0.049	19.92	0.078	4	0.032	4.0	-0.120
1.342	13.48	0.020	0.098	19.86	0.140	4	0.063	4.2	-0.236
1.341	13.68	0.020	0.147	19.79	0.210	4	0.098	4.4	-0.302



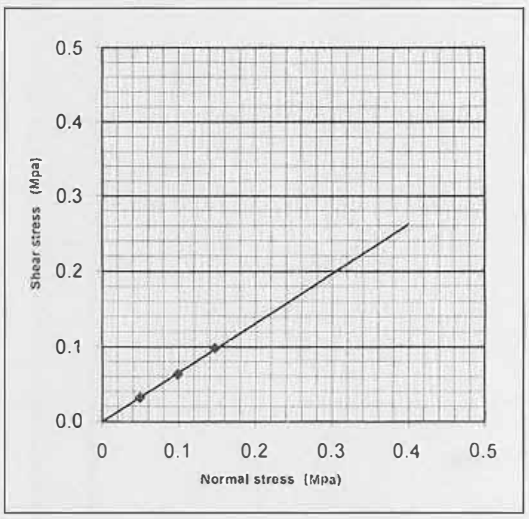
Sample height	20 mm
Area	31.22 cm²
Volume	62.44 cm³
Specimens	3



Lab. Ref:	74/2020

REMARKS

Remoulded
Max. Attainable Densilty
-No.10 sieve material used



Angle of Internal Friction =		33.2 Degree
Cohesion	=	0 MPa

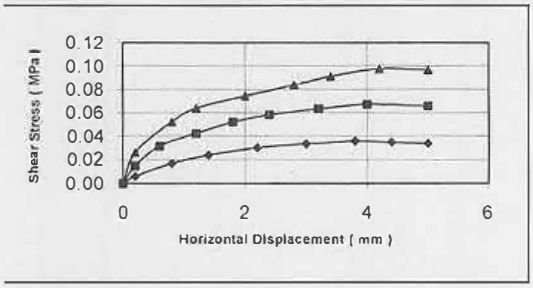
SOILCON

DIRECT SHEAR TEST ASTM - D3080

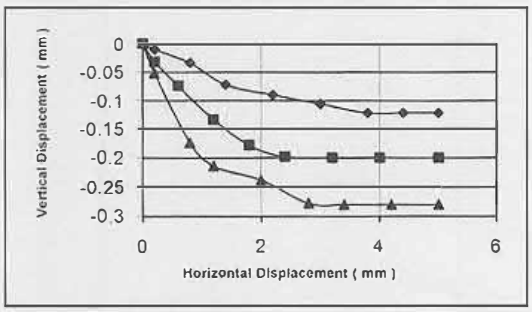
Operator	Checked by
Nisar Ahmad	Mahmood

CLIENT	HALCROW PAKISTAN		
PROJECT	KARACHI WATER CANAL		
SITE			
BORE HOLE	BH-8	SAMPLE	SPT-3
SPECIMEN	1-2-3	TYPE	DISTURBED
DEPTH (m)	3.00	DATE	09.11.2020

Initial Values		Values at beginning of shear cycle					Failure Values		
Dry density	m.c.	Def.rate	Normal stress	Height	Vertical Displacement	tC	Shear Stress	Horizontal Displacement	Vertical Displacement
g/cm^3	%	mm/min	Mpa	mm	mm	hrs	MPa	mm	mm
1.433	10.02	0.020	0.049	19.92	0.078	4	0.036	3.8	-0.122
1.425	10.14	0.020	0.098	19.86	0.142	4	0.067	4.0	-0.200
1.415	10.24	0.020	0.147	19.79	0.214	4	0.098	4.2	-0.280



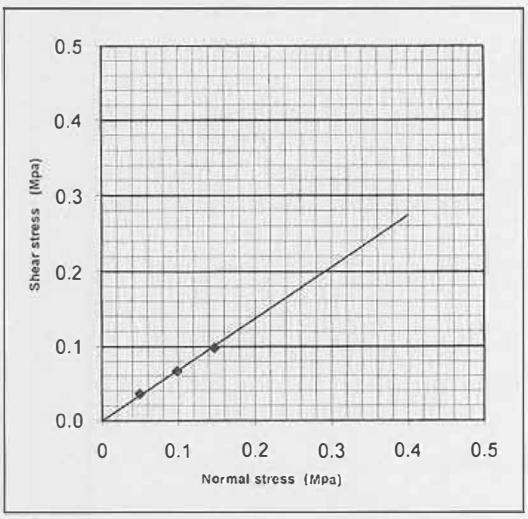
Sample height	20 mm
Area	31.22 cm^2
Volume	62.44 cm^3
Specimens	3



Lab. Ref:	74/2020

REMARKS

Remoulded
Max. Attainable Densilty
-No.10 sieve material used



Angle of Internal Friction =		34.4 Degree
Cohesion	=	0 MPa

SOILCON
GEOTECHNICAL TESTING LABORATORIES
18-Km, Multan Road, Lahore. Ph: 042-7510942-43 Fax:042-7515267

SUMMARY OF SPECIFIC GRAVITY TEST RESULTS

Project: KARACHI WATER CANAL
Location:

Client: HALCROW PAKISTAN
Lab. Ref: 74/2020

BH / TP No.	Sample	Depth (m)	Location	NMC %	DENSITY (g/cu.cm)		Specific Gravity	Remarks
					Bulk	Dry		
BH-9	RUN-1	3.00-4.00					2.589	

Tested By: IKRAM ULLAH
Checked By: Mahmood
Dated: 09.11.2020

SOILCON

GEOTECHNICAL TESTING LABORATORIES

18-Km, Multan Road, Lahore. Ph: 042-7510942-43 Fax:042-7515267

SUMMARY OF CHEMICAL TEST RESULTS

Project: KARACHI WATER CANAL

Location:

HALCROW PAKISTAN

Lab. Ref:74/2020

BH / TP #	Sample #	Depth (m)	Total Dissolved Solids %	Sulphate Contents % (Water Soluble)	Organic Matter %	Chloride Contents %	REMARKS
BH-5	SPT-1	1.00		0.011	0.301	0.002	
BH-6	SPT-3	3.00		0.012	0.298	0.002	
BH-7	SPT-3	3.00		0.020	0.359	0.004	
BH-8	SPT-3	3.00		0.009	0.549	0.002	
BH-11	SPT-2	2.00		0.007	0.317	0.003	
BH-13	SPT-1	1.00		0.012	0.425	0.036	
BH-15	SPT-2	2.00		0.006	0.435	0.004	

Tested By: HAMZA

Checked By: UMAIR

Dated: 09.11.2020

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

SUMMARY OF THE TEST RESULTS

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

Client: HALCROW PAKISTAN

BH/ TP No.	Sample No	Depth (m)	Specific Gravity, Gs	Point Load Strength Index, $I_{s(50)}$, MPa	Remarks
BH-01	RUN-2	0.60-1.40	2.56		
		1.40-2.40	2.60		
BH-02	RUN-2	0.60-1.40	2.58	3.60	Diametrically Loaded for Point Load Test
BH-04	RUN-4	3.0-4.0	2.62		
	RUN-12	11.0-12.0		0.02	Diametrically Loaded for Point Load Test
BH-07	RUN-1	3.0-4.0	2.54	0.18	
BH-10	RUN-1	2.45-3.0	2.58	0.15	
	RUN-3	3.0-4.0	2.64	2.41	

Prepared by:

Checked by:

Director

10/11/2020

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

SUMMARY OF THE TEST RESULTS

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

Client: HALCROW PAKISTAN

BH/ TP No.	Sample No	Depth (m)	Specific Gravity, Gs	Point Load Strength Index, $I_{s(50)}$, MPa	Remarks
BH-13	RUN-3	6.5-7.0		0.20	Diametrically Loaded for Point Load Test
BH-14	RUN-1	1.0-2.0	2.56	3.22	Diametrically Loaded for Point Load Test
	RUN-4	3.0-4.0	2.52		
BH-16	RUN-1	3.0-4.0	2.62	0.10	Diametrically Loaded for Point Load Test
	RUN-3	5.0-6.0	2.60		

Prepared by:

Geotech. Engg. Lab. Director Civil Engg. Dept. UET L.

10/11/2020

Checked by:

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

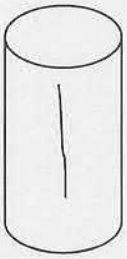
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

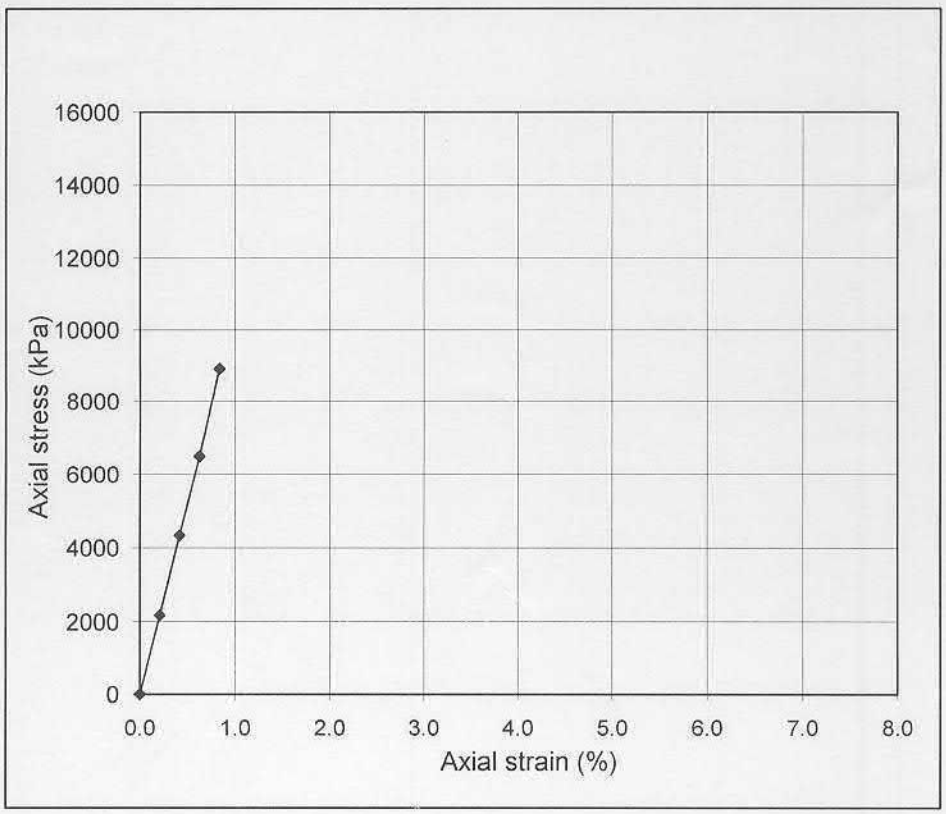
Client: HALCROW PAKISTAN

BH/TP No.	BH-1	Height =	12.192 cm
Sample No.	RUN-2	Diameter =	6.096 cm
Depth (m):	0.60-1.40	Bulk Density =	27.3 kN/m^3
		Moisture Content =	0.60 %

Unconfined Compression Strength = **14850 kPa**



Test Method: ASTM D2166



ired by:

Checked by:

Director

Civil Engg Dept UET Lhr.

10/11/2020

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

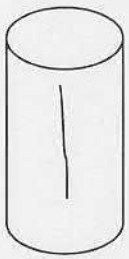
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

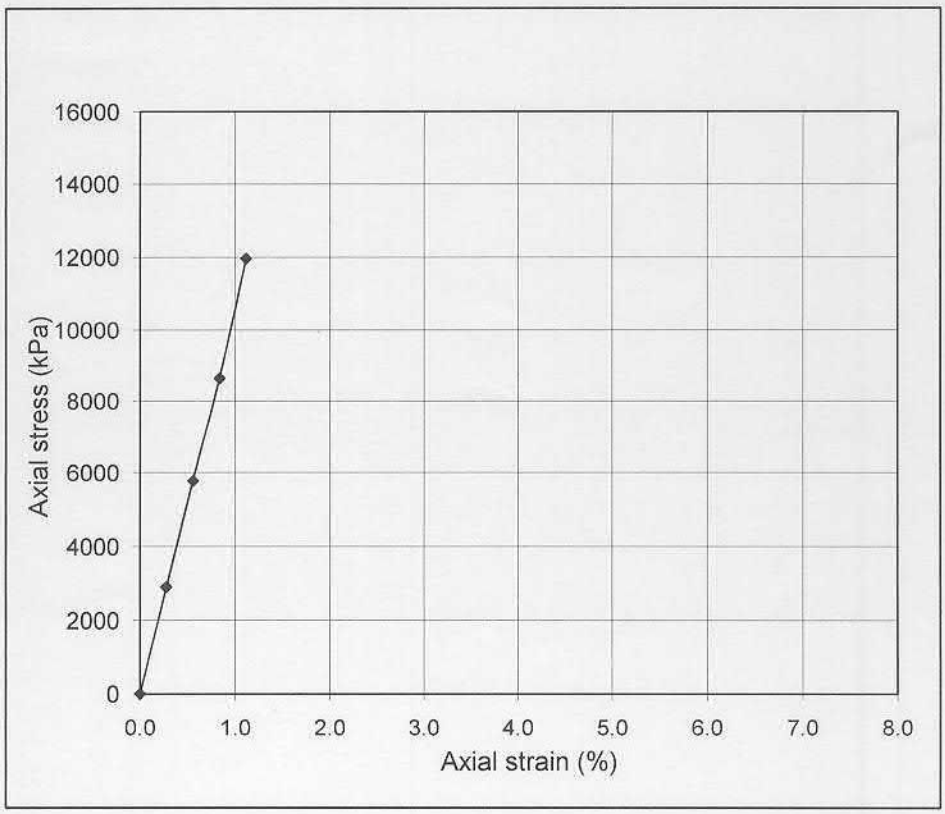
Client: HALCROW PAKISTAN

BH/TP No.	BH-1	Height =	9.144 cm
Sample No.	RUN-3	Diameter =	4.572 cm
Depth (m):	1.40-2.40	Bulk Density =	24.2 kN/m^3
		Moisture Content =	0.73 %

Unconfined Compression Strength = **11960 kPa**



Test Method: ASTM D2166



ired by:

Checked by:

Geotech. Engg. Lab
Director
Civil Engg. Dept. UET Lhr.

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

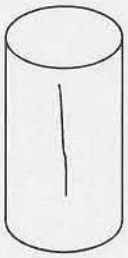
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

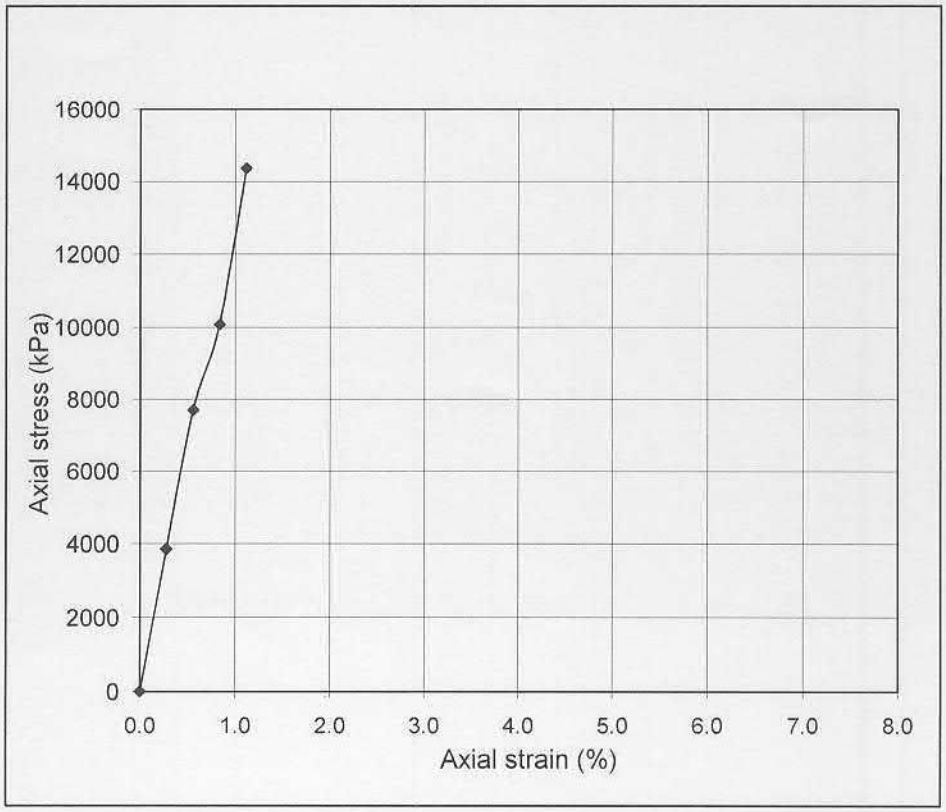
Client: HALCROW PAKISTAN

BH/TP No.	BH-2	Height =	9.144 cm
Sample No.	RUN-4	Diameter =	4.572 cm
Depth (m):	2.40-3.40	Bulk Density =	26.6 kN/m^3
		Moisture Content =	0.49 %

Unconfined Compression Strength = **14350 kPa**



Test Method: ASTM D2166



ired by:

Checked by:

Director

Civil Engg Dept UET Lhr.

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

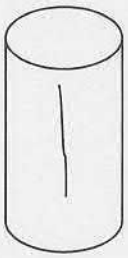
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

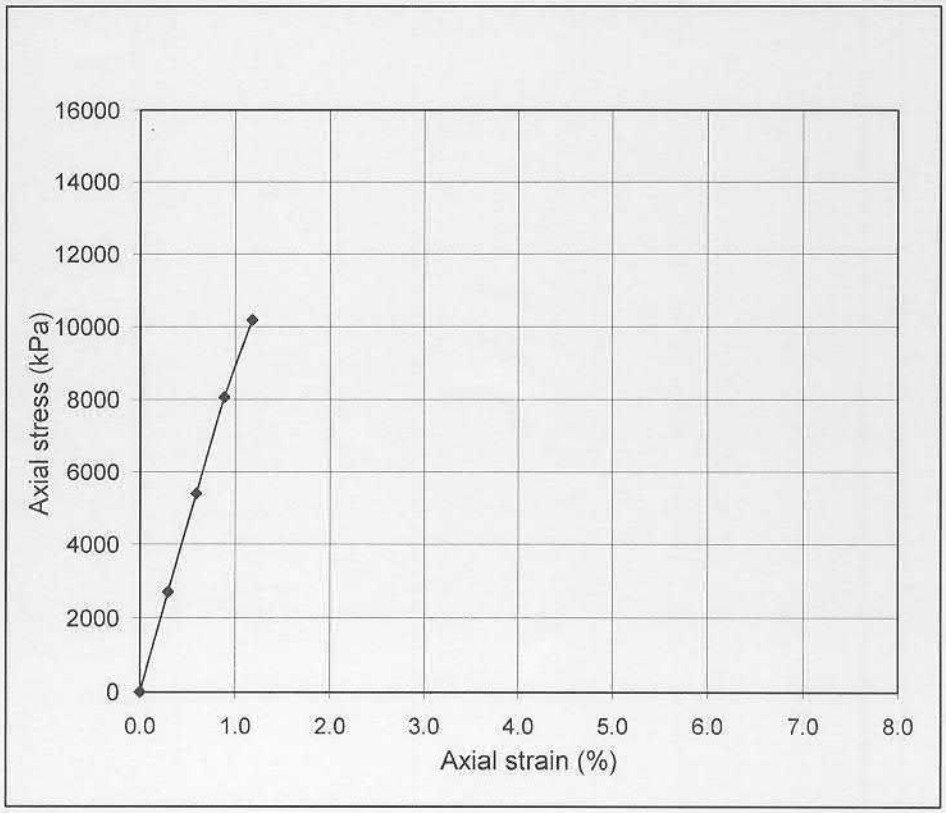
Client: HALCROW PAKISTAN

BH/TP No.	BH-4	Height =	8.636 cm
Sample No.	RUN-4	Diameter =	4.318 cm
Depth (m):	3.0-4.0	Bulk Density =	23.6 kN/m^3
		Moisture Content =	0.38 %

Unconfined Compression Strength = **10190 kPa**



Test Method: ASTM D2166



ired by:

Checked by:

Director

Civil Engg. Dept. UET Lhr.

10/11/2020

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

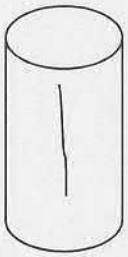
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

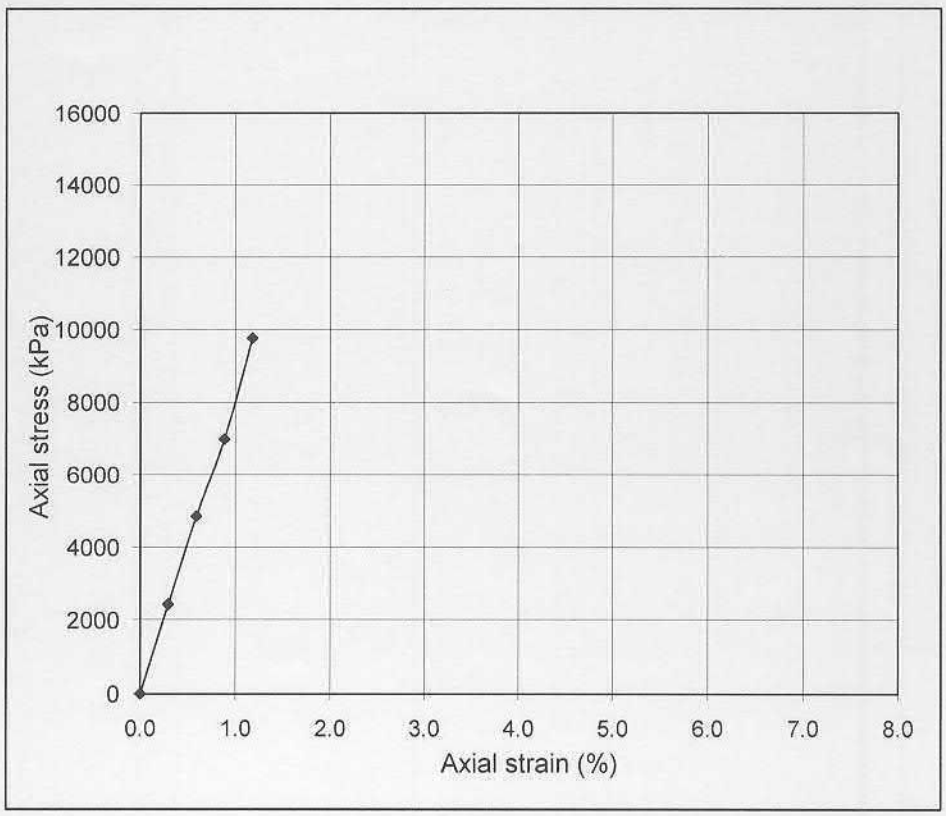
Client: HALCROW PAKISTAN

BH/TP No.	BH-14	Height =	8.636 cm
Sample No.	RUN-4	Diameter =	4.318 cm
Depth (m):	3.0-4.0	Bulk Density =	23.9 kN/m^3
		Moisture Content =	0.64 %

Unconfined Compression Strength = **9760 kPa**



Test Method: ASTM D2166



ired by:

Checked by: 10/11/2020

Geotech. Engg. Lab. Director Civil Engg. Dept UET Lhr.

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

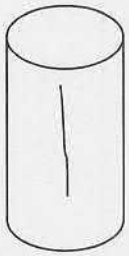
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

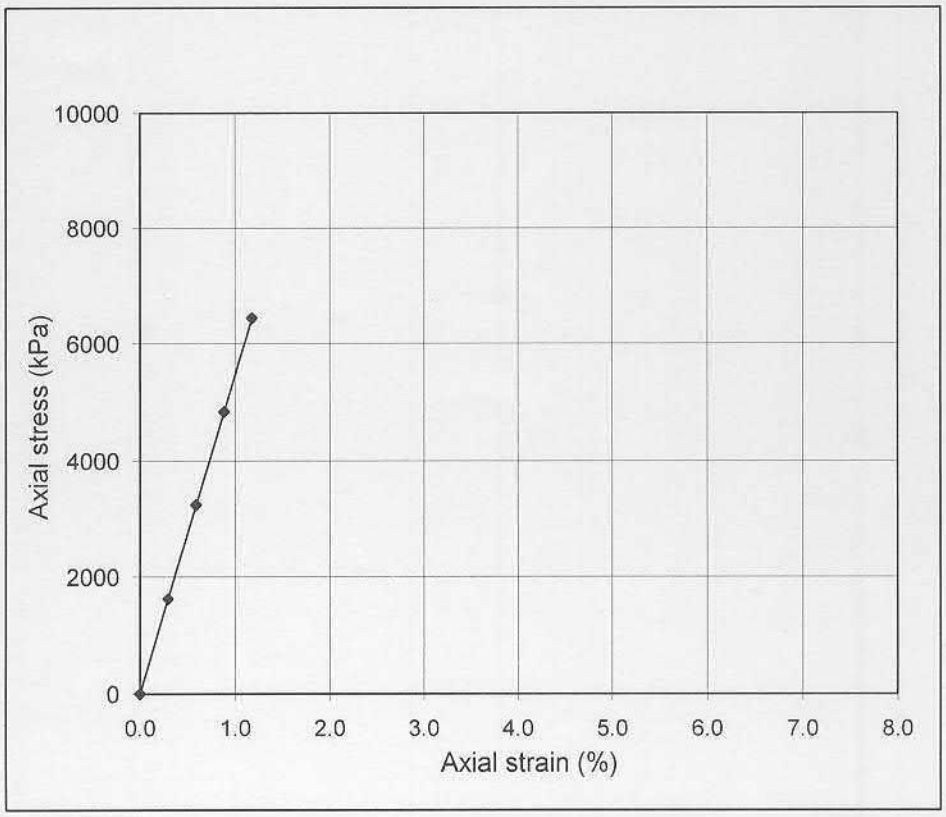
Client: HALCROW PAKISTAN

BH/TP No.	BH-15	Height =	8.636 cm
Sample No.	RUN-2	Diameter =	4.318 cm
Depth (m):	3.0-4.0	Bulk Density =	23.7 kN/m^3
		Moisture Content =	0.53 %

Unconfined Compression Strength = **6435 kPa**



Test Method: ASTM D2166



Checked by:

Geotech. Engg. Lab
Director
Civil Engg. Dept. UET Lhr.

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

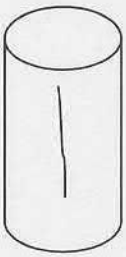
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

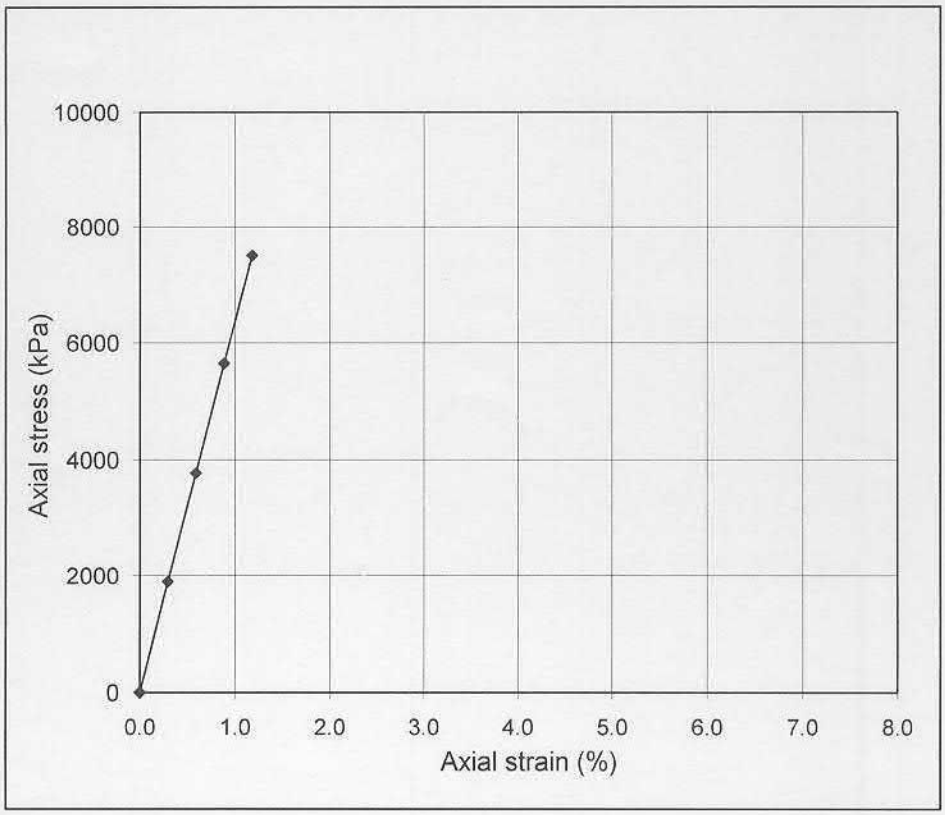
Client: HALCROW PAKISTAN

BH/TP No.	BH-15	Height =	8.636 cm
Sample No.	RUN-5	Diameter =	4.318 cm
Depth (m):	6.0-7.0	Bulk Density =	23.3 kN/m^3
		Moisture Content =	0.75 %

Unconfined Compression Strength = **7500 kPa**



Test Method: ASTM D2166



ıred by:

Checked by:

Director

University of Engineering & Technology, Lahore
Department of Civil Engineering
Geotechnical Engineering Laboratory

UNIAXIAL COMPRESSION TEST

Project: Geotechnical Investigation of Soil for the Karachi Water Canal

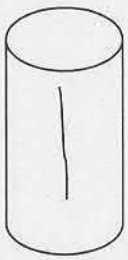
Ref: GSA/GT/W-15/201029

Dated: 4/11/2020

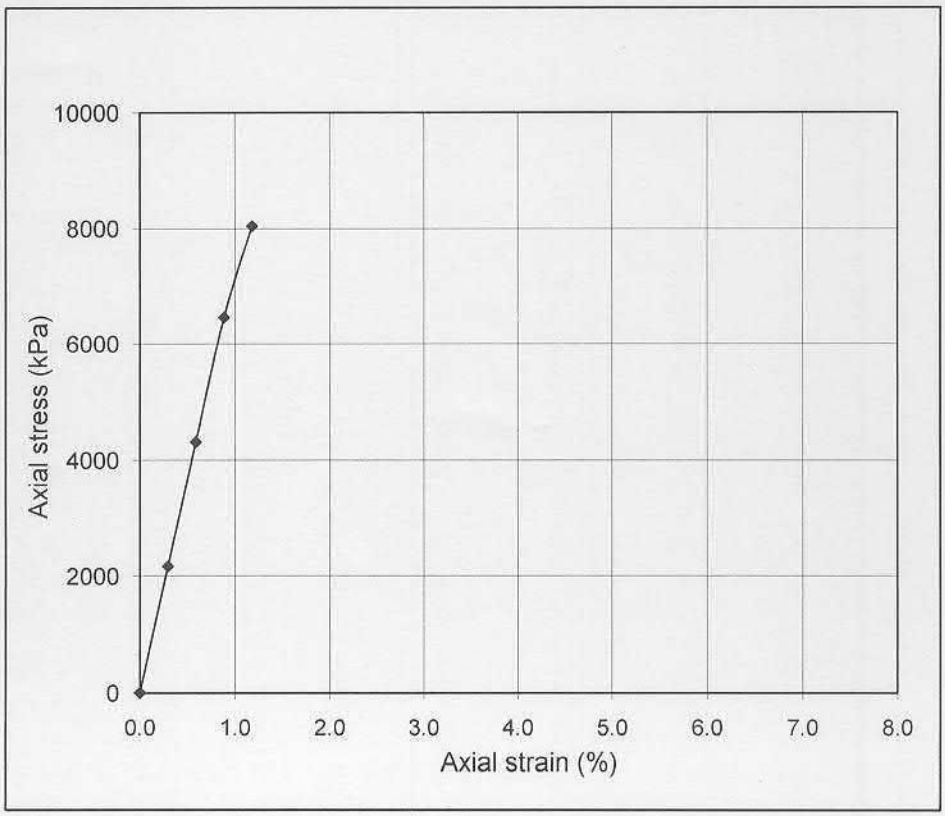
Client: HALCROW PAKISTAN

BH/TP No.	BH-16	Height =	8.636 cm
Sample No.	RUN-3	Diameter =	4.318 cm
Depth (m):	5.0-6.0	Bulk Density =	24.3 kN/m^3
		Moisture Content =	0.56 %

Unconfined Compression Strength = **8043 kPa**



Test Method: ASTM D2166



red by:

Checked by: 10/11/2020

Geotech Engg Lab * Director * Civil Engg. Dept. UE / Lhr.

Annexure-V

Field Photographs

LCP ROOM

GEOPHYSICAL SURVEY

CONSULTING SERVICES KARACHI WATER CANAL PPP

Annex 5.1. Report of ferro scanning of rebar, rebound hammer and non-destructive testing for concrete quality of RCC structure of pump house buildings and Hub dam canal project, Karachi

CONSULTING SERVICES KARACHI WATER CANAL PPP

REPORT OF FERRO SCANING OF REBAR, REBOUND HAMMER AND NON-DESTRUCTIVE TESTING FOR CONCRETE QUALITY OF RCC STRUCTURE OF PUMP HOUSE BUILDINGS AND HUB DAM CANAL PROJECT, KARACHI.

October, 2020

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd

Submitted By:

SURVEY TECH (PVT.) LTD.

CONTRACTOR, ENGINEERS,GEOLOGIST & SURVEYORS

Office: Plot #129,Block#2, Sector C-1,Township, Lahore-Pakistan

Tel.# +92 423 546 5005Cell# +92 335 765 7765 ,+92 300 842 7659

E-Mail surveytech2@gmail.com surveytechpak@gmail.com

Web http://www.surveytechpak.com

REPORT OF FERRO SCANING OF REBAR , REBOUND HAMMER AND NON-DESTRUCTIVE TESTING FOR CONCRETE QUALITY OF RCC STRUCTURE OF PUMP HOUSE BUILDINGS AND HUB DAM CANAL PROJECT, KARACHI.

TABLE OF CONTENTS

Sr.#	DESCRIPTION	Page #
1.0	INTRODUCTION	01
2.0	SCOPE OF WORK	01
3.0	FERRO SCANNING OF RCC MEMBERS	02
4.0	ULTRASONIC PULSE VELOCITY	02
5.0	REBOUND HAMMER TEST	03
	ANNEXURE-I	
6.0	FERRO SCANNING RESULTS	06
	ANNEXURE-II	
7.0	ULTRASONIC PULSE VELOCITY TEST RESULTS	24
	ANNEXURE-III	
8.0	REBOUND HAMMER TEST RESULTS	28
	SITE PICTURE & NOTES AND COMMENTS	

SURVEY TECH (PVT.) LTD.
CONTRACTOR, ENGINEERS,GEOLOGIST & SURVEYORS
Office: Plot #129,Block#2, Sector C-1,Township, Lahore-Pakistan
Tel.# +92 423 546 5005Cell# +92 335 765 7765 ,+92 300 842 7659
E-Mail surveytech2@gmail.com surveytechpak@gmail.com
Web http://www.surveytechpak.com

Ref. No.: BS/201102-044
Date: 02/11/2020

INTRODUCTION

Survey Tech (Pvt) Ltd has been engaged by **"Halcrow Pakistan (pvt) Ltd"** for carrying out ferro scanning of RCC structure for steel reinforcement details and non-destructive testing for uniformity and relative quality of concrete of RCC structure of Pump House Buildings and Hub Dam Canal Project, Karachi.

Following the receipt of ***Notice to Proceed*** by the authority, **Survey Tech** engineering team supervised the field work campaign with a team led by a field engineer to the site on 26th October, 2020. The field investigation was completed in two days. Concurrent with field activities, identified representative data obtained from the site was analyzed at Survey Tech Office/Lab in Lahore.

SCOPE OF WORK

This report on structural assessment covers the reporting requirement stipulated in the scope of work i.e.

- **Scanning of RCC Structure:** Scanning of existing structure for reinforcement details of existing RCC structure identify by the client.
- **Ultrasonic Pulse Velocity:** Non-destructive tests for uniformity and relative quality of concrete.
- **Report:** Analysis of field data and report.

FERRO SCANNING OF RCC MEMBERS

Ferroscanning has been performed on the RCC structure of Pump House Buildings and Hub Dam Canal Project, Karachi to determine rebar dia, spacing and concrete cover. The purpose is to have clear view of steel reinforcement used in the RCC structure.

The overall test show details of steel reinforcement in RCC structure. In ferroscanning survey the Aqueduct No. 11, Column-Pier (Serial no. 13) and Wall (Serial no. 15) the instrument do not detect any steel reinforcement. If the concrete cover over steel reinforcement is larger than 120mm then the instrument cannot provide accurate information regarding steel reinforcement details.

The results are attached in Annexure-I.

ULTRASONIC PULSE VELOCITY TEST

The test consist of measuring the travel time of a pulse of vibrational energy to pass through a concrete member. The test is carried out in accordance with ASTM designation C-597. This test method may be used to assess to uniformity and relative quality of concrete, to indicate the presence of voids and cracks, to estimate the depth of cracks, to indicate changes in the properties of concrete and to estimate the severity of deterioration or cracking. The computation of test results is given in Annexure-II.

Non destructive tests

"Rebound Number of Hardened Concrete"

ASTM C805-85

Scope:

This test is also known as the **Schmidt hammer** or **impact hammer,** and is a **non-destructive method** of testing concrete. The test is based on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges. It has been used world-wide as an index test for a testing equipment to **estimate strength** of concrete due to its rapidity and easiness in execution, simplicity, portability, low cost and non-destructiveness.

Rebound Number used for:-

- Determine the resistance of the concrete.
- Identify the strengths and weaknesses of the structural element.
- Identified at the homogeneity of concrete mix.

Apparatus:

- Rebound hammer.
- Abrasive stone: consisting of medium-grain texture silicon carbide or equivalent material.

A. Selection of Test Surface:

Concrete members to be tested shall be at least 100 mm thick and fixed within a structure. Smaller specimens must be rigidly supported. Areas exhibiting honeycombing, scaling, rough texture, or high porosity should be avoided. Concretes should be approximately the same age and moisture condition in order to be compared. Dry concretes give higher rebound numbers than wet concrete, and the surface layer of concrete may be carbonated, yielding higher rebound numbers.

B. Preparation of test surface:

A test area shall be at least 150 mm in diameter. Heavily textured, soft, or surfaces with loose mortar shall be ground smooth with the abrasive stone. Smooth-formed or toweled surface shall be tested without grinding. Concretes over 6 months old may require grinding to a depth of 5 mm if they are to be compared to younger concretes. Grinding to this depth is not feasible without power equipment.

C. Important condition to do this test :

- Smoothness and flat of the Test Surface.
- Remove all finishes.
- Avoid the steel place in the surface of the test.
- Construction is fixed and its thick not smaller than 10 cm.
- Confined to the inspection area in a radius of 15 cm.
- You must install the device perpendicular to the structural element.

Procedure:

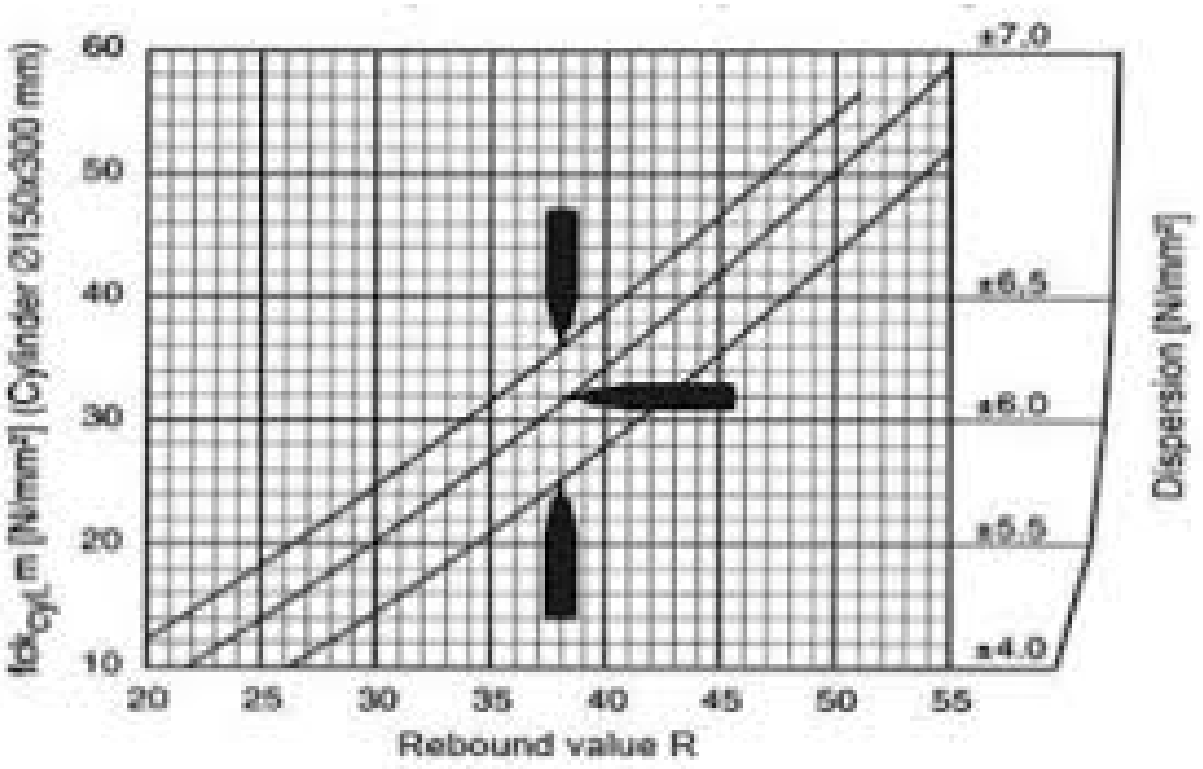
1. Firmly hold the instrument in a position that allows the plunger to strike **perpendicularly** to the surface tested. Gradually increase the pressure on the plunger until the hammer impacts.
2. After impact, record the rebound number to two significant figures.
3. Take ten readings from each test area. No two impact tests shall be closer together than 25 mm.

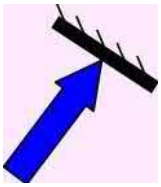
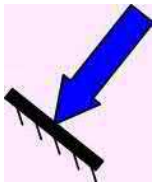
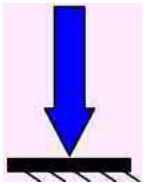
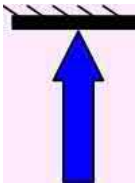
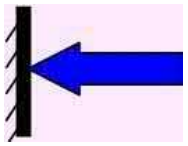
Calculation:

Discard readings differing from the average of 10-16 readings by more than 5 units and determine the average of the remaining readings. If more than 2 readings differ from the average by 7 units, discard the entire set of readings.

$$R = \frac{\sum of\ reaminnig\ reading}{\sum number\ of\ reading}$$

Rebound Hammer Chart



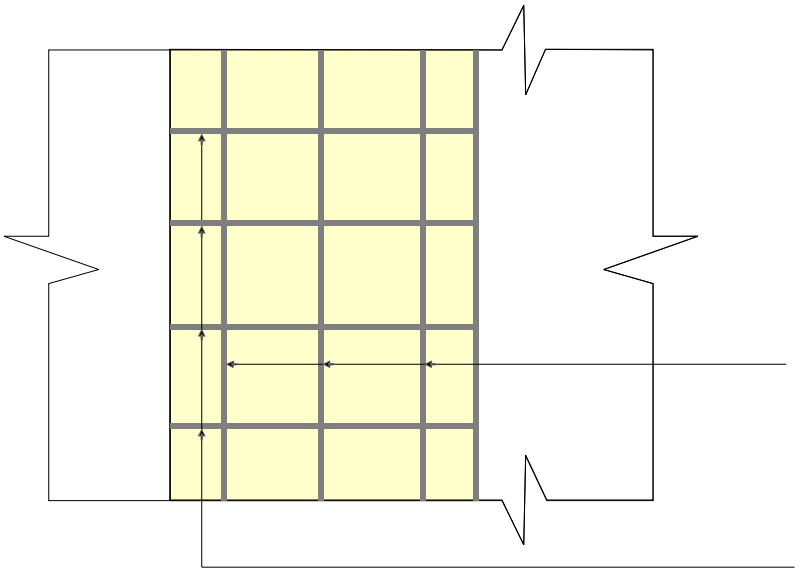
				
a=+45 ^{0}	a= -45 ^{0}	a=-90 ^{0}	a= +90 ^{0}	a=0 ^{0}

ANNEXURE-I

FERRO SCANNING RESULTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Old Pump House Wall (Sr. No. 19)



Reinforcement
12mm dia bars @ 150mm c/c

Reinforcement
12mm dia bars @ 200mm c/c

Non Scan Area

Scan Area

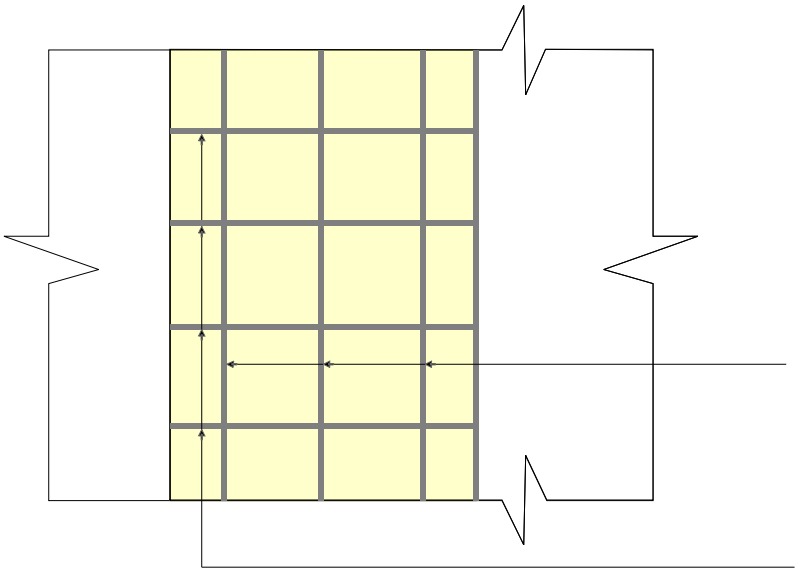
Accuracy of Bar Diameter Determination
± 3 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Old Pump House Wall (Sr. No. 20)



Reinforcement
12mm dia bars @ 150mm c/c

Reinforcement
12mm dia bars @ 225mm c/c

Non Scan Area

Scan Area

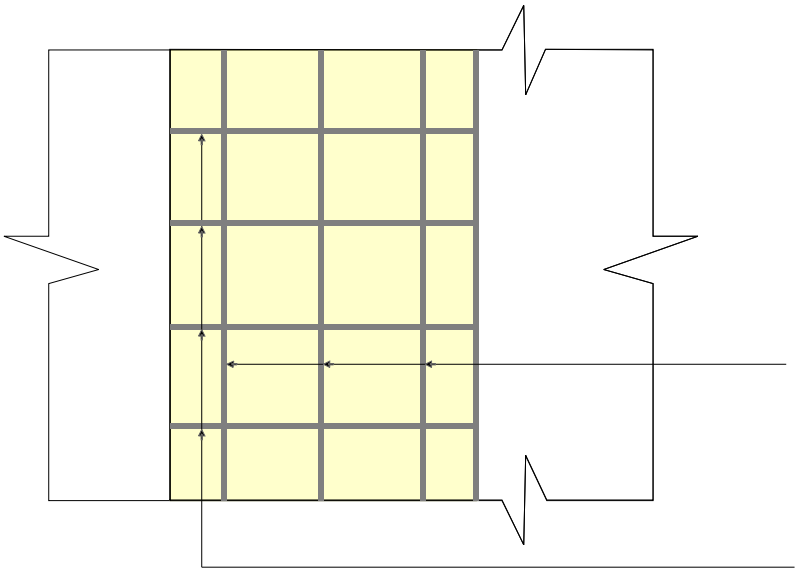
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Reservoir Filter Plant
Northern Wall (Sr. No. 17)



Reinforcement
12mm dia bars @ 225mm c/c

Reinforcement
12mm dia bars @ 250mm c/c

Non Scan Area

Scan Area

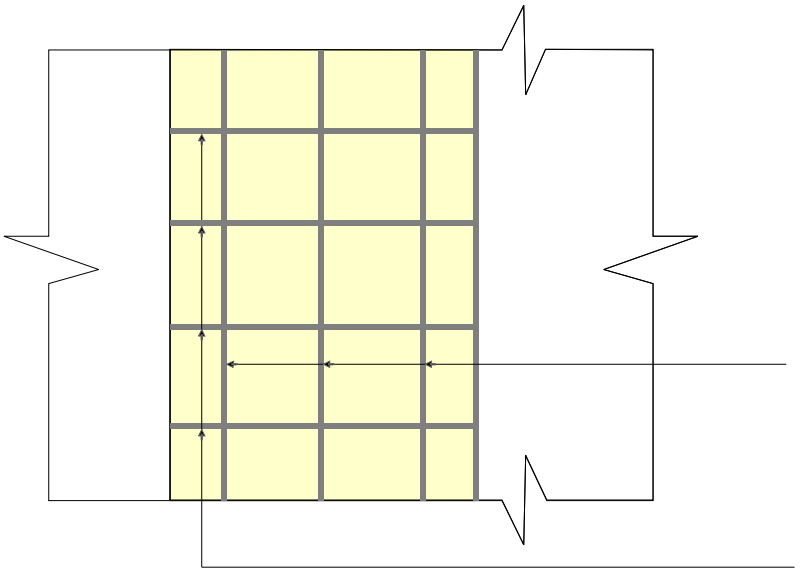
Accuracy of Bar Diameter Determination
± 3 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Reservoir Filter Plant
Western Wall (Sr. No. 18)



Reinforcement
12mm dia bars @ 175mm c/c

Reinforcement
16mm dia bars @ 325mm c/c

Non Scan Area

Scan Area

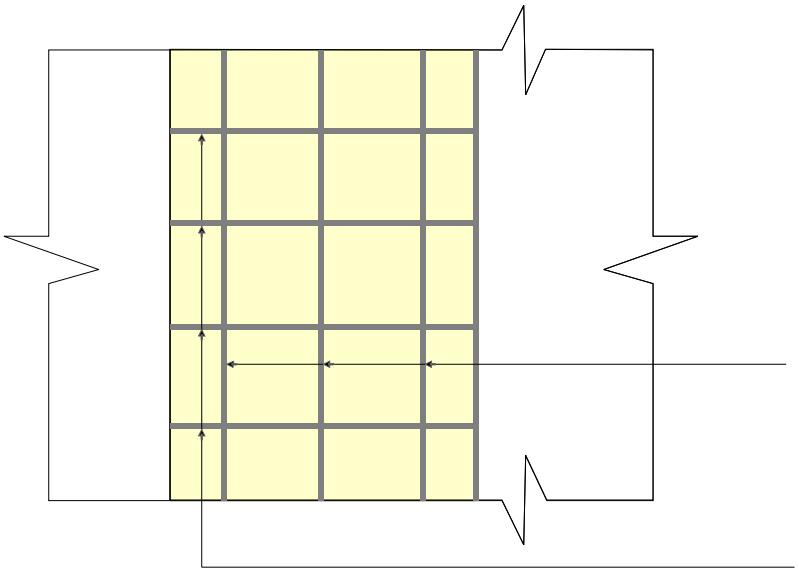
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Bridge No. 03
Top Slab (Sr. No. 16)



Non Scan Area

Scan Area

Reinforcement

Presence of rebar is detected in the scan @ 163mm c/c but diameter of the rebar is not confirmed

Reinforcement

Presence of rebar is detected in the scan @ 200mm c/c but diameter of the rebar is not confirmed

Accuracy of Bar Diameter Determination

± 2 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

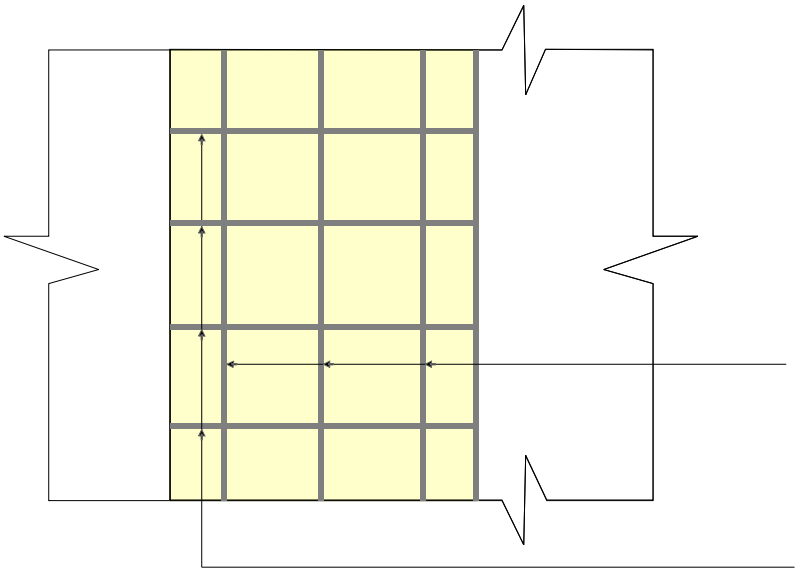
Accuracy of Rebar Location

Relative bar center measurement accuracy (all modes), typical: ± 3 mm or ± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 10
Wall (Sr. No. 12)



Reinforcement
16mm dia bars @ 200mm c/c

Reinforcement
16mm dia bars @ 200mm c/c

Non Scan Area

Scan Area

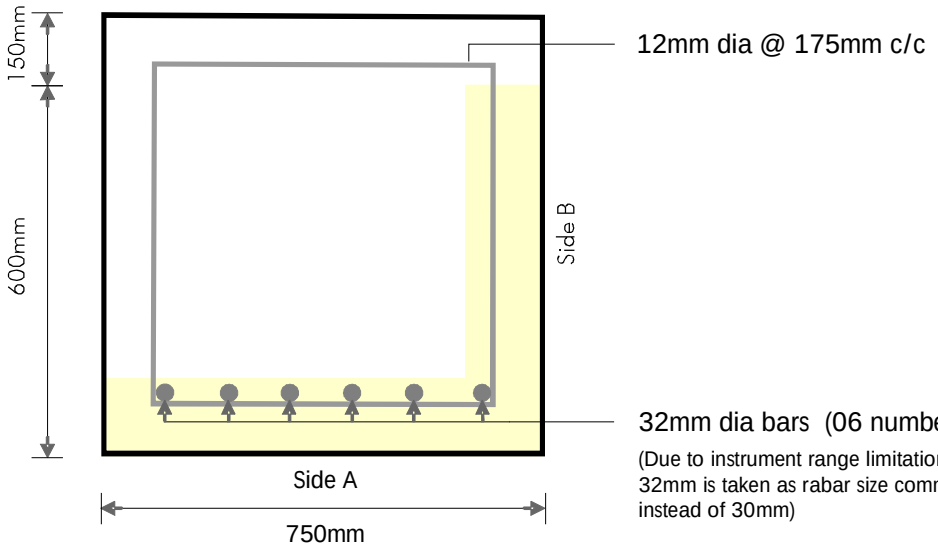
Accuracy of Bar Diameter Determination
± 3 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 10
Transom Beam (Sr. No. 11)



Non Scan Area

Scan Area

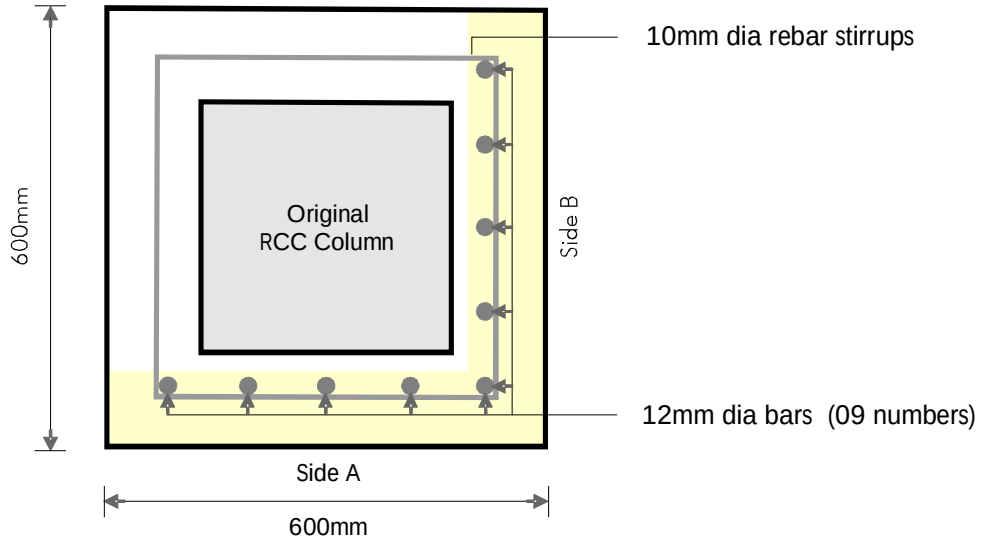
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 10
Column Retrofitting Surface (Sr. No. 10)



Non Scan Area

Scan Area

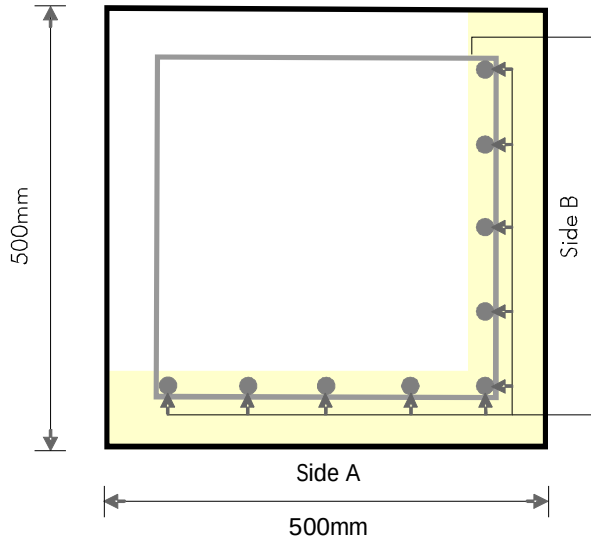
Accuracy of Bar Diameter Determination
± 2 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 01
Column (Sr. No. 01)



12mm dia @ 450mm c/c

32mm dia bars (09 numbers)

(Due to instrument range limitations between 30mm or 36mm. 32mm is taken as rabar size commonly used in Pakistan instead of 30mm)

Non Scan Area

Scan Area

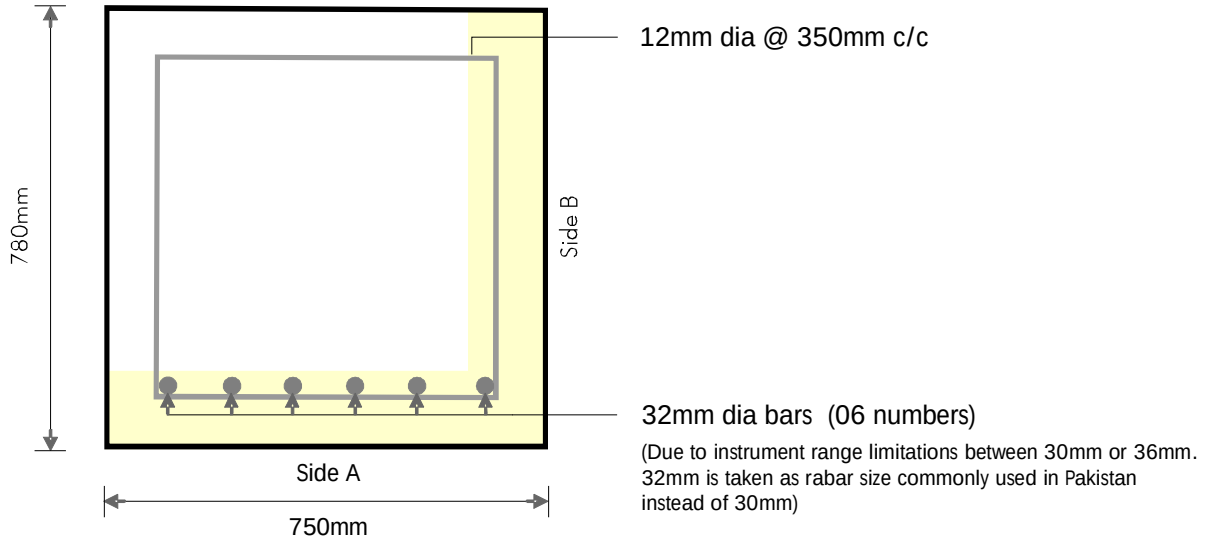
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 01
Transom Beam (Sr. No. 02)



Non Scan Area

Scan Area

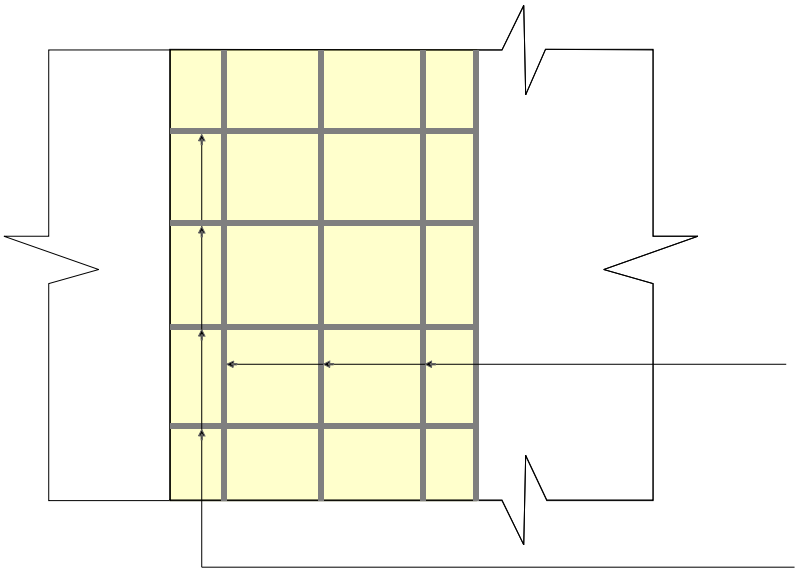
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 01
UPV Wall (Sr. No. 03)



Reinforcement
16mm dia bars @ 200mm c/c

Reinforcement
16mm dia bars @ 200mm c/c

Non Scan Area

Scan Area

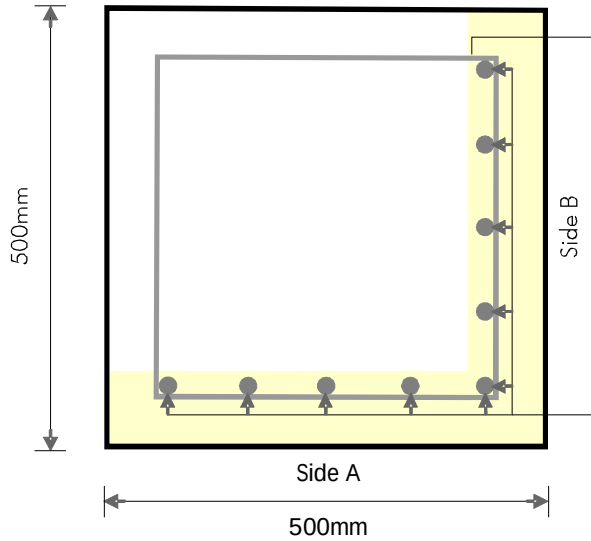
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 06
Column (Sr. No. 04)



12mm dia @ 450mm c/c

32mm dia bars (09 numbers)

(Due to instrument range limitations between 30mm or 36mm. 32mm is taken as rabar size commonly used in Pakistan instead of 30mm)

Non Scan Area

Scan Area

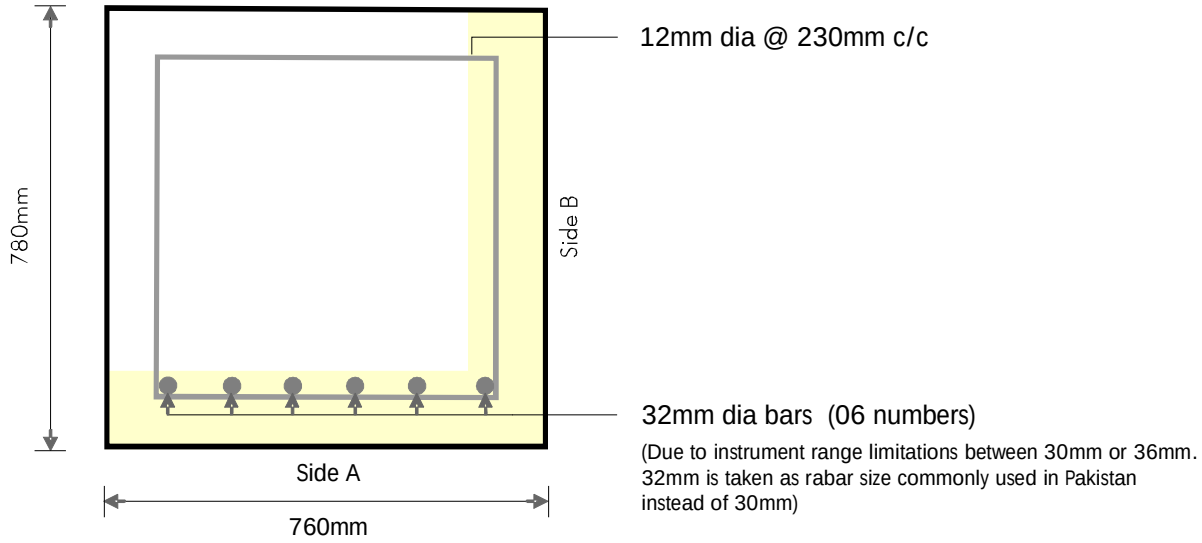
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 06
Transom Beam (Sr. No. 05)



Non Scan Area

Scan Area

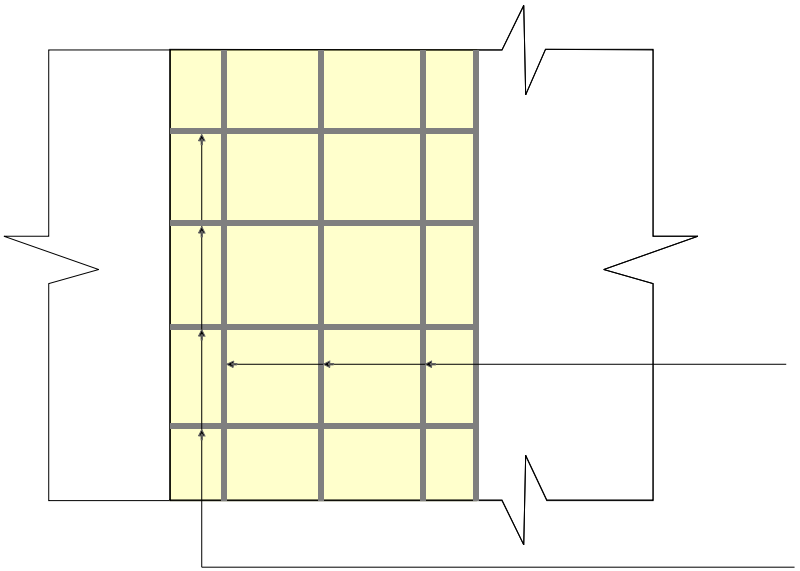
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 06
Wall (Sr. No. 06)



Reinforcement
16mm dia bars @ 200mm c/c

Reinforcement
16mm dia bars @ 200mm c/c

Non Scan Area

Scan Area

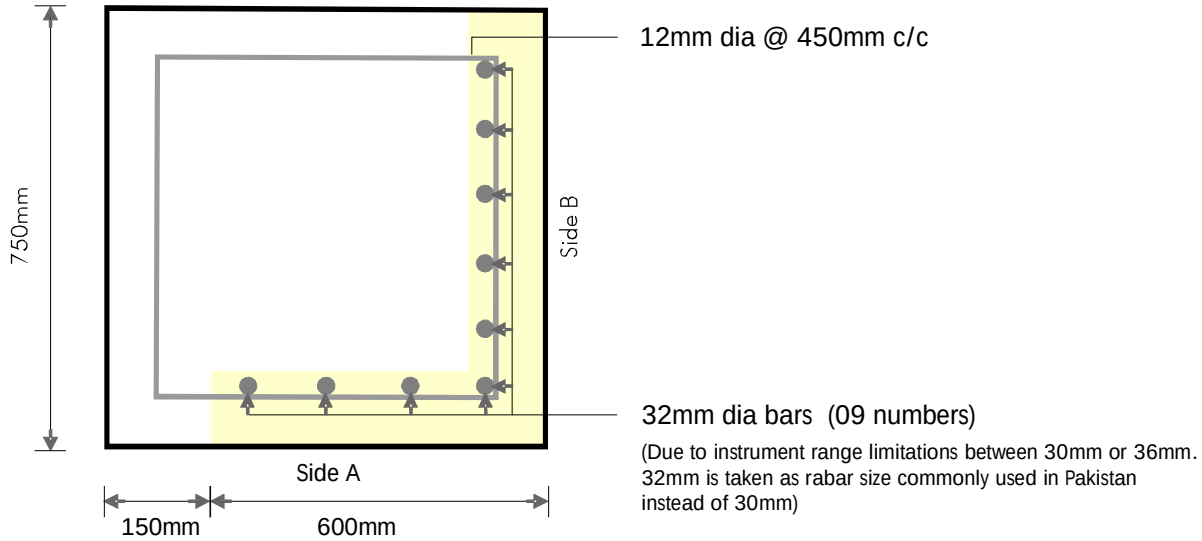
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 09
Column (Sr. No. 07)



Non Scan Area

Scan Area

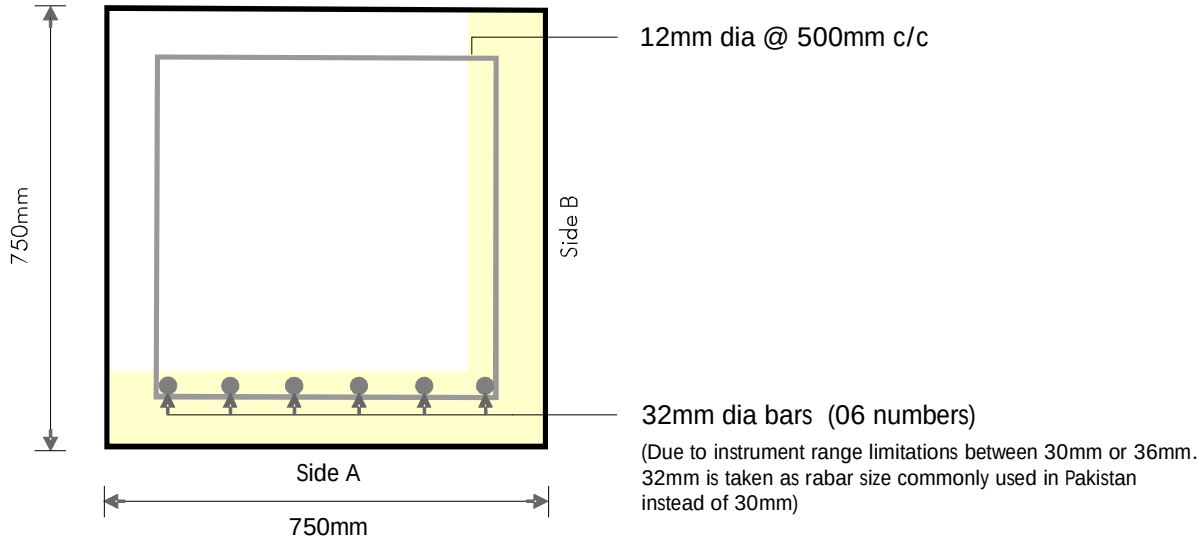
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 09
Transom Beam (Sr. No. 08)



Non Scan Area

Scan Area

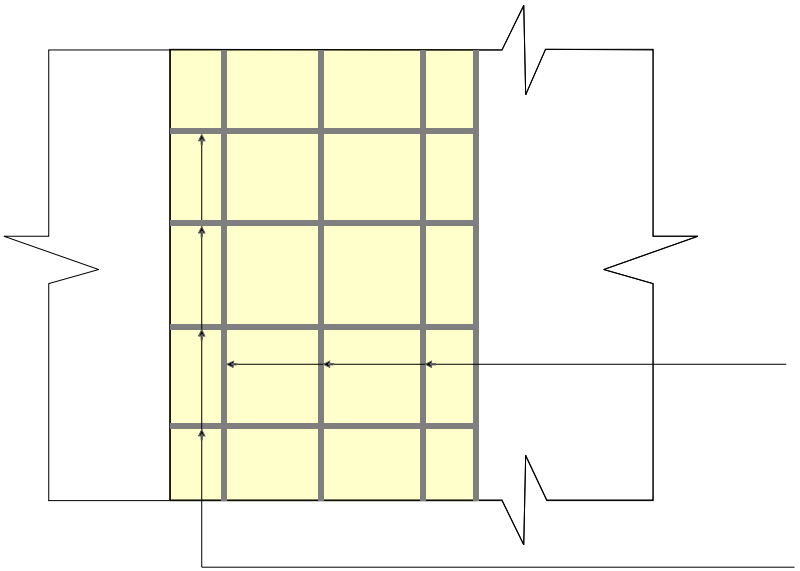
Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

Reinforcement Detail of RCC Structure of Hub Dam Canal Project

Aqueduct No. 09
Wall (Sr. No. 09)



Reinforcement
16mm dia bars @ 225mm c/c

Reinforcement
16mm dia bars @ 200mm c/c

Non Scan Area

Scan Area

Accuracy of Bar Diameter Determination
± 4 standard diameter typical, when bar spacing : coverage (s:c) ≥ 1.5:1

Accuracy of Rebar Location
Relative bar center measurement accuracy (all modes), typical: ± 3 mm or
± 0.1 inch relative to measured position, when bar spacing : coverage (s:c) ≥ 1.5: 1.

***Client*:** HPK Halcrow Pakistan (Pvt) Ltd	Submitted by: SURVEY TECH (PVT.) LTD.	Title: Steel Reinforcement detail of RCC Structure of Pump House Buildings and Hub Dam Canal Project, Karachi.	**Scan Date**	26-10-2020
			Drawing Date	02-11-2020
			Drawing No.	BS/201102-044
			Scale	NTS

ANNEXURE-II

ULTRASONIC PULSE VELOCITY TEST RESULTS

ULTRASONIC PULSE VELOCITY TEST-UPV
(NON-DESTRUCTIVE TESTING)
(ASTM DESIGNATION: C 597)

CLIENT HACROW PAKISTAN (PVT) LTD. B.S. NO. BS/201102-044

CONSULTANT -- CLIENT NO./DATE 02-11-2020

CONTRACTOR -- SPECIMEN RCC Structure

LOCATION Karachi. CONCRETE CLASS Unknown

PROJECT Ferro Scanning & Non-Destructive Testing of Hub Dam Canal Project

Sr. No.	Description of Point	Mode of Transmission	Corrected Time Observed (µsec)	Distance (m)	Velocity (km/sec)
1.	Old Pump House Serial No. 13, Wall	Indirect	91.5	0.152	1.661
2.	Old Pump House Serial No. 14, Column	Semi Direct	46.2	0.170	3.680
3.	New Pump House Serial No. 15, Column	Direct	134.5	0.50	3.717
4.	Reservoir Filter Plant Serial No 11, Northern Wall	Indirect	42.2	0.152	3.602
5.	Reservoir Filter Plant Serial No 12, Western Wall	Indirect	37.5	0.152	4.053

Reference Book A.M Neville Properties of Concrete
Classification of the Quality of Concrete on the basis of Pulse Velocity

Pulse Velocity km/sec	Quality of Concrete
>4.5	Excellent
3.5 – 4.5	Good
3.0 – 3.5	Doubtful
2.0 – 3.0	Poor
<2.0	Very Poor

Note: 1. This test mainly provides information about uniformity, quality and density of concrete and this test does not claim to predict direct strength. However the strength is obtained from the velocity and it is an approximate value given on the basis of direct relations.

CHECKED BY _____ LAB. INCH. _____

ULTRASONIC PULSE VELOCITY TEST-UPV
(NON-DESTRUCTIVE TESTING)
(ASTM DESIGNATION: C 597)

CLIENT HACROW PAKISTAN (PVT) LTD. B.S. NO. BS/201102-044

CONSULTANT -- CLIENT NO./DATE 02-11-2020

CONTRACTOR -- SPECIMEN RCC Structure

LOCATION Karachi. CONCRETE CLASS Unknown

PROJECT Ferro Scanning & Non-Destructive Testing of Hub Dam Canal Project

Sr. No.	Description of Point	Mode of Transmission	Corrected Time Observed (µsec)	Distance (m)	Velocity (km/sec)
6.	Aqueduct No. 10 Serial No 10, Wall	Indirect	46.4	0.165	3.556
7.	Aqueduct No. 10 Serial No 9, Column	Indirect	52.2	0.152	2.912
8.	Aqueduct No. 01 Serial No 1, Column	Direct	128.5	0.500	3.891
9.	Aqueduct No. 01 Serial No 2, Transom Beam	Semi Direct	161.4	0.430	2.664
10.	Aqueduct No. 01 Serial No 3, Wall	Indirect	63.4	0.254	4.006

Reference Book A.M Neville Properties of Concrete
Classification of the Quality of Concrete on the basis of Pulse Velocity

Pulse Velocity km/sec	Quality of Concrete
>4.5	Excellent
3.5 – 4.5	Good
3.0 – 3.5	Doubtful
2.0 – 3.0	Poor
<2.0	Very Poor

Note: 1. This test mainly provides information about uniformity, quality and density of concrete and this test does not claim to predict direct strength. However the strength is obtained from the velocity and it is an approximate value given on the basis of direct relations.

CHECKED BY _____ LAB. INCH. _____

ULTRASONIC PULSE VELOCITY TEST-UPV
(NON-DESTRUCTIVE TESTING)
(ASTM DESIGNATION: C 597)

CLIENT HACROW PAKISTAN (PVT) LTD. B.S. NO. BS/201102-044

CONSULTANT -- CLIENT NO./DATE 02-11-2020

CONTRACTOR -- SPECIMEN RCC Structure

LOCATION Karachi. CONCRETE CLASS Unknown

PROJECT Ferro Scanning & Non-Destructive Testing of Hub Dam Canal Project

Sr. No.	Description of Point	Mode of Transmission	Corrected Time Observed (µsec)	Distance (m)	Velocity (km/sec)
11.	Aqueduct No. 06 Serial No 4, Column	Direct	153.7	0.5	3.253
12.	Aqueduct No. 06 Serial No 4A, Transom Beam	Semi Direct	130.5	0.43	3.295
13.	Aqueduct No. 06 Serial No 5, Wall	Indirect	56.7	0.202	3.563
14.	Aqueduct No. 09 Serial No 6, Column	Semi Direct	109.2	0.43	3.938
15.	Aqueduct No. 09 Serial No 7, Transom Beam	Direct	184.4	0.76	4.121
16.	Aqueduct No. 09 Serial No 8, Wall	Indirect	45.4	0.202	4.449

Reference Book A.M Neville Properties of Concrete
Classification of the Quality of Concrete on the basis of Pulse Velocity

Pulse Velocity km/sec	Quality of Concrete
>4.5	Excellent
3.5 – 4.5	Good
3.0 – 3.5	Doubtful
2.0 – 3.0	Poor
<2.0	Very Poor

Note: 1. This test mainly provides information about uniformity, quality and density of concrete and this test does not claim to predict direct strength. However the strength is obtained from the velocity and it is an approximate value given on the basis of direct relations.

CHECKED BY _____ LAB. INCH. _____

ANNEXURE-III

REBOUND HAMMER TEST RESULTS

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	27/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	AQUEDUCT # 01	NO OF TEST	3

Structure Component			
READING NO'S	COLUMN	TRANSOM BEAM	WALL
1	33	48	42
2	33	51	42
3	34	38	38
4	41	42	36
5	30	38	46
6	35	38	51
7	38	36	46
8	41	37	40
9	36	32	32
10	35	32	36
11	40	41	48
12	35	41	48
13	34	38	32
14	37	38	30
15	38	46	30
16	36	32	32
AVERAGE REBOUND NO	**36**	**39**	**39**
MPa	34	38	38
N/cm^2	3400	3800	3800
KG/cm^2	347	388	388

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	27/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	AQUEDUCT # 06	NO OF TEST	3
Structure Component			
READING NO'S	COLUMN	TRANSOM BEAM	WALL
1	35	38	36
2	38	48	38
3	35	36	40
4	32	40	38
5	38	48	44
6	34	38	42
7	38	48	38
8	34	40	34
9	36	38	32
10	32	36	35
11	32	32	32
12	38	40	30
13	32	37	32
14	38	37	38
15	38	38	34
16	38	38	32
AVERAGE REBOUND NO	**36**	**40**	**36**
MPa	34	41	34
N/cm^2	3400	4100	3400
KG/cm^2	347	418	347

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	27/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	AQUEDUCT # 09	NO OF TEST	3

Structure Component			
READING NO'S	COLUMN	TRANSOM BEAM	WALL
1	34	42	37
2	32	39	36
3	38	38	39
4	39	38	44
5	38	38	39
6	32	37	33
7	38	36	36
8	39	36	35
9	34	33	38
10	36	35	39
11	38	36	35
12	36	38	38
13	30	37	37
14	34	34	37
15	32	35	38
16	38	41	35
AVERAGE REBOUND NO	**36**	**37**	**37**
MPa	34	35	35
N/cm^2	3400	3500	3500
KG/cm^2	347	357	357

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	27/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	AQUEDUCT # 10	NO OF TEST	3

Structure Component			
READING NO'S	COLUMN	TRANSOM BEAM	WALL
1	28	46	46
2	40	36	42
3	32	38	44
4	25	38	45
5	35	42	40
6	27	40	47
7	32	40	41
8	27	36	35
9	24	38	35
10	28	40	35
11	40	38	36
12	28	38	30
13	-	-	29
14	-	-	30
15	-	-	30
16	-	-	28
AVERAGE REBOUND NO	**31**	**39**	**37**
MPa	25	38	35
N/cm^2	2500	3800	3500
KG/cm^2	255	388	357

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	26/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	AQUEDUCT # 11	NO OF TEST	2
Structure Component			
READING NO'S	COLUMN	WALL	
1	52	54	
2	54	55	
3	48	56	
4	46	54	
5	50	48	
6	48	50	
7	52	48	
8	49	54	
9	53	40	
10	50	51	
11	47	52	
12	55	52	
13	50	48	
14	48	50	
15	46	48	
16	55	46	
AVERAGE REBOUND NO	**50**	**50**	-
MPa	59	59	-
N/cm^2	5900	5900	-
KG/cm^2	602	602	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	27/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	BRIDGE - 01	NO OF TEST	1
Structure Component			
READING NO'S	BOTTOM SLAB		
1	34		
2	50		
3	44		
4	40		
5	50		
6	48		
7	38		
8	42		
9	50		
10	46		
11	48		
12	44		
13	43		
14	53		
15	46		
16	48		
AVERAGE REBOUND NO	**45**		
MPa	54	-	-
N/cm^2	5400	-	-
KG/cm^2	551	-	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	26/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	BRIDGE - 03	NO OF TEST	1
Structure Component			
READING NO'S	BOTTOM SLAB		
1	28		
2	26		
3	32		
4	26		
5	24		
6	30		
7	30		
8	32		
9	34		
10	28		
11	24		
12	32		
13	26		
14	26		
15	28		
16	30		
AVERAGE REBOUND NO	**29**		
MPa	27	-	-
N/cm^2	2700	-	-
KG/cm^2	276	-	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	27/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	FALL # 01	NO OF TEST	1
Structure Component			
READING NO'S	SIDE WALL		
1	35		
2	35		
3	30		
4	30		
5	34		
6	34		
7	35		
8	32		
9	34		
10	30		
11	35		
12	31		
13	35		
14	30		
15	30		
16	30		
AVERAGE REBOUND NO	**33**		
MPa	28	-	-
N/cm^2	2800	-	-
KG/cm^2	286	-	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	26/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	FALL # 02	NO OF TEST	1
Structure Component			
READING NO'S	SIDE WALL		
1	40		
2	40		
3	40		
4	41		
5	42		
6	32		
7	30		
8	38		
9	36		
10	38		
11	39		
12	40		
13	49		
14	36		
15	38		
16	34		
AVERAGE REBOUND NO	**38**		
MPa	37	-	-
N/cm^2	3700	-	-
KG/cm^2	378	-	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	27/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	PEDESTRIAN CROSSING	NO OF TEST	1
Structure Component			
READING NO'S	BOTTOM SLAB		
1	28		
2	26		
3	32		
4	26		
5	24		
6	30		
7	30		
8	32		
9	34		
10	28		
11	24		
12	32		
13	26		
14	26		
15	28		
16	30		
AVERAGE REBOUND NO	**29**		
MPa	27	-	-
N/cm^2	2700	-	-
KG/cm^2	276	-	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	26/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	FILTER PLANT	NO OF TEST	3
Structure Component			
READING NO'S	RESERVOIR WALL NORTH	RESERVOIR WALL WEST	ADMIN BLD COLUMN
1	42	40	43
2	40	41	40
3	40	44	40
4	42	48	38
5	42	40	44
6	40	42	43
7	43	46	42
8	46	46	42
9	40	42	44
10	40	41	42
11	40	42	40
12	44	42	39
13	40	40	42
14	40	42	40
15	50	44	40
16	48	46	40
AVERAGE REBOUND NO	**42**	**43**	**41**
MPa	44	46	42
N/cm^2	4400	4600	4200
KG/cm^2	449	469	429

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	26/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	OLD PUMPING STATION	NO OF TEST	3

Structure Component			
READING NO'S	COLUMN	BEAM	G.FLOOR SLAB
1	36	36	34
2	44	37	25
3	52	36	30
4	43	40	24
5	42	37	32
6	44	37	20
7	42	38	21
8	40	37	23
9	42	48	31
10	42	52	29
11	42	46	28
12	42	38	29
13	40	30	32
14	44	26	25
15	42	38	25
16	41	38	28
AVERAGE REBOUND NO	**42**	**38**	**27**
MPa	44	37	24
N/cm^2	4400	3700	2400
KG/cm^2	449	378	245

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	26/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	OLD PUMPING STATION	NO OF TEST	2
Structure Component			
READING NO'S	BASEMENT R.WALL	BASEMENT R.WALL	
1	30	30	
2	26	31	
3	23	32	
4	25	27	
5	29	28	
6	29	27	
7	28	28	
8	26	25	
9	27	30	
10	29	30	
11	27	30	
12	26	26	
13	27	30	
14	26	30	
15	23	29	
16	28	27	
AVERAGE REBOUND NO	**27**	**29**	-
MPa	19	22	-
N/cm^2	1900	2200	-
KG/cm^2	194	224	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

CLIENT	HALCROW PAKISTAN (PVT) LTD	DATE	26/10/2020
PROJECT LOCATION	KARACHI	SPECIMEN	RCC Structure
PROJECT	Hub Dam Canal Project	CONCRETE CLASS	Unknown

REBOUND HAMMER TEST

TEST LOCATION	NEW PUMPING STATION	NO OF TEST	2
Structure Component			
READING NO'S	INTERNAL COLUMN	EXTERNAL COLUMN	
1	40	42	
2	43	41	
3	47	44	
4	46	43	
5	42	40	
6	40	41	
7	40	42	
8	40	42	
9	39	40	
10	41	40	
11	44	40	
12	40	41	
13	40	39	
14	40	40	
15	42	42	
16	43	42	
AVERAGE REBOUND NO	**42**	**41**	**-**
MPa	44	42	-
N/cm^2	4400	4200	-
KG/cm^2	449	429	-

AVERAGE REBOUND NO	QUALITY OF CONCRETE
>40	Very good hard layer
30-40	Good layer
20-30	Fair
<20	Poor concrete
0	Delaminated

Client: HPK Halcrow Pakistan (Pvt) Ltd

Submitted by : SURVEY TECH (PVT.) LTD.

SITE PICTURES

Testing concrete using the Rebound Hammer.

N O T E S A N D C O M M E N T S

Annex 5.2. Measurement of subsurface resistivities at Pump Station & Filtration Plant

FILTRATION PLANT CONSULTING SERVICES KARACHI WATER CANAL PPP

SURVEY TECH (PVT) LTD
ENGINEERS, CONTRACTORS, GEOLOGIST & PROFESSIONAL SURVEYORS

REPORT ON
MEASUREMENT OF SUBSURFACE RESISTIVITIES

AT
PUMP STATION & FILTRATION PLANT

PROJECT
REHABILITATION OF KARACHI HUB CANAL PROJECT

CLIENT:

HPK
Halcrow Pakistan (Pvt) Ltd

October, 2020

H-129,Block-II,Sector C-I, Township, Lahore-Pakistan. ☎+92-42-35465005, Fax: 042- 35465005
E-mail: surveytech2@gmail.com URL: www.surveytechpak.com

TABLE OF CONTENTS

Sr. #	Title	Page #
1.0	Introduction	1
2.0	Purpose and Scope	1
3.0	Field Procedure	1
4.0	Evaluation of Resistivity Data	3
5.0	Corrosion Potential Classification	3
6.0	Results of Resistivity Survey	5

Figures Location Plan showing soil resistivity sounding points

Annexures

Annexure –1 Earth resistivity Performa, indicating apparent resistivity of the subsurface at different spacing.

Annexure – 2 Data Set of sounding points.

Annexure – 3 Table – 1 (Site – 1 Pump Station) - Showing the results of True resistivity values.
Table – 2 (Site – 2 Filtration Plant) - Showing the results of True resistivity values.

1.0 INTRODUCTION

M/s Halcrow Pakistan awarded the assignment of conducting Electrical Soil Resistivity Test to SURVEY TECH (PVT) PLT (STPL) at 2 no. locations (Pump Station & Filtration Plant) of Hub Canal, Karachi. The field investigations in this regard were executed during the period from 05-10-2020 to 07-10-2020 in the presence of Client's representatives by field engineer of SURVEY TECH (PVT) PLT. The specific survey point locations were decided by the technical staff of Client & STPL.

2.0 PURPOSE AND SCOPE

The purpose of soil resistivity measurements was to determine the electrical resistivity of the subsurface material which could be used for the design of earthing system. The survey was conducted up to the maximum depth of 10 meters.

The resistivity measurements were made in accordance with IEEE 81 Standard and ASTM Designation G-57. As required the resistivity readings were taken at electrode spacing of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 meters.

The coordinates of each resistivity point were recorded with the help of handheld GPS and were entered in the respective field resistivity Performa. The locations of all the sounding points are given in location plan (Figure -1 & Figure -2).

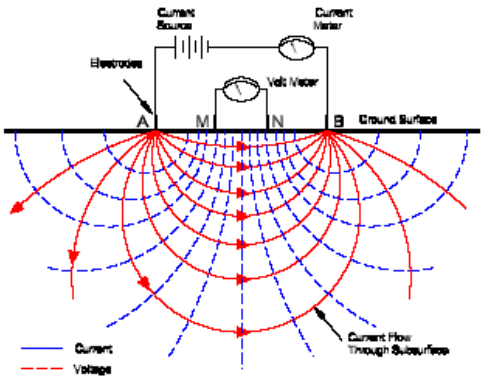
The results of the survey are presented in the form of apparent resistivity of the subsurface material. Such information is required in connection with the designing of “Earthing System” for the electrical installations at project site.

The electrical resistivity sounding points are designated as S-01 to S-04 at Site no. 1 (Pump Station) and S-01 to S-06 at Site no. 2 (Filtration Plant). The field resistivity data of all the sounding points along with their apparent resistivity (ohm-m) VS electrode spacing (m) curves are given in Annexure-1 of the report.

3.0 FIELD PROCEDURE

Considering the variable electrical properties of subsoil, the technique of electrical resistivity survey makes use of measuring the current and potential

differences of various subsoil materials at the surface. In general, current is conducted electrolytically in the soils containing interstitial fluids. The resistivity is controlled by porosity, water content, as well as the quantity of dissolved salts. Clay minerals, however, are capable of storing electrical charges and current conduction in clay minerals is electronic as well as electrolytic. Thus the resistivity of soils depends directly on the amount of contained electrolyte and clay minerals and is inversely related to the porosity and degree of saturation of the formation. Therefore, resistivity of soils varies considerably not only from formation to formation, but also within the same layer. In particular, the resistivity variations can be large in unconsolidated sediments. It has generally been observed that the resistivity increases progressively from fine grained to coarse grained material in the order of clay, silty clay, clayey silt, silty sand & fine to medium sand. Fully calibrated resistivity-measuring equipment ***"Super Sting R1 (USA)"*** was used to measure directly the resistance R at each electrode spacing by deploying Wenner Configuration. In the case of Wenner array, all the four electrodes are placed at equal distance apart in a straight line symmetrically from the centre point C. The two outer electrodes A & B are used for passing current into the ground and the resulting potential difference is measured across the inner electrodes M & N.



Wenner Array

Measurements are recorded against each electrode spacing before re-positioning the electrodes for the next one. The midpoint of the electrode is fixed as the sounding location while the length of the configuration is gradually increased accordingly in order to measure the resistivity at the required depth levels. At each location, in one sounding, apparent resistivity values against the respective electrode spacing are obtained by applying the formula:

$$\rho a = K \times V/I = K \times R \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

ρa	=	apparent resistivity in ohms.m
K	=	geometric factor of the electrodes arrangement
		2Лa for Wenner array
R	=	resistance in ohms
V	=	voltage in milli volts
I	=	current in milli amps
a	=	interspacing between electrodes

4.0 EVALUATION OF RESISTIVITY DATA

The resistivity field curves are obtained by plotting the apparent resistivity values against different electrode spacing on a bi-log graph paper. After smoothing the plotted curves all the field data is registered to computer and is interpreted by the computer-aided technique using INTERPEX USA software, RESIXP to get the true resistivity values of different subsoil resistive layers (Annexure – 2).

5.0 CORROSION POTENTIAL CLASSIFICATION

Though corrosion of metal embedded in the soil generally not as rapid as in atmosphere or underwater, yet we present problems of sizeable magnitude. Factors governing corrosion by soil include its (i) Oxygen content (ii) moisture

content (iii) hydrogen ion concentration (iv) electrical conduction (v) particle size (vi) drainage (vii) bacterial process activity etc.

In the case of pipeline corrosion, the concentration of electrolytic cells, formed due to localized difference in the physical and chemical characteristics of the soil coming in contact with the pipe, could lead to localized attack. Similarly soil water and groundwater attack metals to a degree, which depends upon the nature and concentration of various salts present in the water.

Soils are generally assigned one of the following classes of corrosivity.

- Soils with very low corrosivity for steel and iron generally include somewhat excessively drained coarse textured soils that have little clay, water and air move through these soils rapidly. Electrical resistivity of such soils at natural moisture content is above 100 ohm-meters.
- Soils with low corrosivity for steel and iron generally include well drained soils that have a coarse to medium texture. These soils are moderately permeable. The electrical resistivity of such soils is 50 to 100 ohm-meters.
- Soils with moderate corrosivity for the steel and iron generally include well drained soil that have medium to fine texture. Electrical resistivity of these soils varies between 20 to 50 ohm-meters.
- Soil with high corrosivity for steel and iron generally include moderately well drained fine textured soils. Very poorly drained soils are included when the water table fluctuates within 30 centimeters at some time during the year. Electrical resistivity of these soils at natural moisture equivalent is 10 to 20 ohm-meters.
- Soil with very high corrosivity for steel and iron generally include poorly to very poorly drained fine texture. Electrical resistivity of these soils at natural moisture equivalent is below 10 ohm-meters.

6.0 RESULTS OF RESISTIVITY SURVEY

I. Field resistivity data of each sounding point along with all relative information are recorded on the Performa titled “In-situ electrical resistivity measurements of soil” The field resistivity values against the respective electrode spacing are also given in the graphic form to visualize the general trend in the variation of resistivities with depth in Annexure-1. The measured apparent resistivity of subsurface layers at the site-1 (Pump Station) varies between 5.708 ohm-m to 79.75 ohm-m and at site-2 (Filtration Plant) varies between 50.79 ohm-m to 926.47 ohm-m within 10 meters depth.

II. The measured apparent resistivities at each sounding point were also interpreted by computer aided technique to get true resistivity values of different subsurface iso-resistive layers. The results of earth resistivity survey show that subsurface material has almost two resistivity layers up to the maximum investigation depth of 10 meters in almost all cases except S-01 (Filtration Plant- Site-2) where the subsurface material has three resistivity layers. High to low true resistivity values are observed varying from 117.8 ohm-m to 6.11 ohm-m at Site-1 (Pump Station) & very high to moderate true resistivities are observed varying from 1013.2 ohm-m to 35.53 ohm-m at Site-2 (Filtration Plant). The true resistivity values at all sounding points are generally high to low, show that the soil is of low to high corrosive nature at Site-1 (Pump Station) and low to very low corrosive nature at Site-2 (Filtration Plant). The thickness and depth of each iso-resistive layer with its true resistivity values are given in table-1 of site -1 & table-2 of site -2 (Annexure-3).

The results are given in the form of data sets and computer interpreted models in Annexure-2.

- First part of the data set contains header, showing the information regarding site identity, sounding point location and other details.
- Second part of the data set contains information about interpreted number of subsurface layers, layers resistivities in Ohm-m and their thickness/depth from ground level (m), longitudinal conductance and transverse resistance.
- Third part of the data set contains information about measurements, spacing in meter, “Data i.e. (measured apparent resistivities) and synthetic i.e. matching curve resistivities” etc.

FIGURES

LOCATION PLAN OF THE SOUNDING POINTS

Figure 1:

Showing the location of sounding points (S-01 to S-04) conducted at Site - 1 (Pump Station), Karachi Hub Canal.

Figure 2:

Showing the location of sounding points (S-01 to S-06) conducted at Site - 2 (Filtration Plant), Karachi Hub Canal.

ANNEXURES

ANNEXURE – 1

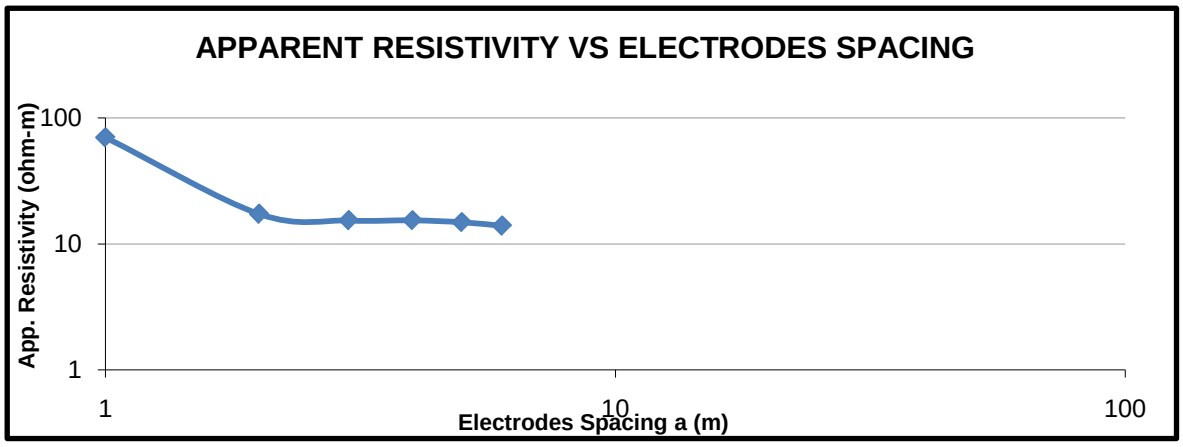
Earth Resistivity Performas Indicating Apparent Resistivity Of The Subsurface At Different Spacing

SITE - 1
Pump Station

IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	6/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	1
Location:	Site - 1 (Pump Station)		
Coordinates:	25.01784 N , 67.02041 E	**Soil Temp:**	41°C
Weather Conditions:	Sunny		
Surface Material:	Soil		
Surface Conditions:	Dry	**Configuration:**	Wenner

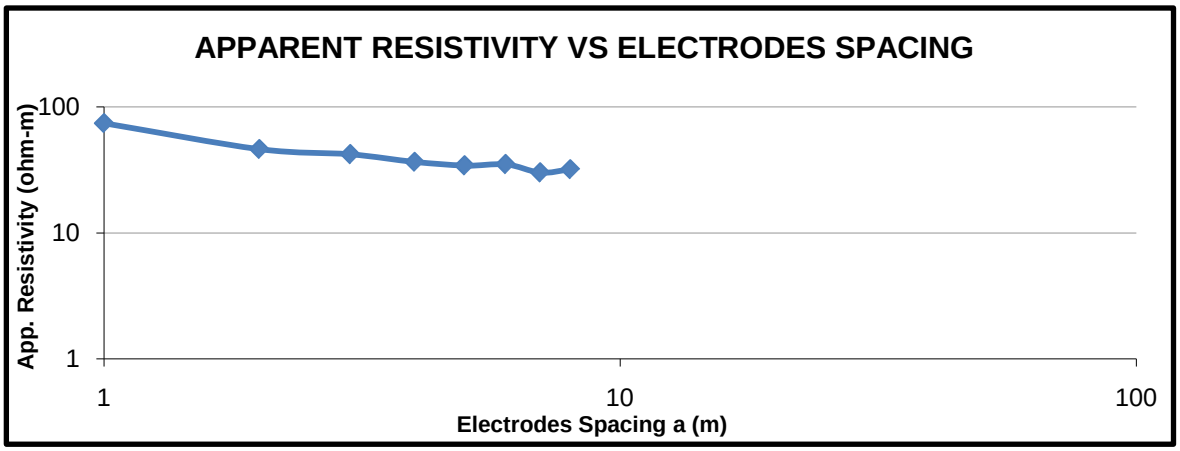
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	2,944.21	264.10	11.15	70.01
2	2	1.00	3.00	12.56	241.57	176.20	1.37	17.22
3	3	1.50	4.50	18.84	164.67	202.80	0.81	15.30
4	4	2.00	6.00	25.12	105.51	172.60	0.61	15.36
5	5	2.50	7.50	31.40	106.24	224.90	0.47	14.83
6	6	3.00	9.00	37.68	68.30	185.50	0.37	13.87



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	6/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	2
Location:	Site - 1 (Pump Station)		
Coordinates:	25.01826 N , 67.01992 E	**Soil Temp:**	40.5°C
Weather Conditions:	Sunny		
Surface Material:	Soil		
Surface Conditions:	Dry	**Configuration:**	Wenner

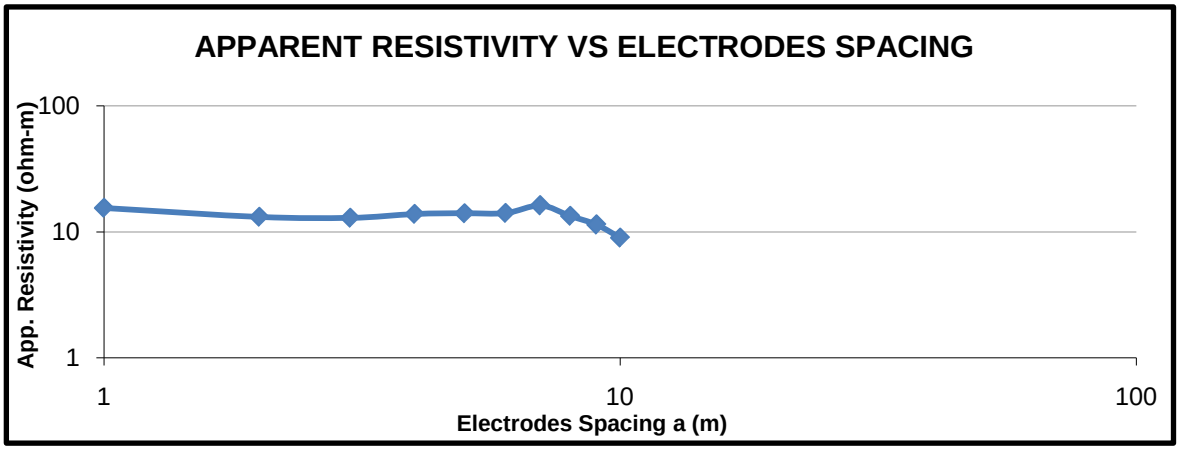
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	3,484.54	295.30	11.80	74.10
2	2	1.00	3.00	12.56	733.41	199.30	3.68	46.22
3	3	1.50	4.50	18.84	406.02	182.40	2.23	41.94
4	4	2.00	6.00	25.12	250.22	171.50	1.46	36.65
5	5	2.50	7.50	31.40	171.95	157.90	1.09	34.19
6	6	3.00	9.00	37.68	167.57	180.20	0.93	35.04
7	7	3.50	10.50	43.96	148.84	217.60	0.68	30.07
8	8	4.00	12.00	50.24	139.83	219.30	0.64	32.03



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	6/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	3
Location:	Site - 1 (Pump Station)		
Coordinates:	25.01816 N , 67.02087 E	**Soil Temp:**	40.5°C
Weather Conditions:	Sunny		
Surface Material:	Soil		
Surface Conditions:	Dry	**Configuration:**	Wenner

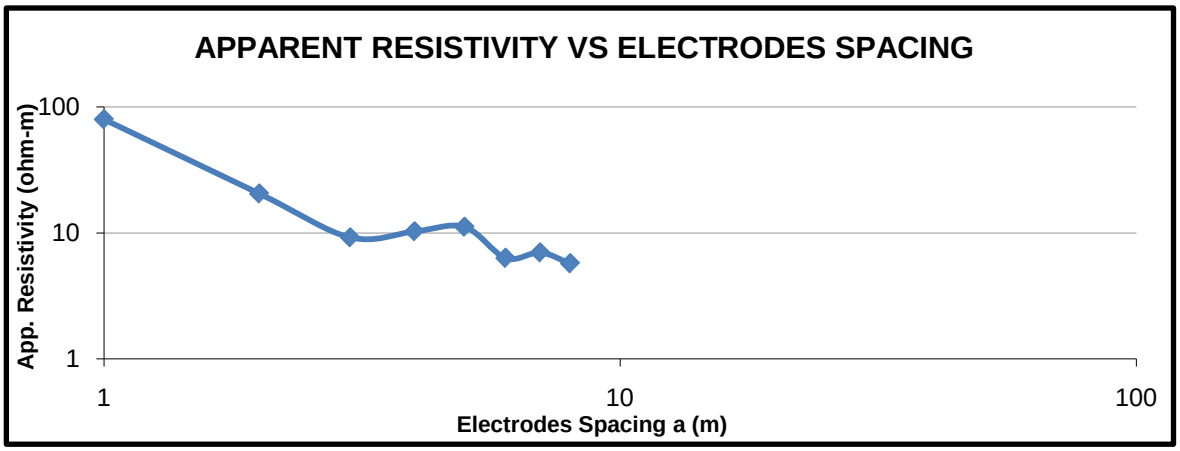
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	711.52	289.00	2.46	15.46
2	2	1.00	3.00	12.56	290.06	277.30	1.05	13.14
3	3	1.50	4.50	18.84	149.25	217.50	0.69	12.93
4	4	2.00	6.00	25.12	111.75	202.60	0.55	13.86
5	5	2.50	7.50	31.40	135.86	304.00	0.45	14.03
6	6	3.00	9.00	37.68	108.57	290.60	0.37	14.08
7	7	3.50	10.50	43.96	144.62	393.00	0.37	16.18
8	8	4.00	12.00	50.24	54.87	206.50	0.27	13.35
9	9	4.50	13.50	56.52	41.71	207.20	0.20	11.38
10	10	5.00	15.00	62.80	16.39	114.60	0.14	8.98



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	6/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	4
Location:	Site - 1 (Pump Station)		
Coordinates:	25.01877 N , 67.02071 E	**Soil Temp:**	40.5°C
Weather Condition:	Sunny		
Surface Material:	Soil		
Surface Conditions:	Dry	**Configuration:**	Wenner

Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2πa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	1,077.25	84.89	12.69	79.69
2	2	1.00	3.00	12.56	219.45	134.30	1.63	20.52
3	3	1.50	4.50	18.84	75.78	155.00	0.49	9.21
4	4	2.00	6.00	25.12	36.03	88.19	0.41	10.26
5	5	2.50	7.50	31.40	19.50	54.78	0.36	11.18
6	6	3.00	9.00	37.68	28.52	170.40	0.17	6.31
7	7	3.50	10.50	43.96	13.57	85.41	0.16	6.99
8	8	4.00	12.00	50.24	13.04	114.80	0.11	5.71

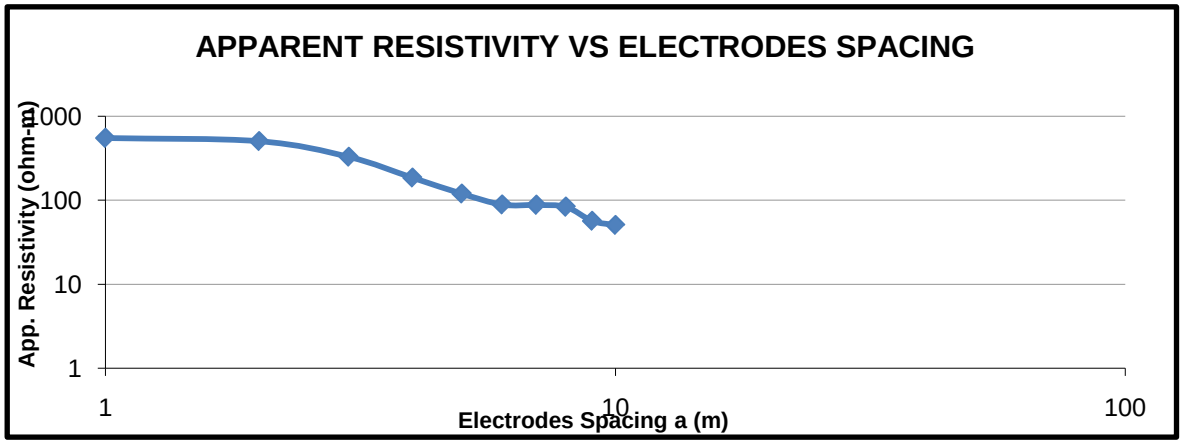


SITE - 2
Filtration Plant

IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	6/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	1
Location:	Site - 2 (Filtration Plant)		
Coordinates:	24.99887 N , 67.02305 E	**Soil Temp:**	40.5°C
Weather Conditions:	Sunny		
Surface Material:	Soil		
Surface Conditions:	Dry	**Configuration:**	Wenner

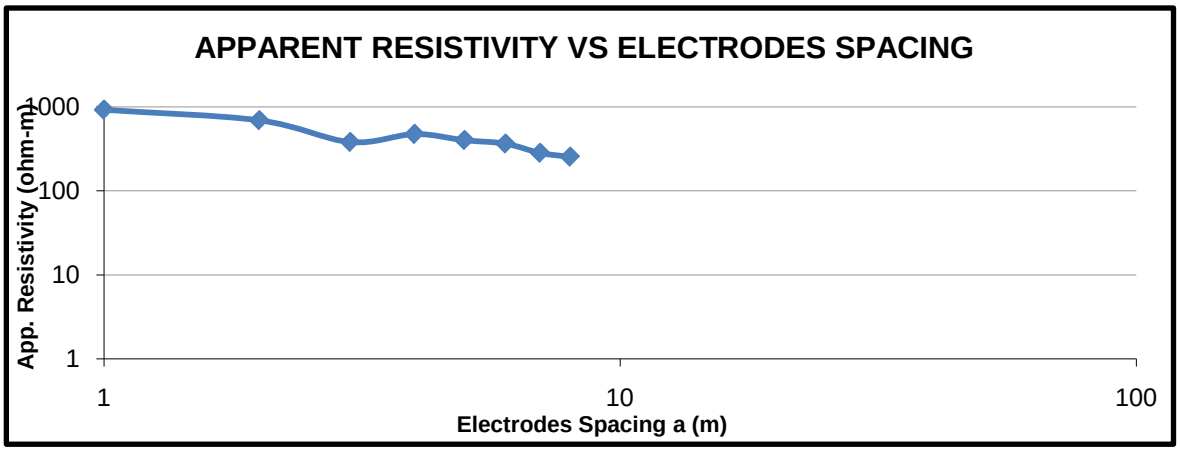
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	5,971.40	68.12	87.66	550.50
2	2	1.00	3.00	12.56	2,635.42	65.46	40.26	505.67
3	3	1.50	4.50	18.84	561.78	32.01	17.55	330.64
4	4	2.00	6.00	25.12	339.83	45.91	7.40	185.94
5	5	2.50	7.50	31.40	226.60	59.15	3.83	120.29
6	6	3.00	9.00	37.68	114.20	48.41	2.36	88.89
7	7	3.50	10.50	43.96	237.88	119.00	2.00	87.88
8	8	4.00	12.00	50.24	132.30	79.70	1.66	83.40
9	9	4.50	13.50	56.52	30.55	30.28	1.01	57.03
10	10	5.00	15.00	62.80	45.29	56.03	0.81	50.76



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	6/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	2
Location:	Site - 2 (Filtration Plant)		
Coordinates:	24.99862 N , 67.02300 E	**Soil Temp:**	40°C
Weather Conditions:	Sunny		
Surface Material:	Soil		
Surface Conditions:	Dry	**Configuration:**	Wenner

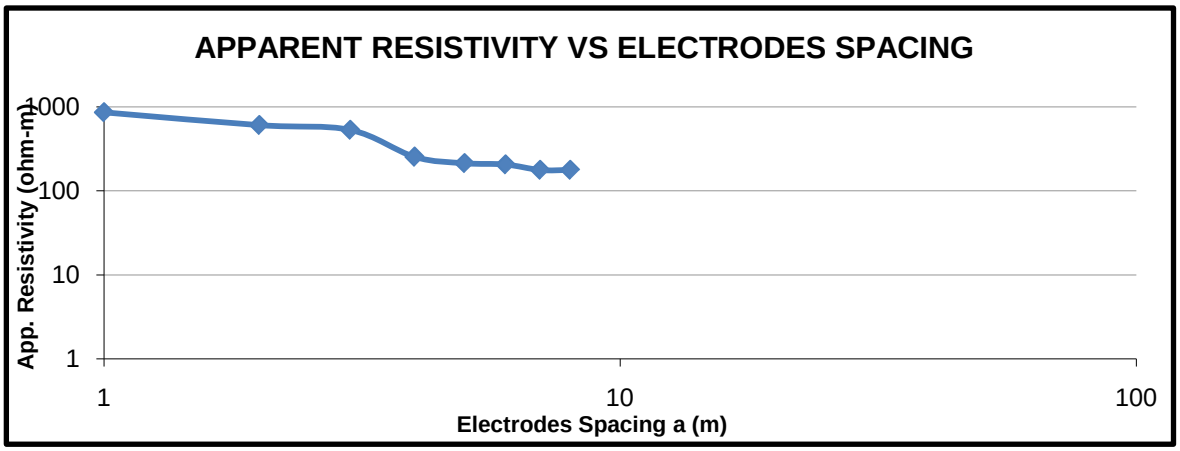
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	2,832.52	19.20	147.53	926.47
2	2	1.00	3.00	12.56	3,503.61	63.52	55.16	692.78
3	3	1.50	4.50	18.84	1,027.99	50.74	20.26	381.70
4	4	2.00	6.00	25.12	1,684.86	89.43	18.84	473.26
5	5	2.50	7.50	31.40	1,535.03	120.30	12.76	400.66
6	6	3.00	9.00	37.68	1,072.35	110.70	9.69	365.01
7	7	3.50	10.50	43.96	112.47	17.45	6.45	283.32
8	8	4.00	12.00	50.24	183.79	36.23	5.07	254.87



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	6/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	3
Location:	Site - 2 (Filtration Plant)		
Coordinates:	24.99851 N , 67.02284 E	**Soil Temp:**	39.5°C
Weather Condition:	Sunny		
Surface Material:	Soil		
Surface Conditions:	Dry	**Configuration:**	Wenner

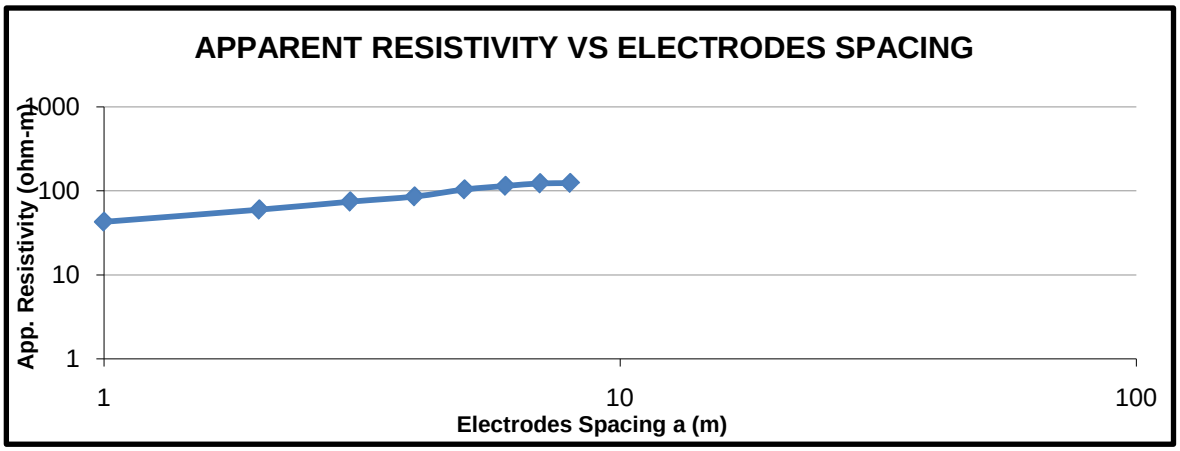
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	7,611.91	55.44	137.30	862.24
2	2	1.00	3.00	12.56	2,115.98	43.90	48.20	605.39
3	3	1.50	4.50	18.84	1,382.84	48.95	28.25	532.23
4	4	2.00	6.00	25.12	93.00	9.22	10.09	253.46
5	5	2.50	7.50	31.40	262.23	38.54	6.80	213.65
6	6	3.00	9.00	37.68	282.31	51.47	5.49	206.67
7	7	3.50	10.50	43.96	347.10	86.13	4.03	177.16
8	8	4.00	12.00	50.24	299.49	84.72	3.54	177.60



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	7/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	4
Location:	Site - 2 (Filtration Plant)		
Coordinates:	25.00055 N , 67.02626 E	**Soil Temp:**	40°C
Weather Conditions:	Sunny		
Surface Material:	Limestone		
Surface Conditions:	Dry	**Configuration:**	Wenner

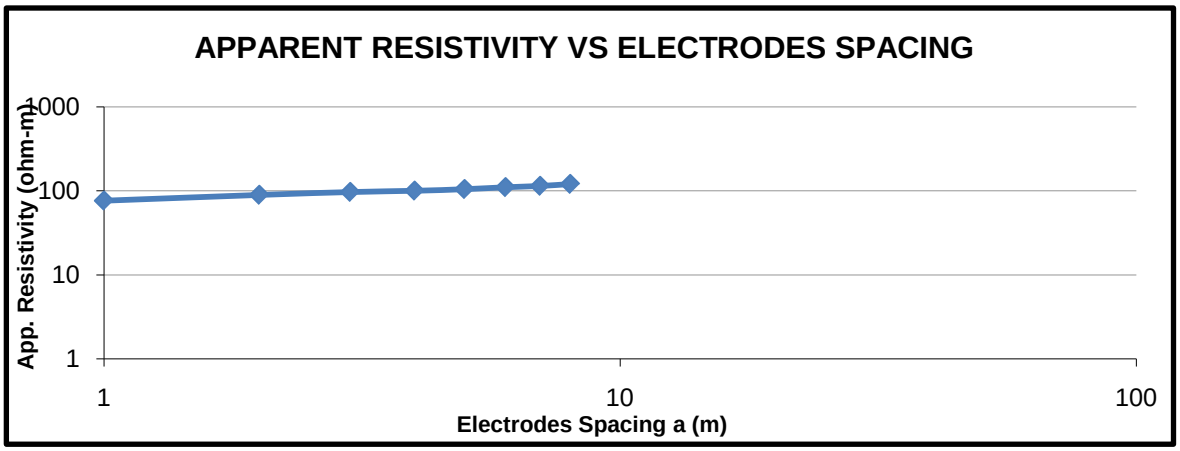
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	784.42	114.90	6.83	42.87
2	2	1.00	3.00	12.56	529.36	111.50	4.75	59.63
3	3	1.50	4.50	18.84	735.45	186.90	3.94	74.14
4	4	2.00	6.00	25.12	322.54	94.53	3.41	85.71
5	5	2.50	7.50	31.40	161.34	48.62	3.32	104.20
6	6	3.00	9.00	37.68	206.42	67.70	3.05	114.89
7	7	3.50	10.50	43.96	120.42	43.27	2.78	122.34
8	8	4.00	12.00	50.24	325.46	131.80	2.47	124.06



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	7/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	5
Location:	Site - 2 (Filtration Plant)		
Coordinates:	25.00071 N , 67.02602 E	**Soil Temp:**	40°C
Weather Condition:	Sunny		
Surface Material:	Limestone		
Surface Conditions:	Dry	**Configuration:**	Wenner

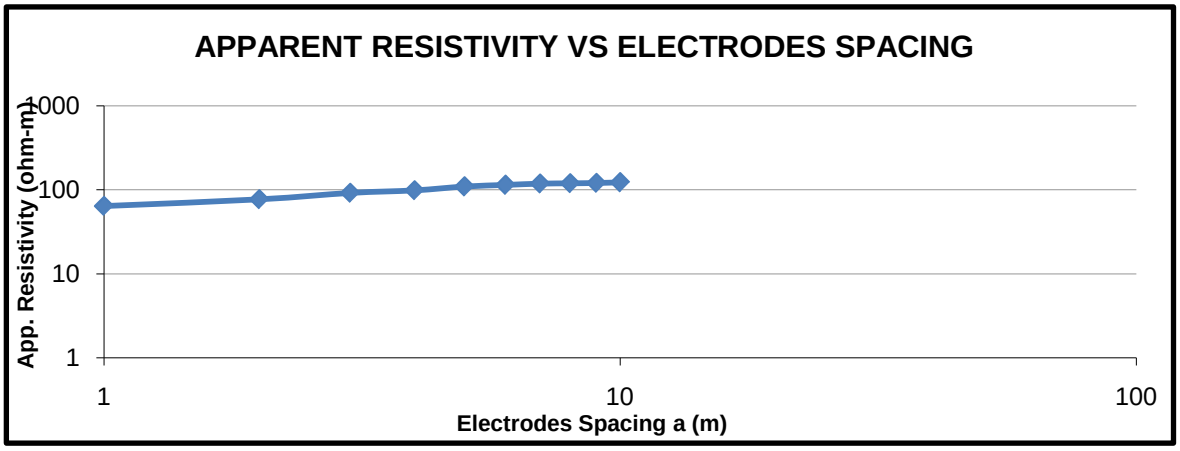
Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	2,638.58	216.10	12.21	76.68
2	2	1.00	3.00	12.56	1,232.34	172.50	7.14	89.73
3	3	1.50	4.50	18.84	2,355.60	456.60	5.16	97.20
4	4	2.00	6.00	25.12	1,026.74	257.20	3.99	100.28
5	5	2.50	7.50	31.40	917.46	275.10	3.34	104.72
6	6	3.00	9.00	37.68	713.22	242.20	2.94	110.96
7	7	3.50	10.50	43.96	668.80	255.90	2.61	114.89
8	8	4.00	12.00	50.24	377.00	157.00	2.40	120.64



IN-SITU ELECTRICAL RESISTIVITY MEASUREMENTS OF SOIL

Project:	Rehabilitation of Hub Canal Project	**Date:**	7/10/2020
Client/ Consultant:	Halcrow Pakistan	**Sounding No.**	6
Location:	Site - 2 (Filtration Plant)		
Coordinates:	25.00054 N , 67.02547 E	**Soil Temp:**	39.5°C
Weather Condition:	Sunny		
Surface Material:	Limestone		
Surface Conditions:	Dry	**Configuration:**	Wenner

Sr. #	Space a(m)	Inside a/2 (m)	Outside 3a/2	K=2лa	P (mV)	C (mA)	R (Ω)	ρ (ohm-m)
1	1	0.50	1.50	6.28	1,113.02	108.80	10.23	64.24
2	2	1.00	3.00	12.56	886.69	144.60	6.13	77.02
3	3	1.50	4.50	18.84	513.64	105.30	4.88	91.90
4	4	2.00	6.00	25.12	421.35	107.40	3.92	98.55
5	5	2.50	7.50	31.40	305.16	87.84	3.47	109.08
6	6	3.00	9.00	37.68	234.18	77.39	3.03	114.02
7	7	3.50	10.50	43.96	136.03	50.53	2.69	118.34
8	8	4.00	12.00	50.24	44.87	18.88	2.38	119.40
9	9	4.50	13.50	56.52	164.52	77.08	2.13	120.64
10	10	5.00	15.00	62.80	333.32	171.10	1.95	122.34



ANNEXURE – 2

Data set of Sounding Points

SITE - 1
Pump Station

DATA SET: HALPUMP1

CLIENT: HALCROW PAKISTAN DATE: 06-10-2020
LOCATION: PUMP STATION SOUNDING: 01
COUNTY: KARACHI PAKISTAN AZIMUTH:
PROJECT: REHABILITATION OF HUB CANAL EQUIPMENT: SUPERSTING R1
ELEVATION: 0.00
SOUNDING COORDINATES: X: 25.0178 Y: 67.0204

Wenner Configuration

FITTING ERROR: 0.219 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	95.85	0.863	-0.863	0.00900	82.72
2	13.29				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	65.04	65.10	-0.0868
2	2.00	29.84	29.75	0.309
3	3.00	18.31	18.38	-0.362
4	4.00	15.20	15.22	-0.124
5	5.00	14.27	14.24	0.179
6	6.00	13.88	13.87	0.0639

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	0.00	1.00
	P 1	P 2	T 1

* *

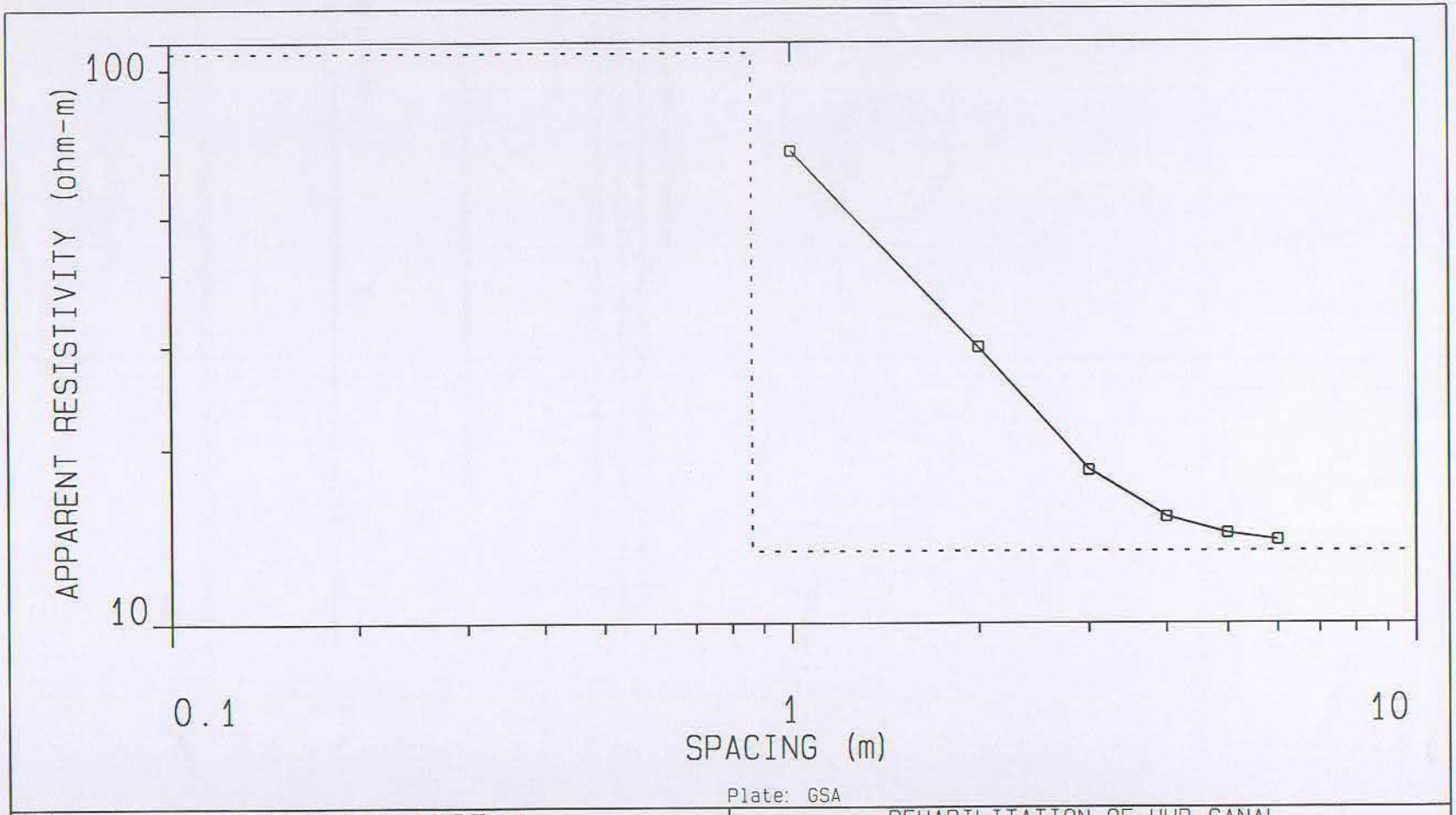


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	PUMP STATION KARACHI PAKISTAN
Data Set: HALPUMP1 — Date: 06-10-2020	
Equipment: SUPERSTING R1 — Sounding: 01	Azimuth:

DATA SET: HALPUMP2

CLIENT: HALCROW PAKISTAN
LOCATION: PUMP STATION
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 25.0183 Y: 67.0199

DATE: 06-10-2020
SOUNDING: 02
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.259 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	94.19	0.874	-0.874	0.00929	82.41
2	31.49				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	73.84	73.79	0.0756
2	2.00	47.91	48.07	-0.315
3	3.00	38.33	38.19	0.361
4	4.00	34.76	34.72	0.122
5	5.00	33.33	33.33	0.0169
6	6.00	32.64	32.68	-0.0993
7	7.00	32.42	32.32	0.294
8	8.00	31.97	32.11	-0.433

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	T 1
P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	0.00	1.00

* *

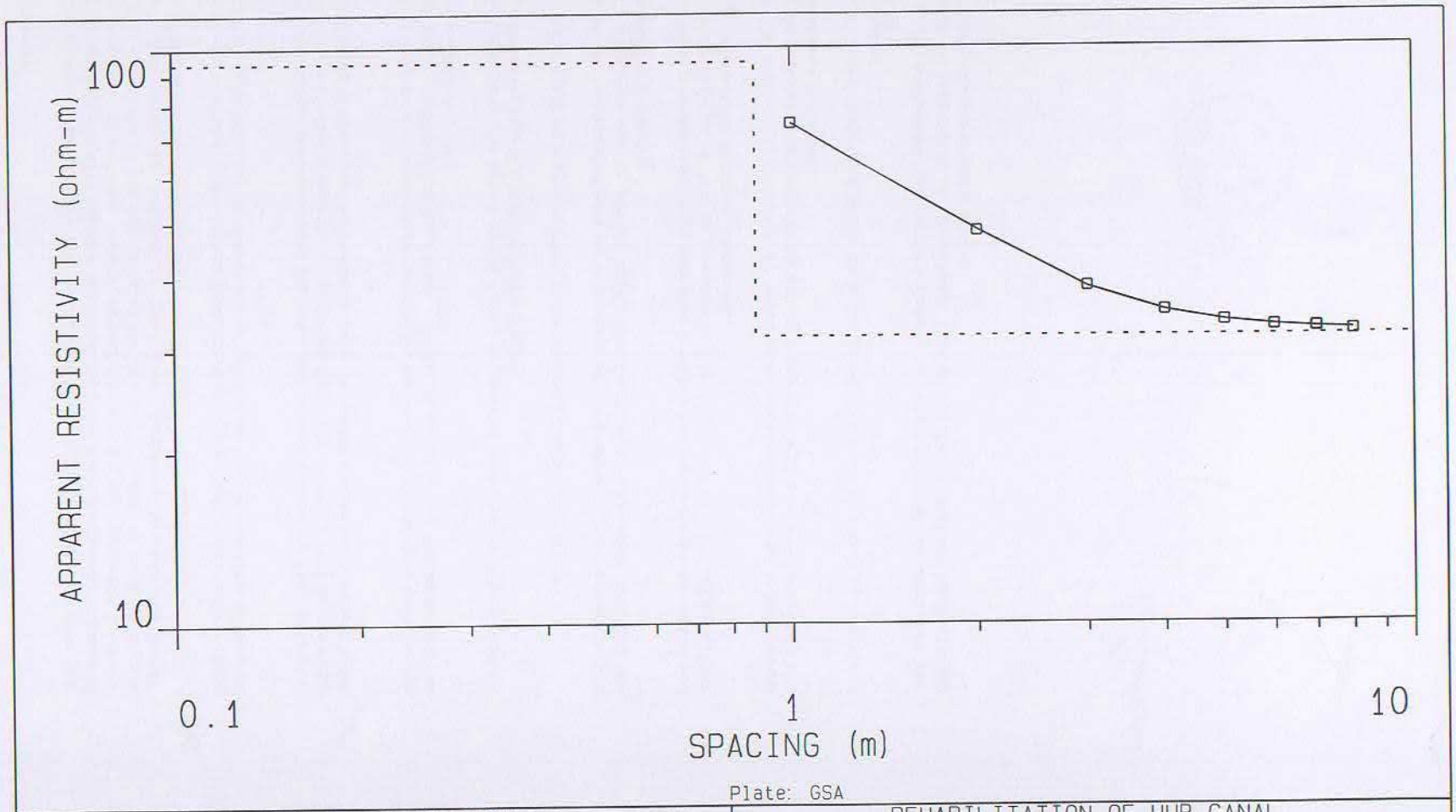


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	PUMP STATION KARACHI PAKISTAN
Data Set: HALPUMP2 / Date: 06-10-2020	
Equipment: SUPERSTING R1 / Sounding: 02	Azimuth:

DATA SET: HALPUMP3

CLIENT: HALCROW PAKISTAN
LOCATION: PUMP STATION
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 25.0182 Y: 67.0209

DATE: 06-10-2020
SOUNDING: 03
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.102 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	16.84	0.804	-0.804	0.0477	13.56
2	13.11				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.00	15.71	15.71	0.0201
2	2.00	14.32	14.33	-0.0781
3	3.00	13.73	13.73	0.00317
4	4.00	13.48	13.47	0.0593
5	5.00	13.35	13.34	0.0902
6	6.00	13.29	13.27	0.162
7	7.00	13.23	13.23	0.0248
8	8.00	13.17	13.20	-0.227
9	9.00	13.17	13.18	-0.0806
10	10.00	13.17	13.17	0.0244

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99		
P 2	0.00	1.00	
T 1	0.02	0.00	0.88
	P 1	P 2	T 1

* *

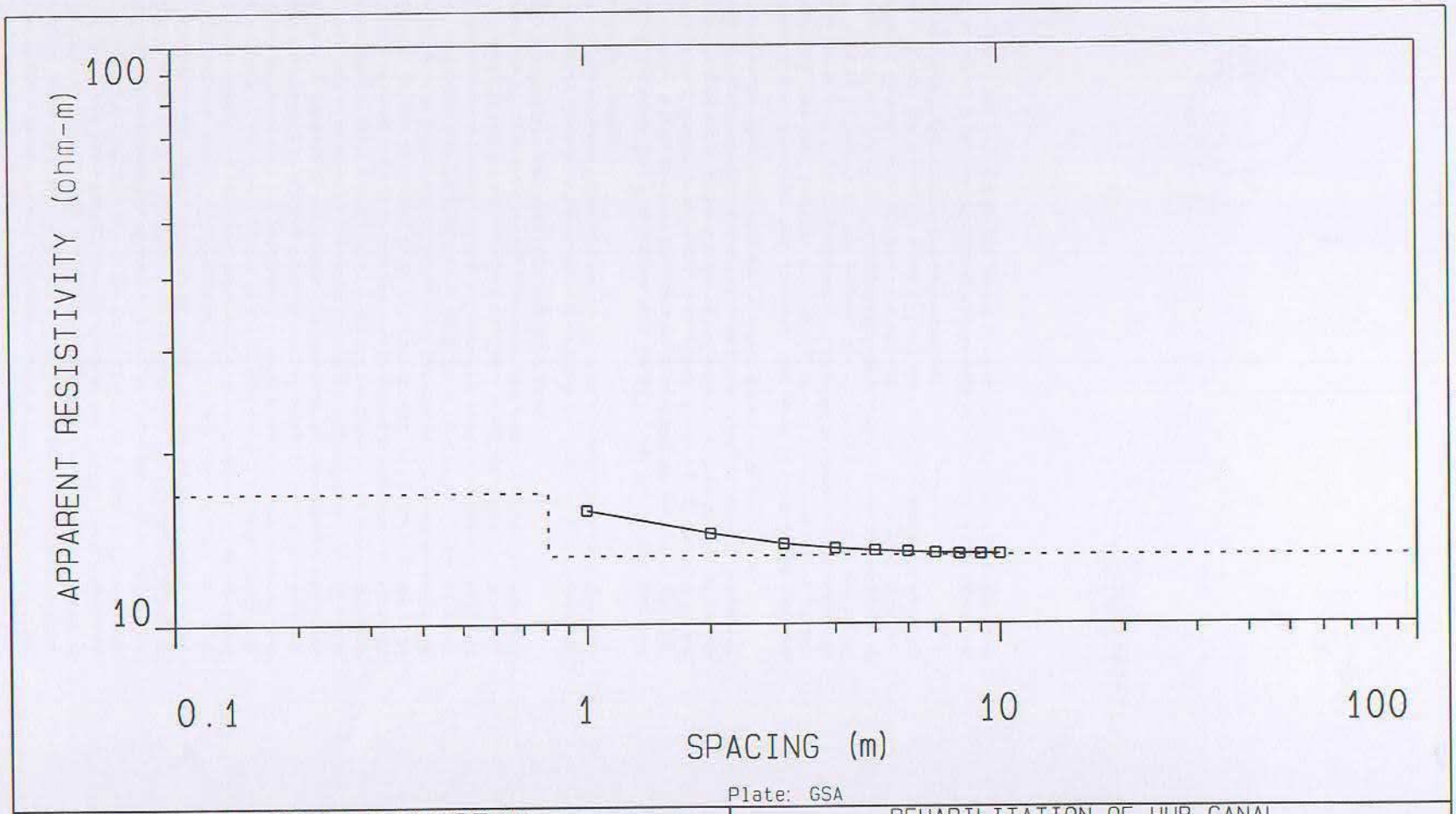


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	PUMP STATION KARACHI PAKISTAN
Data Set: HALPUMP3 — Date: 06-10-2020	
Equipment: SUPERSTING R1 — Sounding: 03	Azimuth:

DATA SET: HALPUMP4

CLIENT: HALCROW PAKISTAN
LOCATION: PUMP STATION
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
DATE: 06-10-2020
SOUNDING: 04
AZIMUTH:
EQUIPMENT: SUPERSTING R1
ELEVATION: 0.00
SOUNDING COORDINATES: X: 25.0188 Y: 67.0207

Wenner Configuration

FITTING ERROR: 0.333 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	117.8	0.842	-0.842	0.00715	99.34
2	6.11				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	72.07	72.19	-0.157
2	2.00	24.03	23.92	0.465
3	3.00	10.36	10.41	-0.485
4	4.00	7.34	7.34	-0.0553
5	5.00	6.63	6.60	0.404
6	6.00	6.36	6.38	-0.370
7	7.00	6.31	6.29	0.301
8	8.00	6.23	6.24	-0.0984

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	0.00	1.00
	P 1	P 2	T 1

*

*

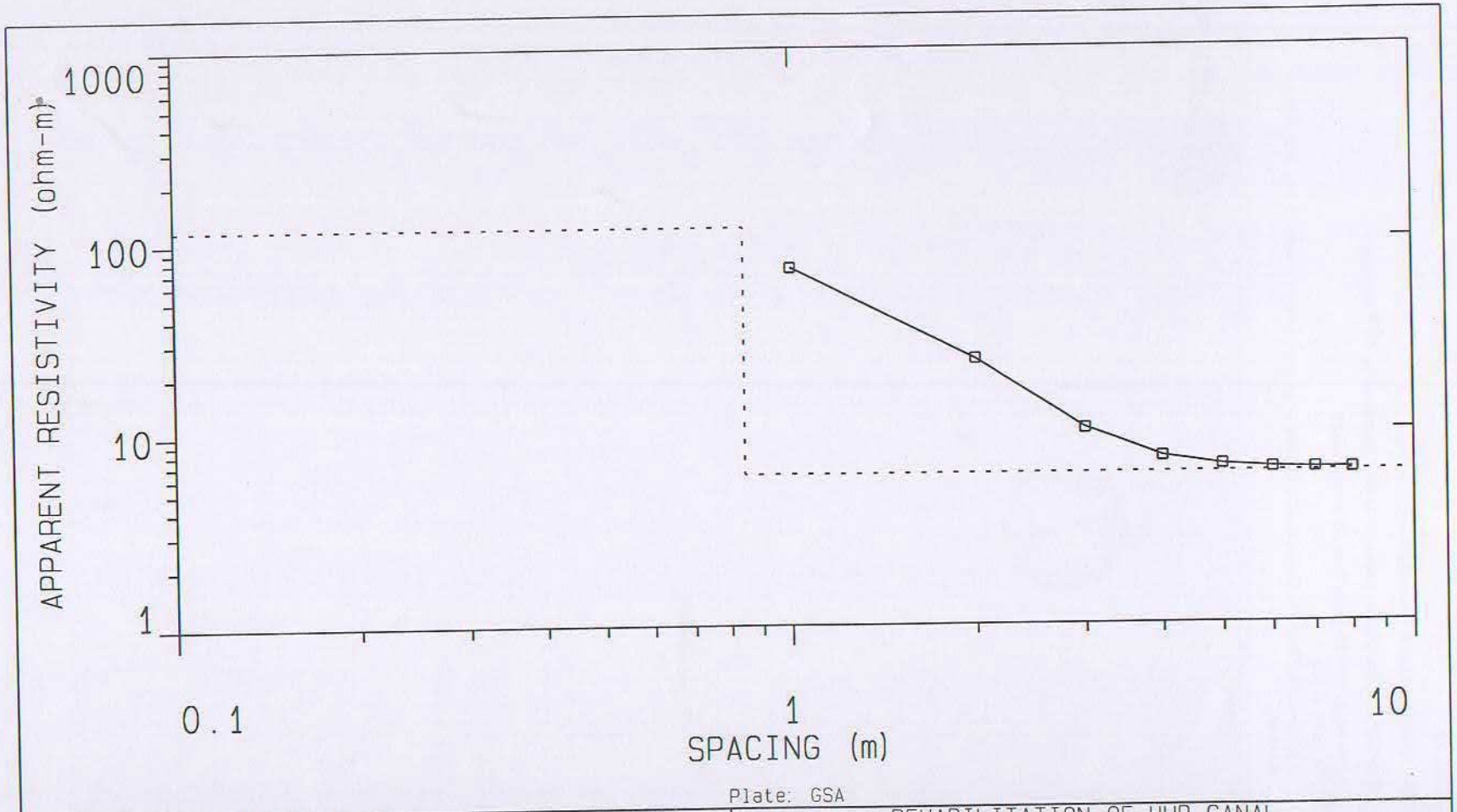


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	PUMP STATION KARACHI PAKISTAN
Data Set: HALPUMP4 — Date: 06-10-2020	
Equipment: SUPERSTING R1 — Sounding: 04	Azimuth:

SITE - 2
Filtration Plant

DATA SET: HALFILT1

CLIENT: HALCROW PAKISTAN
LOCATION: FILTRATION PLANT
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 24.9989 Y: 67.0230

DATE: 06-10-2020
SOUNDING: 01
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.498 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	586.4	1.91	-1.91	0.00327	1123.0
2	62.76	5.93	-7.85	0.0946	372.8
3	35.53				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	550.7	550.1	0.123
2	2.00	419.0	419.3	-0.0612
3	3.00	282.2	282.8	-0.228
4	4.00	187.8	187.8	0.00859
5	5.00	131.9	130.8	0.882
6	6.00	97.10	98.21	-1.14
7	7.00	79.87	79.48	0.481
8	8.00	68.50	68.37	0.195
9	9.00	61.27	61.41	-0.229
10	10.00	56.72	56.69	0.0531

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00				
P 2	0.00	0.95			
P 3	0.00	0.01	0.71		
T 1	0.00	0.01	-0.01	1.00	
T 2	0.00	0.11	0.37	-0.02	0.23
	P 1	P 2	P 3	T 1	T 2

* *

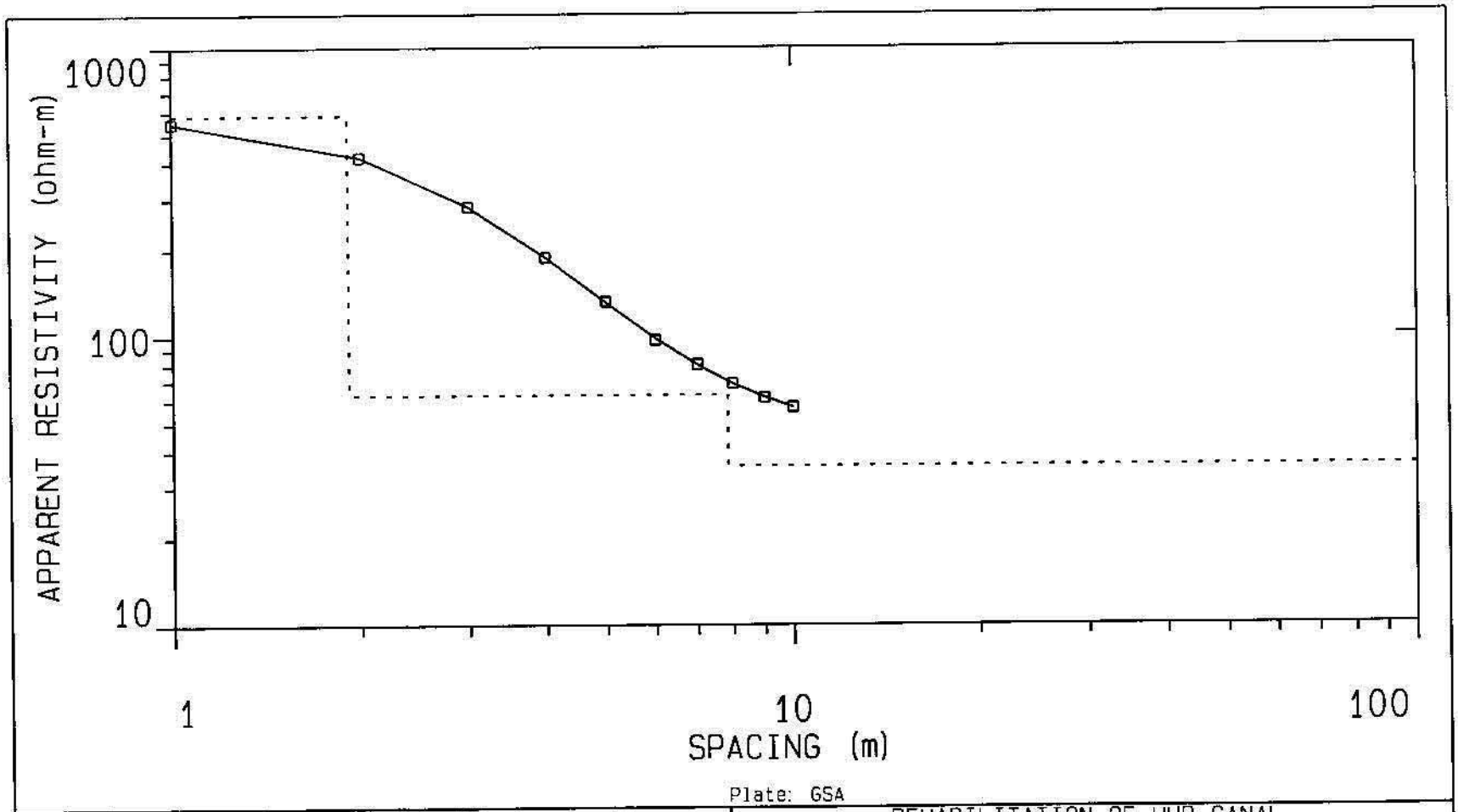


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	FILTRATION PLANT KARACHI PAKISTAN
Data Set: HALFILT1 — Date: 06-10-2020	
Equipment: SUPERSTING R1 — Sounding: 01	Azimuth:

DATA SET: HALFILT3

CLIENT: HALCROW PAKISTAN
LOCATION: FILTRATION PLANT
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 24.9986 Y: 67.0230

DATE: 06-10-2020
SOUNDING: 02
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.151 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	1013.2	1.59	-1.59	0.00157	1613.3
2	259.1				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	937.3	938.6	-0.138
2	2.00	717.3	715.1	0.304
3	3.00	522.0	523.2	-0.212
4	4.00	408.0	407.7	0.0775
5	5.00	344.8	345.0	-0.0656
6	6.00	311.5	311.6	-0.0123
7	7.00	293.0	293.2	-0.0659
8	8.00	283.0	282.7	0.104

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	0.00	1.00
	P 1	P 2	T 1

*

*

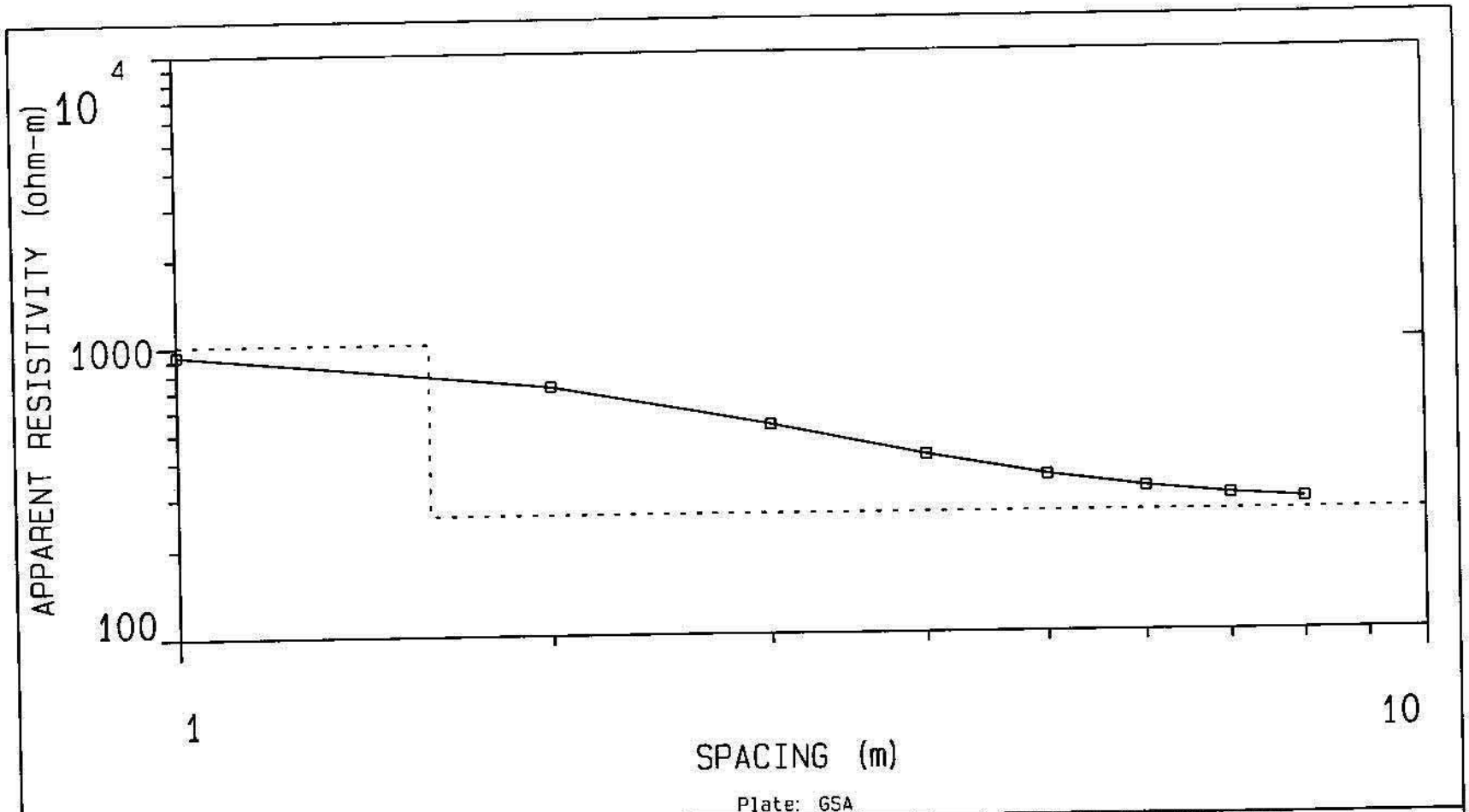


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	FILTRATION PLANT KARACHI PAKISTAN
Data Set: HALFILT3	Date: 06-10-2020
Equipment: SUPERSTING R1	Sounding: 02
	Azimuth:

DATA SET: HALFILT5

CLIENT: HALCROW PAKISTAN
LOCATION: FILTRATION PLANT
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 24.9985 Y: 67.0228

DATE: 06-10-2020
SOUNDING: 03
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.166 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	965.5	1.62	-1.62	0.00168	1567.5
2	152.4				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	885.4	883.6	0.201
2	2.00	633.4	635.5	-0.333
3	3.00	422.6	422.2	0.0933
4	4.00	296.1	296.1	-0.00472
5	5.00	230.3	230.0	0.152
6	6.00	196.2	196.3	-0.0808
7	7.00	179.2	179.0	0.107
8	8.00	169.4	169.7	-0.139

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	0.00	1.00
	P 1	P 2	T 1

*

*

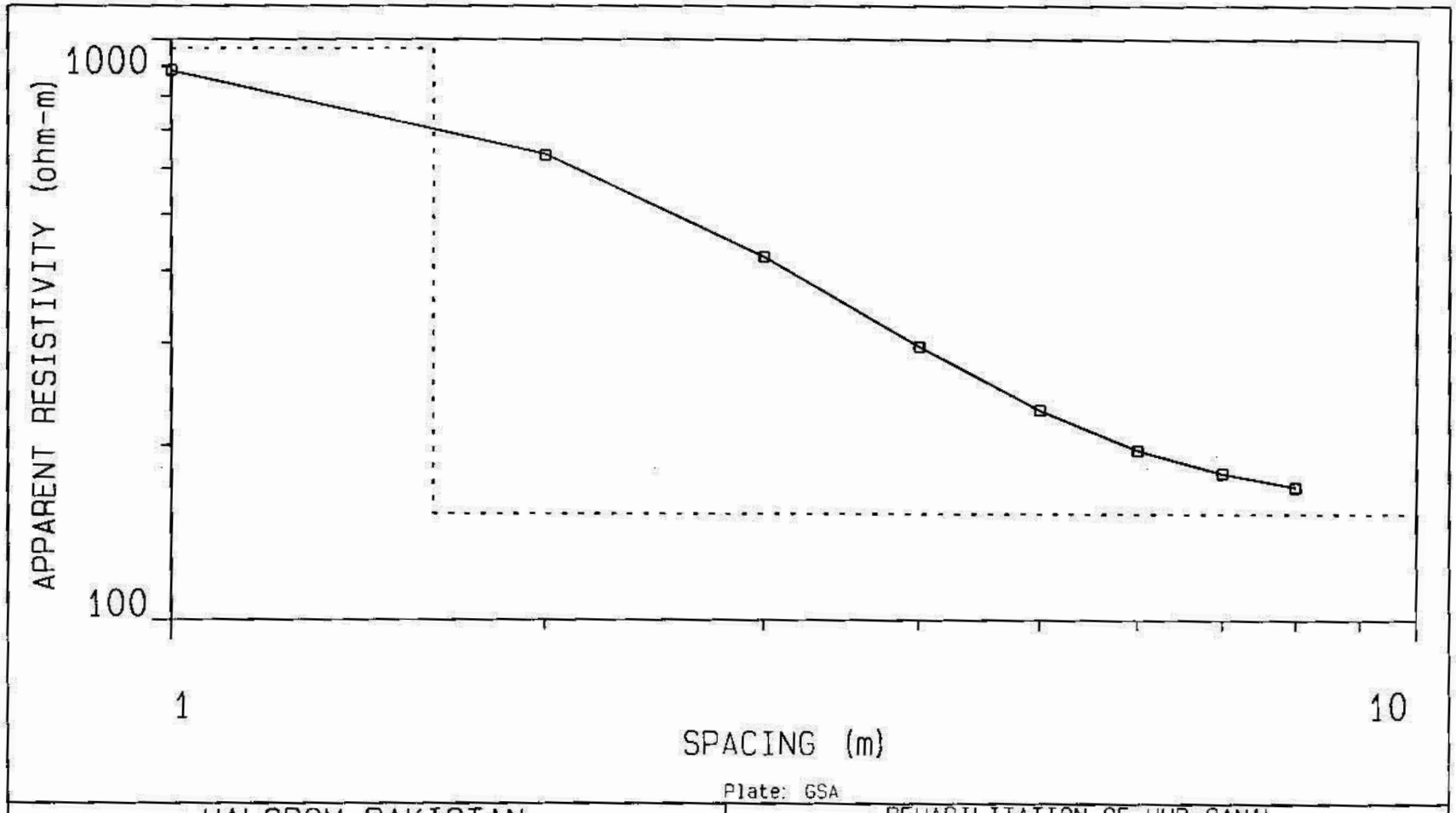


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	FILTRATION PLANT KARACHI PAKISTAN
Data Set: HALFILT5 / Date: 06-10-2020	
Equipment: SUPERSTING R1 / Sounding: 03	Azimuth:

DATA SET: HALFILT2

CLIENT: HALCROW PAKISTAN
LOCATION: FILTRATION PLANT
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 25.0005 Y: 67.0263

DATE: 07-10-2020
SOUNDING: 04
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.145 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	47.00	1.79	-1.79	0.0381	84.24
2	181.3				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	50.09	50.07	0.0302
2	2.00	61.75	61.78	-0.0552
3	3.00	76.13	76.10	0.0307
4	4.00	89.38	89.16	0.243
5	5.00	99.93	100.2	-0.301
6	6.00	109.4	109.5	-0.0883
7	7.00	117.3	117.3	-0.00672
8	8.00	124.0	123.9	0.0732

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	-0.01	0.99
	P 1	P 2	T 1

* *

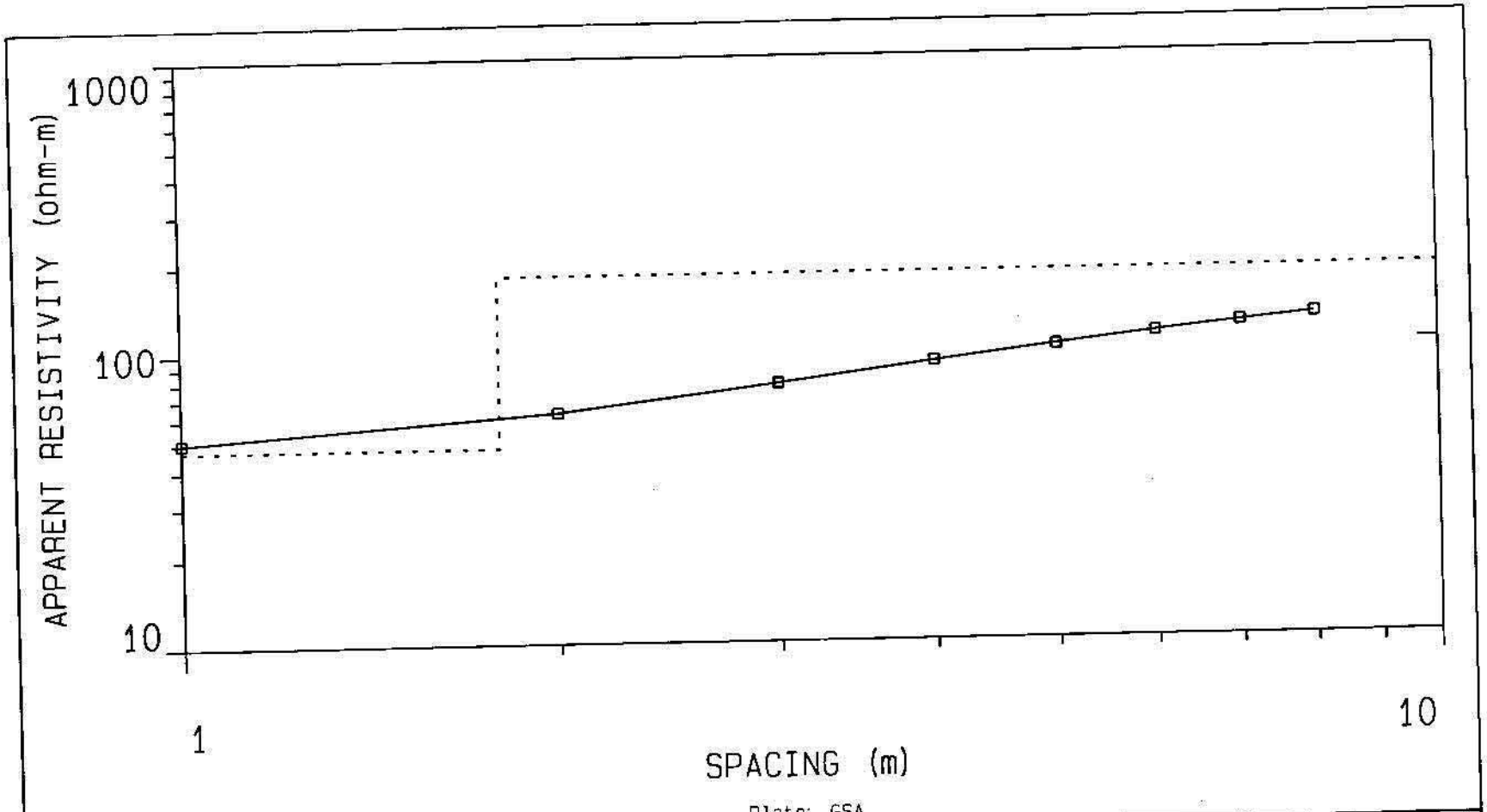


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	FILTRATION PLANT KARACHI PAKISTAN
Data Set: HALFILT2	Date: 07-10-2020
Equipment: SUPERSTING R1	Sounding: 04
	Azimuth:

DATA SET: HALFILT4

CLIENT: HALCROW PAKISTAN
LOCATION: FILTRATION PLANT
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 25.0007 Y: 67.0260

DATE: 07-10-2020
SOUNDING: 05
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.099 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	75.79	1.82	-1.82	0.0240	138.1
2	132.6				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	77.89	77.85	0.0516
2	2.00	85.48	85.58	-0.114
3	3.00	94.69	94.55	0.144
4	4.00	102.0	102.1	-0.0976
5	5.00	107.8	107.9	-0.0653
6	6.00	112.5	112.3	0.133
7	7.00	115.6	115.7	-0.0946
8	8.00	118.3	118.4	-0.0296

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	-0.01	0.98
	P 1	P 2	T 1

* *

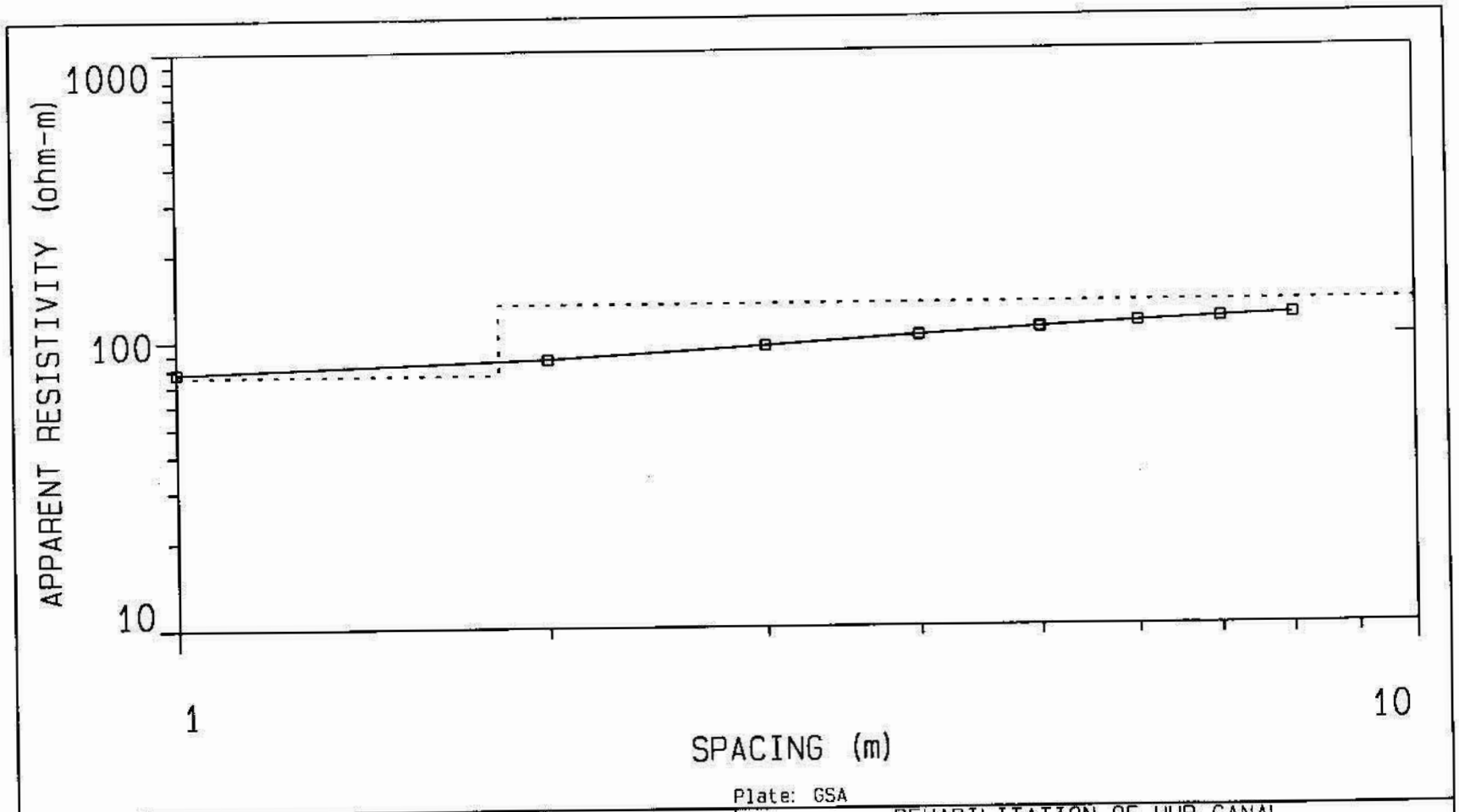


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	FILTRATION PLANT KARACHI PAKISTAN
Data Set: HALFILT4 / Date: 07-10-2020	
Equipment: SUPERSTING R1 / Sounding: 05	Azimuth:

DATA SET: HALFILT6

CLIENT: HALCROW PAKISTAN
LOCATION: FILTRATION PLANT
COUNTY: KARACHI PAKISTAN
PROJECT: REHABILITATION OF HUB CANAL
ELEVATION: 0.00
SOUNDING COORDINATES: X: 25.0005 Y: 67.0255

DATE: 07-10-2020
SOUNDING: 06
AZIMUTH:
EQUIPMENT: SUPERSTING R1

Wenner Configuration

FITTING ERROR: 0.132 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	LONG. COND. (Siemens)	TRANS. RES. (Ohm-m^2)
			0.0		
1	65.11	1.83	-1.83	0.0281	119.2
2	142.3				

ALL PARAMETERS ARE FREE

No.	SPACING (m)	RHO-A (ohm-m) DATA	RHO-A (ohm-m) SYNTHETIC	DIFFERENCE (percent)
1	1.00	67.61	67.55	0.0885
2	2.00	76.66	76.80	-0.191
3	3.00	87.90	87.80	0.116
4	4.00	97.18	97.32	-0.142
5	5.00	104.9	104.9	0.0292
6	6.00	110.9	110.8	0.0906
7	7.00	115.7	115.5	0.119
8	8.00	119.4	119.3	0.131
9	9.00	122.3	122.3	-0.0299
10	10.00	124.5	124.8	-0.232

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	T 1
P 1	1.00		
P 2	0.00	1.00	
T 1	0.00	0.00	0.99

* *

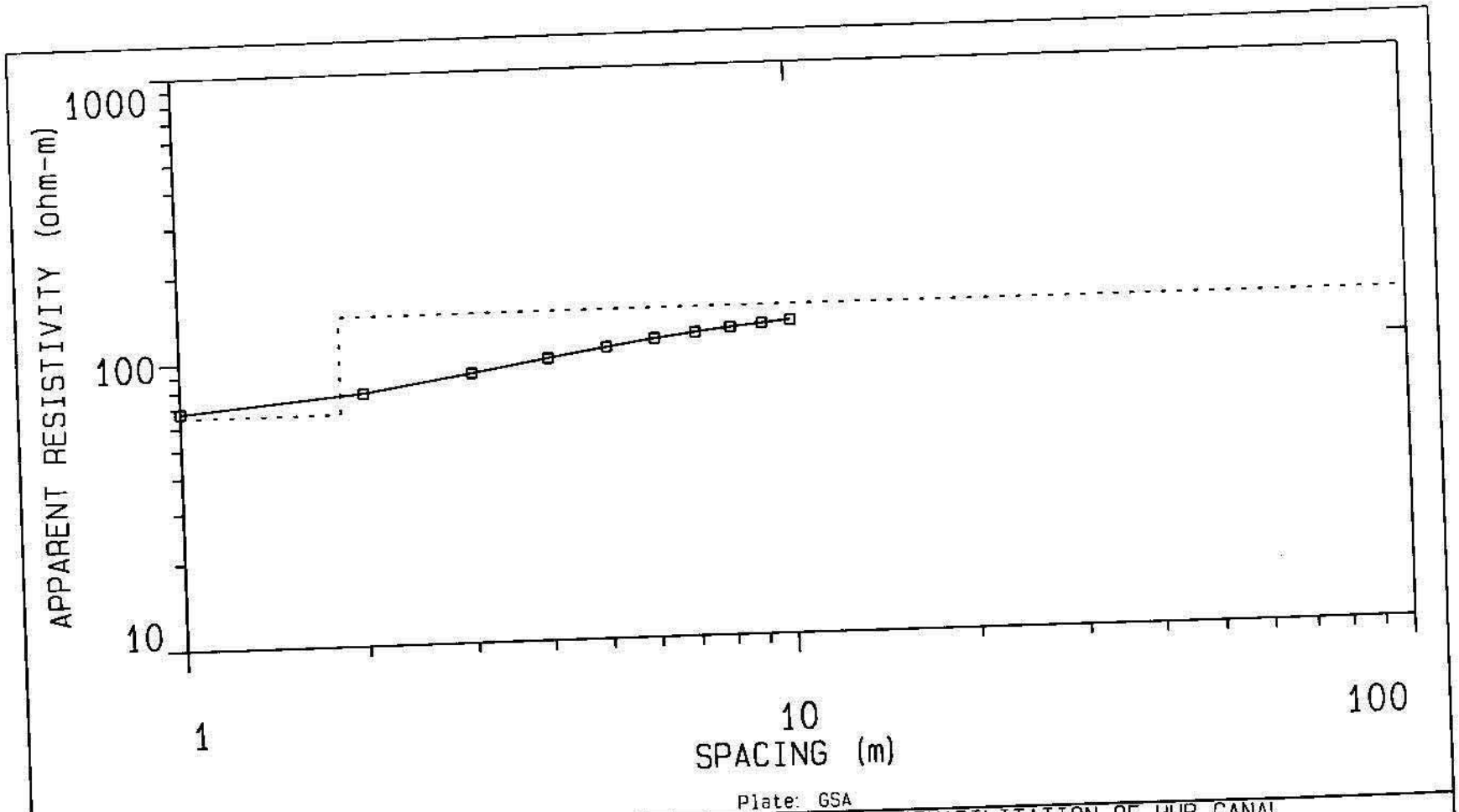


Plate: GSA

HALCROW PAKISTAN	REHABILITATION OF HUB CANAL
PROJECT PAKISTAN	FILTRATION PLANT KARACHI PAKISTAN
Data Set: HALFILT6	Date: 07-10-2020
Equipment: SUPERSTING R1	Sounding: 06
	Azimuth:

ANNEXURE – 3

Tables showing the results of True Resistivity values for different layers with corrosion potential classifications

Table -1
Site - 1 (Pump Station)
RESULTS OF ELECTRICAL RESISTIVITY SURVEY

S-No	Sounding Points	Co-ordinates	Depth (m)	Layer Thickness (m)	True Resistivity (ohm-m)	Corrosivity
1	S-01	25.0178 N 67.0204 E	0.00 - 0.86 0.86 - 6.00	0.86 5.14	95.85 13.29	Low High
2	S-02	25.0183 N 67.0199 E	0.00 - 0.87 0.87 - 8.00	0.87 7.13	94.19 31.49	Low Moderate
3	S-03	25.0182N 67.0209 E	0.00 - 0.80 0.80 - 10.00	0.80 9.20	16.84 13.11	High High
4	S-04	25.0188 N 67.0207 E	0.00 - 0.84 0.84 - 8.00	0.84 7.16	117.80 6.11	Very Low Very High

Table -2
Site - 2 (Filtration Plant)
RESULTS OF ELECTRICAL RESISTIVITY SURVEY

S-No	Sounding Points	Co-ordinates	Depth (m)	Layer Thickness (m)	True Resistivity (ohm-m)	Corrosivity
1	S-01	24.9989 N 67.0230 E	0.00 - 1.91	1.91	586.40	Very Low
			1.91 - 7.85	5.94	62.76	Low
			7.85 - 10.00	2.15	35.53	Moderate
2	S-02	24.9986 N 67.0230 E	0.00 - 1.59	1.59	1013.20	Very Low
			1.59 - 8.00	6.41	259.10	Very Low
3	S-03	24.9985 N 67.0228 E	0.00 - 1.62	1.62	965.50	Very Low
			1.62 - 8.00	6.38	152.40	Very Low
4	S-04	25.0005 N 67.0263 E	0.00 - 1.79	1.79	47.00	Moderate
			1.79 - 8.00	6.21	181.30	Very Low
5	S-05	25.0007 N 67.0260 E	0.00 - 1.82	1.82	75.79	Low
			1.82 - 8.00	6.18	132.60	Very Low
6	S-06	25.0005 N 67.0255 E	0.00 - 1.83	1.83	65.11	Low
			1.83 - 10.00	8.17	142.30	Very Low

GEOTAG MAPS

CONSULTING SERVICES KARACHI WATER CANAL PPP

KARACHI WATER CANAL PROJECT

SHEET NO 1

GATE VALVE

0+000

Lasbela Canal

Lotari Nai

0+000

0+100

0+200

0+000 - 0+200

0+300

Aduequct - 1

0+400

Aduequct - 1

0+500

Aduequct - 2

Aduequct - 2

0+600

Aduequct - 3

0+700

Aduequct - 3

0+800

0+900

1+000

1+100

1+200

1+300

1+300 - 1+400

1+400

1+500

1+600

1+700

1+800

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA

HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 2

1+800

1+900

Aduequct - 4

2+000

2+100

2+200

2+300

Aduequct - 5

2+400

Aduequct - 5

2+500

Aduequct - 6

2+600

2+700

Aduequct - 6

2+800

2+900

3+000

3+100

3+200

3+000 - 3+200

3+300

3+400

3+500

3+600

3+700

3+800

3+900

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA

HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 3

3+800

3+900

4+000

4+100

4+200

4+300

4+400

Aduequct - 7

4+500

4+600

4+700

4+800

4+900

5+000

5+100

5+200

5+300

5+400

5+500

Aduequct - 8

5+600

5+700

5+800

5+900

Aduequct - 7

5+000 - 5+100

Aduequct - 8

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Ghar Nai

Grupo TYPSA

HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 4

5+900
6+000
6+100
6+200
6+300
6+400
6+500
6+600
6+700
6+800
6+900
7+000
7+100
7+200
7+300
7+400
7+500
7+600
7+700
7+800
7+900

Aduequct - 9

Aduequct - 9

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA
HPK
Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 5

7+900
8+000
8+100
8+200
8+300
8+400
8+500
8+600
8+700
8+800
8+900
9+000
9+100
9+200
9+300
9+400
9+500
9+600
9+700
9+800

9+600 - 9+700

Grupo TYPSA
HPK Halcrow Pakistan (Pvt) Ltd

LEGEND
- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

KARACHI WATER CANAL PROJECT

SHEET NO 6

9+800

9+900

10+000

10+100

10+200

10+300

10+400

10+500

10+600

10+700

10+800

10+900

11+000

11+100

11+200

11+300

11+400

11+500

11+600

11+700

11+800

10+000

9+800

Aduequct - 10

Aduequct - 10

10+900 - 11+000

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA

HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 7

11+800 (Fall Structure)

11+700

11+800

11+900

12+000

12+100

12+200

12+300

12+400

12+500

12+600

12+700

12+800

12+900

13+000

13+100

13+200

13+300

13+400

13+500

13+600

13+700

12+150 - 12+200

12+350

12+600

12+800 - 13+100

13+300

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Gothabad Scheme

Grupo TYPSA

HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 8

Northern Bypass

13+700
13+800
13+900
14+000
14+100
14+200
14+300
14+400
14+500
14+600
14+700
14+800
14+900
15+000
15+100
15+200
15+300
15+400
15+500
15+600
15+700

14+400

14+100

LEGEND
- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA
HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 9

Goth Achar

15+700
15+800
15+900
16+000
16+100
16+200
16+300
16+400
16+500
16+600
16+700
16+800
16+900
17+000
17+100
17+200
17+300
17+400
17+500
17+600
17+700
17+800

16+900 (Bridge)

Aduequct - 11

Aduequct - 11

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA
HPK
Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 10

17+700
17+800
17+900
18+000
18+100
18+200
18+300
18+400
18+500
18+600
18+700
18+800
18+900
19+000
19+100
19+200
19+300
19+400
19+500
19+600
19+700
19+800
19+900

Lahro Nai

Hub Dam Road

Nishan e Haider Farms

LEGEND
- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

TYPSA
HPK
Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 11

19+900

20+000

20+100

20+200

20+300

20+400

20+500

20+600

20+700

20+800

20+900

21+000

21+090

20+100 - 20+200

Hub Dam Road

Pumping Station

PUMPING STATION

Haji Malik Goth

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA

HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER CANAL PROJECT

SHEET NO 12

Hub Staff Colony

Hub Dam Road

Haji Malik Goth

FILTER PLANT

LEGEND

- Gate Valve
- Bridge
- Culvert
- Hydrants
- Tracks
- Contours
- Damages 2018
- Damage 2020
- Water Pipe
- ROW
- Aqueducts
- Karachi Water Canal
- Major Streams
- Lasbela Canal
- Cultivation
- Vegetation
- Pondings
- Settlements
- Mountain Ranges
- Receational Establishment
- Health and Human Services
- Open/Barren Land
- Religious Institutions

100 50 0 100 Meters

Grupo TYPSA

HPK Halcrow Pakistan (Pvt) Ltd

KARACHI WATER SUPPLY CANAL PROJECT
LANDFILL SITES AND CONSTRCUTION CAMPS
TENTATIVE LOCATIONS

67°0'0"E
67°5'0"E
25°10'0"N
25°5'0"N
25°0'0"N

Construction Camp - 1
Construction Camp - 2
Construction Camp - 4
Head Regulator
Aduequct - 1
Aduequct - 2
Aduequct - 3
Aduequct - 4
Aduequct - 5
Aduequct - 6
Aduequct - 7
Aduequct - 8
Aduequct - 9
Aduequct - 10
Aduequct - 11
Lasbela Canal
KARACHI WATER CANAL
HUB RIVER
Goth Band Murad Khan
Areesha City
Madinatul Hikmah
Gothabad Scheme
Hikmat City
Samama City
Hub Dam Road
Gul Mohmmad Goth
Hazratabad
Nishan e Haider Farms
Gulistan e Sakina
Northern Bypass
Sector 14
Sector 15
Noman Royal City
Sector 12
Sector 13
Lyari River
Sector 11
Sector 10
Surjani Town
Sector 6
Sector 7
Lyari Basti Road
Gulshan e Rahim
Sector 5
Sector 4
Sector 3
Lyari River Road
HUB
PUMPING STATION
Haji Malik Goth
Ahsan City
Saima Arabian Villas
Sector 1
Sector 2
Maymar Ave
Khameso Goth
Ahsanabad
Gond Pass LFS
Jam Chakro LFS
Swat Colony
HUB
FILTER PLANT
Rajput Society
Gulshan e Tauheed
Fine Valley
Gulshan-e-Zia
New Karachi
Sector 3 NK
Sector 5 NK
Maulana Shaukat Ali Khan Road
Saba Cinema LFS
Sukhia Goth
Khalifa Mir Mohammad Goth
Sultanabad
Monghopir
Sector 4 NK
Mangopir Road
Sector 8 NK
Sector 11 - A
Sector 11 - L
Sector 11 - D
Sector 11 - F
New Karachi - University Link Road
Shah Latif Road

Legend
- Construction Camps
- Landfill Sites

TYPSA
HPK Halcrow Pakistan (Pvt) Ltd

2 1 0 2 km

KWSB Hub Water Supply System
Karachi (Pakistan)
Feasibility study on a Solar PV Plant

November 2020

TYPSA

Index

Executive Summary 4

Part I. Report 5

1. OBJECT AND SCOPE 5
2. BACKGROUND 6
3. HUB DAM WATER TREATMENT PLANT 6
   3.1. OPERATING FACILITIES 6
      3.1.1. WATER FILTRATION PLANT 6
      3.1.2. WATER PUMPING STATION 7
   3.2. EXISTING POWER SUPPLY FACILITIES 8
      3.2.1. WATER FILTRATION SUBSTATION 8
      3.2.2. PUMP STATION SUBSTATIONS 8
      3.2.3. K-ELECTRIC ROOM 9
4. LOCAL CONDITIONS AND MAIN REQUIREMENTS 11
   4.1. LOCATION 11
   4.2. METEOROLOGICAL CONDITIONS 12
   4.3. LOCAL REGULATIONS 12
   4.4. POWER DEMAND AND CONSUMPTION PROFILES 13
5. PROPOSED SOLUTION 14
   5.1. SITE PROPOSAL 14
   5.2. TECHNICAL PROPOSAL 17
6. ESTIMATION OF YIELD 22
7. IMPLEMENTATION SCHEDULE 25
8. ECONOMIC ASSESSMENT 26
   8.1. CAPEX 26
   8.2. OPEX 27
9. CONCLUSIONS 28

Part II. Appendixes 29

1. PVSyst REPORT 29
2. LAYOUT AND SINGLE-LINE DIAGRAM 30

Index of figures

Figure 1. Old & New Pump House Equipment & Layout 7
Figure 2. Single line diagram of Water Filtration Plant 8
Figure 3. Single line Diagram of Old Pump House 9
Figure 4. Single line diagram of New Pump House 9
Figure 5. Single line diagram of K-electric room 10
Figure 6. Location 11
Figure 7. Location of boreholes (Geotechnical Survey) 15
Figure 8. Seismicity of the area (Geotechnical survey) 15
Figure 9. Site proposal 16
Figure 10. PV plant distribution 19
Figure 11. Single line diagram PV Plant 21
Figure 12. Estimated daily production profile 23

Index of tables

Table 1. Irradiation data 12
Table 2. Estimated power demand 13
Table 3. Coordinates 14
Table 4. General characteristics 18
Table 5. Estimated energetic production 22
Table 6. Estimated monthly production profile 24
Table 7. Solar PV plant schedule 25
Table 8. Budget of the project 26

Executive Summary

This report is part of Phase 1b Due Diligence and Transaction Structure. The scope of works of the project includes defining a project structure and assessment of the feasibility of developing a PPP transaction structure that would set an appropriate risk allocation for both the public and the private sectors.

The IFC, within the scope of works of this project, has requested to evaluate the feasibility of a solar photovoltaic plant to cover the energy requirements of the water treatment plant.

The result of the study shows that a solar photovoltaic plant is technical and economically viable.

The good solar resource in the site and the characteristics of both the land and the facilities associated to the energy production support makes the plant very convenient as associated power generator.

The expected savings in consumption will produce a profitable return of the investment in a short time.

Part I. Report

1. OBJECT AND SCOPE

The purpose of this document is to analyse the applicability and feasibility of the photovoltaic solar technology to cover the power demand from the Hub Water Treatment plant at Karachi, Pakistan.

This report presents the studies that have been carried out to outline a potential PV plant to fit the site conditions and limited information provided by the client regarding available locations and power requirements in the facilities.

This plant will be primarily designed for self-consumption of the large electrical power demand of the water filtration and the pumping stations with the possibility of exporting the excess in production to the grid.

The report also intends to provide information of the expected CAPEX and OPEX of a PV plant to the economic feasibility of the installation can be assessed in combination with the whole development project.

This initial design includes:

- Configuration and capacity of the PV plant, comprising the kind of equipment and estimated layout on the selected location.
- Energy yield estimate based on the available meteorological data of the site for the first year of operation.
- CAPEX and OPEX estimates to evaluate the feasibility of developing a photovoltaic solar plant designed for self-consumption that will be used in the feasibility study of the complete project.

2. BACKGROUND

IFC has requested Typsa to provide technical support for the feasibility study of an upgradation/revamping of the KWSB Hub Water Supply System.

The Hub Water Supply System was planned in the late 70s and commissioned in 1981. It is located in Karachi, Pakistan and require from large energy demands. This system comprises several components that include: the main canal, the head regulator, the Hub canal, the K III connection, the Old Pump House, the New Pump House, the rising mains, the Filtration Plant, the Reservoir and the Electricity Supply.

As part of an environmental strategy, a solar PV plant that could cover part of the energy demand is now being considered. This solution has the main objective of reducing the significant electricity charges the system costs every year. The implementation of the solar PV plant is related to some of the components mentioned above and thus, the following description of the affected components is going to explain the current energy requirements that could be covered by the implementation of the PV power generator and the possible modifications that need to be executed in order to carry out the project.

3. HUB DAM WATER TREATMENT PLANT

3.1. OPERATING FACILITIES

3.1.1. WATER FILTRATION PLANT

The Water Filtration Plant is located on the outskirts of Karachi, in the North East area. The construction of this plant was completed in 2005. It was originally designed to treat 100 MGD water coming from hub dam, which was reduced to 80 MGD due to the declining water availability at Hub Dam. The Filter plant comprises the following components:

- Raw Water Distribution Chamber: The raw water from the pumping stations is first delivered to raw water distribution chamber from the bottom.
- Alum dosing: The system comprises of 4 mixing tanks and 7 dosing pumps.
- Chlorination: It comprises chlorine liquid drums, Chlorine evaporator and chlorinator.
- Sulfuric Acid: The system comprises of acid tank and air dryer.
- Filter Beds: It comprises a total of 16 rapid sand filter beds. Each one is designed for 5 MGD.
- Lime dosing.
- Sludge thickener: The backwash water from filter bed is collected in wash water balance tank to store water and to further pump it to sludge thickeners having slow moving paddles.
- Other facilities: Other facilities such as chemical storage facilities, administration building and Laboratory are available to store.

3.1.2. WATER PUMPING STATION

The Hub Water Pumping Station is located about 2 km North from the Water Filtration Plant and comprises two pump houses: The Old Pump House and the New Pump House. Both Houses have a total of six pumps installed and two 630 kVA transformers each. The transformers are used for low voltage supply in the Houses. A scheme of this layout can be seen in the following figure:

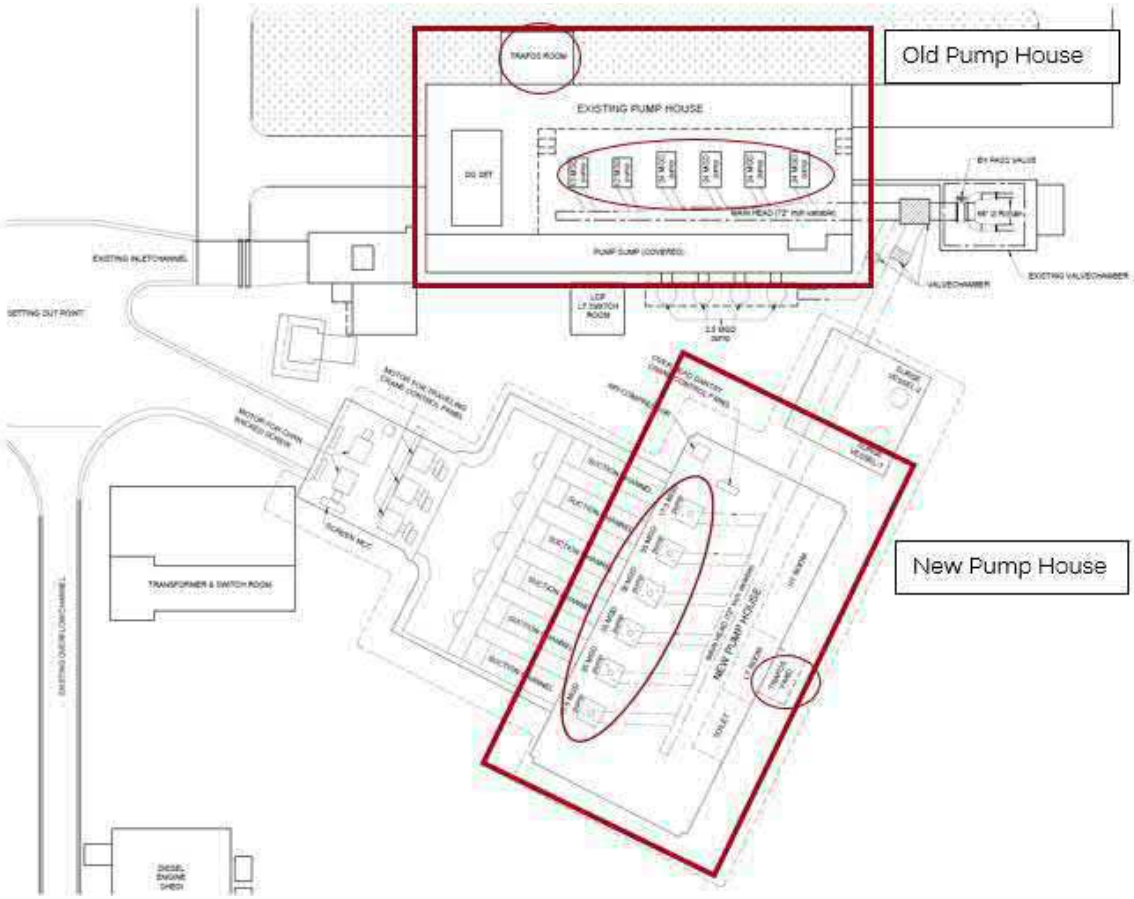


Figure 1. Old & New Pump House Equipment & Layout

3.1.2.1. The Old Pump House (1981)

The original pump house comprises 2 pumps of 12 MGD and 4 pumps of 24 MGD. There is a DG set, only used for old pump motors and 17 OCB panels (11kV). The motors and pumps are installed in the basement and the generator and electrical panels are positioned at the entrance level, which is approximately 3m higher than the pump floor. All the equipment is dated from 1981, when this house was commissioned.

3.1.2.2. The New Pump House (2006)

The New Pump House has installed 2 pumps of 17.5 MGD and 4 pumps of 35 MGD. Within the New House, there are 19 OCB panels installed (11kV). Currently, there is no DG set for the supply of the New House, but it is a future provision. The motors and pumps are installed in the basement and the generator and electrical panels are installed at the entrance level to the pump house about 2m above the pump room, therefore both houses follow the same configuration. The pumps draw water directly from the water channels under the pump floor, which are fed by the canal.

3.2. EXISTING POWER SUPPLY FACILITIES

The complex includes some electrical infrastructure to supply power to those mentioned large consumers and all the ancillary system.

As main power system supplier, the whole complex is connected to the distribution grid at 11 kV from the K-Electricity (K-E) (Walika Grid) company. Also, the critical machinery, as pumps might be fed by dedicated gensets as backup.

The next paragraph provides details.

3.2.1. WATER FILTRATION SUBSTATION

The filtration plant substation is connected to the existing (Old) Pump House through a 11kV feeder. At the entrance of the substation, there is an isolator switch (11kV) and an 800 kVA transformer. It also has installed a DG set of 800 kVA. The single line diagram is illustrated in the following figure:

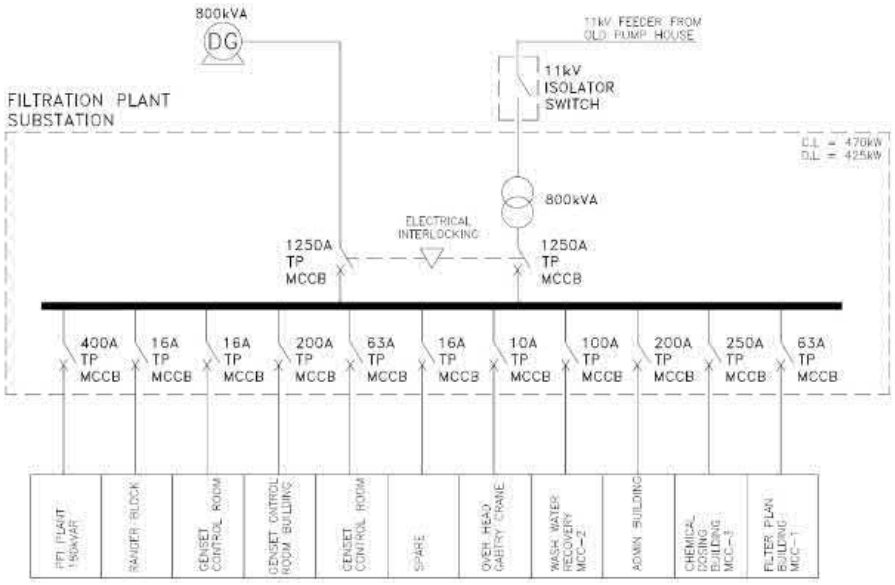


Figure 2. Single line diagram of Water Filtration Plant

3.2.2. PUMP STATION SUBSTATIONS

The Old Pump House HT Panel is directly connected to the K-Electric substation line, having each pump fed through a dedicated electrical panel. It also has installed a DG set (11 kV) of a capacity of 3,600 kW and an 11 kV power exchanger to the New Pump House. The following figure shows the single line diagram:

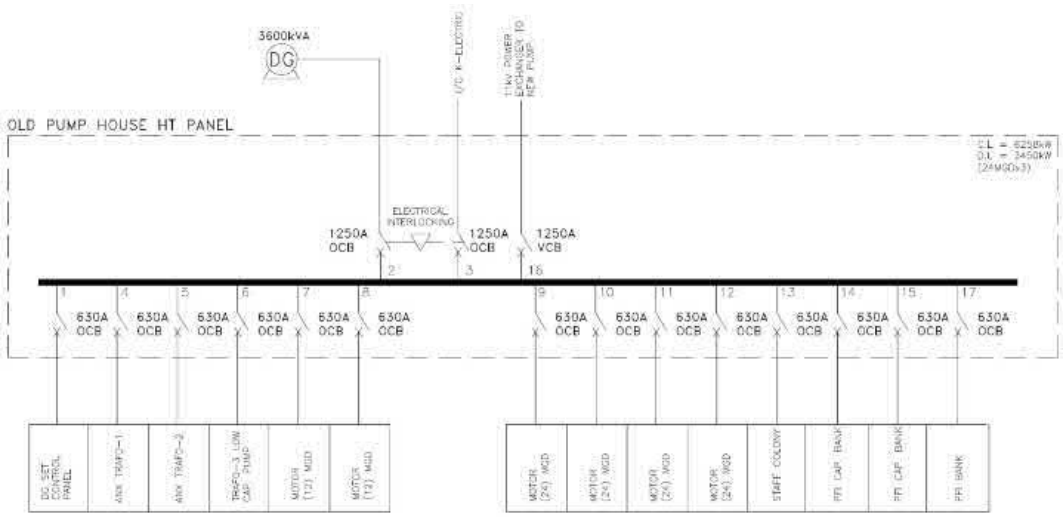


Figure 3. Single line Diagram of Old Pump House

The New Pump House HT panel is connected to the K-Electric substation line, having each pump fed through a dedicated electrical panel, with a provision of establishing a second standby line. There is also a 11 kV power exchanger to the Old House. In the following figure, the single line diagram is represented:

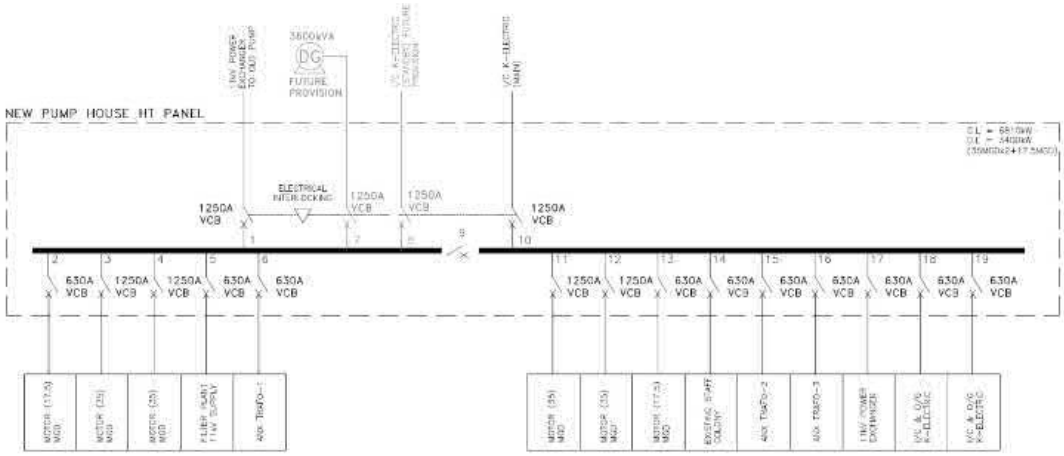


Figure 4. Single line diagram of New Pump House

3.2.3. K-ELECTRIC ROOM

The power supply to the whole Hub Water Supply System comes at 11 kV. The point of interconnection with the grid is the so-called K-electric room (that belongs to the K-E company) with the main 11 kV busbar. It is located beside the pumping station building and has two main 11 kV feeders. One, called “HUB DAM”, is the main power source while the second one is called “MUMTAZ” serves as standby power source. The figure below shows the single line diagram of this switchyard:

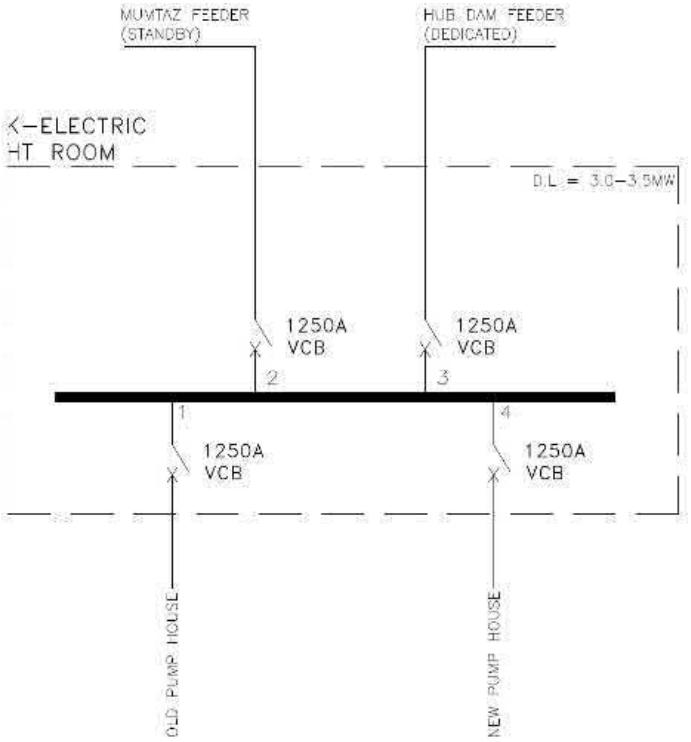


Figure 5. Single line diagram of K-electric room

4. LOCAL CONDITIONS AND MAIN REQUIREMENTS

4.1. LOCATION

This project is located in Karachi, the largest city of Pakistan and capital of Sindh province. It is the country's main financial centre, occupying an area of 3,500 square kilometres. The steady growth of the city has provoked a shortfall in the water supply and thus, needs improvement. One of the water sources that is going to be refurbished, the Hub Dam Water Supply System, is located on the outskirts of Karachi metropolitan area in the hilly zone of Hub near Manghopir in Gadap Town. It is on this location where the solar photovoltaic generator is going to be located.

The Hub Dam Water System, that comprises an area of approximately 340 Ha that belongs to KWSB including both the water filtration plan and the water pumping station. The area shows elevations from 60 to 115 m.a.s.l. and offers a variety of possible locations with similar conditions.

The following figure shows the general area within the white polygon where the water treatment complex is located:

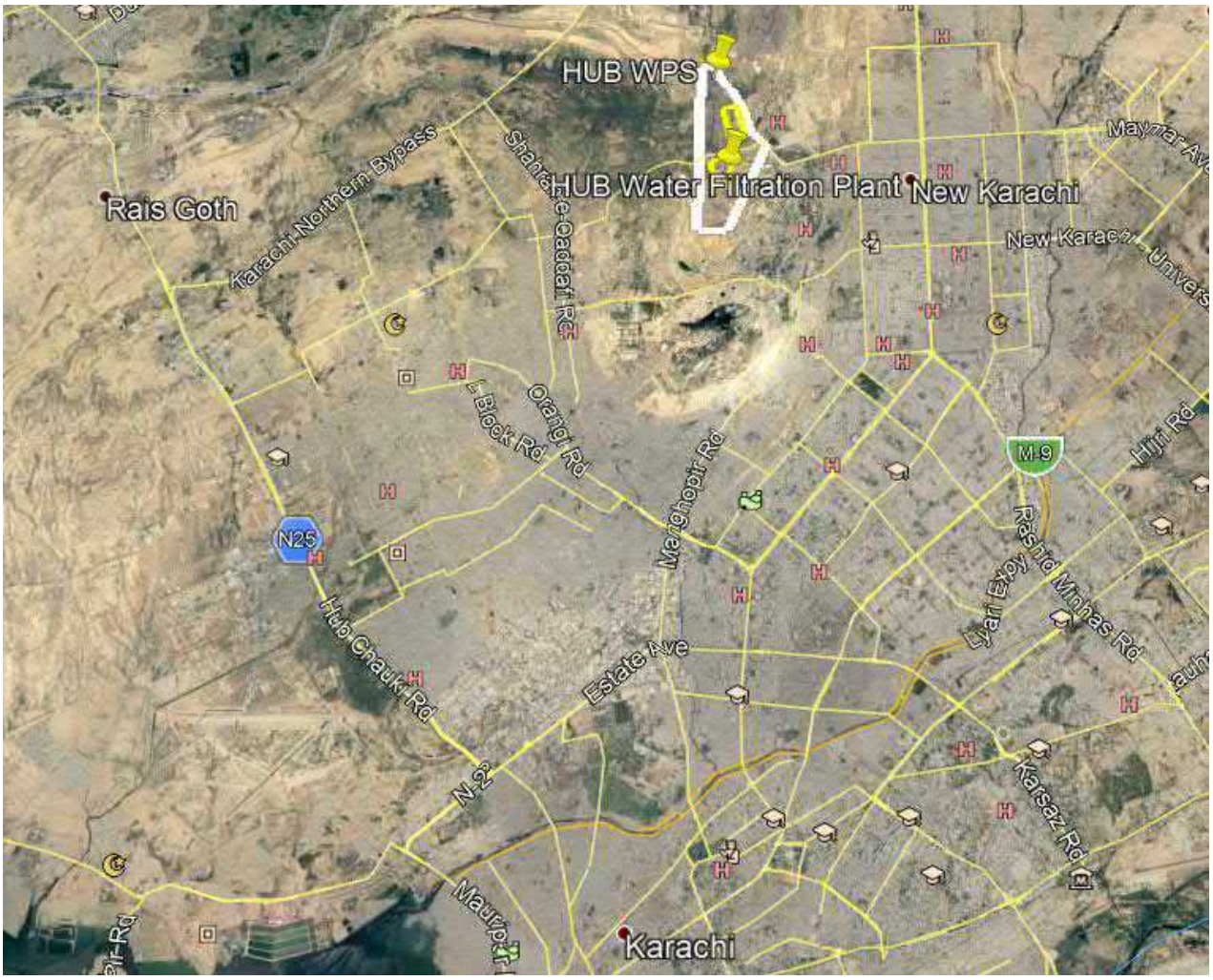


Figure 6. Location

4.2. METEOROLOGICAL CONDITIONS

The historical meteorological data has been obtained from the Solargis database. The following table show the typical meteorological year (TMY) and the most relevant parameters for this area:

Month	GHI (kWh/m^2)	DHI (kWh/m^2)	T^a (ºC)
January	134.0	50.5	18.8
February	147.4	53.2	21.2
March	194.8	71.9	24.7
April	210.3	84.0	27.8
May	216.8	100.1	30.2
June	180.6	102.3	31.3
July	135.1	97.0	30.4
August	130.3	91.5	29.2
September	158.7	84.0	28.8
October	171.7	65.7	27.8
November	137.9	52.8	24.2
December	126.4	47.4	20.4
Year	1,944.0	900.4	26.3

Table 1. Irradiation data

The estimated yearly global irradiation is 1,944 kWh/m^2 and the diffuse irradiation is estimated at 900.4 kWh/m^2 (46%).

The irradiation values in this location are high, which makes the site quite optimal for the installation of a photovoltaic solar plant.

The maximum operating temperature obtained from the TMY with a GHI > 35 W/m^2 is 41.5 ºC. This temperature will be the design temperature.

The average temperature throughout the year is 26.3ºC, also high, which will impact on the performance of the main equipment and thus, the potential derating must be considered in the simulation.

4.3. LOCAL REGULATIONS

The PV plant in this project is primarily designed for self-consumption, so all the yield will be used to run the pumps and filtration equipment, together the ancillary systems. In case the production exceeds the internal demand, the possibility of selling this excess to the grid will be considered. The total capacity of this PV plant is 4.5 MW. According to the local regulations in Pakistan regarding the policy for the development of renewable energy (2006), a renewable power project designed for dedicated use, may sell the excess of energy to the grid through net billing (> 1 MW). The conditions are as follows:

- An RE power project of capacity greater than 1 MW set up for self (captive) or dedicated use may supply surplus electricity to the power utility (grid spill over), while at other times drawing electricity

from the utility to supplement its own production for local use, subject to the provisions in Section 8.2.2. In such cases, the **net electricity**:

- **supplied by the power producer** to the utility in a month (i.e., units supplied by the producer minus units received by the producer, if greater than zero), **shall be paid for by the utility** at a tariff equal to the average energy cost per kWh for oil-based power generation (as determined by NEPRA for GENCOs/IPPs over the applicable quarter of the year) less 10%, or
- **supplied by the utility** to the power producer in a month, (i.e., units received by the producer minus units supplied by the producer, if greater than zero), **shall be paid for by the producer** at the applicable retail tariff (e.g., industrial or commercial rates, depending upon the type of user connection). Such net purchase and sales—or net billing — arrangements will involve measurement of the electricity received and supplied to the utility by the power producer using two separate sets of unidirectional meters.

Section 8.2.2 Grid Connection, Off-take Voltage and Interface Electricity shall be purchased from RE power producers at a voltage of 220 kV at the outgoing bus bar of the power station if the power station is located within 70 km of an existing 220 kV transmission line, or at 132 kV if it is within 50 km of an existing 132 kV transmission line, or at 11 kV if it is within 5 km of an existing 11 kV transmission line, or at 400 V if it is within 1 km of a 400 V distribution feeder. The minimum average power to be supplied in each case would be 1,250 kW/km, 250 kW/km, 100 kW/km, and 20 kW/km, respectively. The producer may also undertake to lay a new transmission line for connection with the main electricity grid. The power purchase tariff determination will be adjusted accordingly for each of these options.

4.4. POWER DEMAND AND CONSUMPTION PROFILES

The information provided by KWSB on power and consumption of the complex is illustrated in the following table. It shows an estimate of the power demand of the facilities based on their existing capacity:

Power Demand	
Water Pumping Station	~ 3,000 kW
Water Filtration Plant	~ 700 kW
Ancillary equipment	~ 800 kW

Table 2. Estimated power demand

The provided information also considers that demand remains 24/7 and, then a total and constant power demand of 4.5 MW could be considered as base load for the complex.

Considering these data, the energy demand throughout the year will be around 39,500 MWh.

5. PROPOSED SOLUTION

5.1. SITE PROPOSAL

The site of this PV plant has been proposed considering the location of the facilities and main points of consumption as well as the residential and industrial buildings in the area. Furthermore, the selected area is located at the highest point of the complex to be free of shadows.

The geographical coordinates of the PV site are:

Coordinates	
Latitude (º)	25 (N)
Longitude (º)	67.03 (E)
Altitude (m)	110 m

Table 3. Coordinates

This PV plant is proposed to be on an empty area at the East of the Hub Water Filtration Plant, still, within the area owned by the KWSB. The proximity to a high energy consumption point also facilitates the interconnection of the PV plant and avoids distribution losses.

The distance to the pump station at the North is around 3 km and can be interconnected with a 11 kV line (either overhead or buried) with reasonable losses.

Furthermore, the water filtration plant seems to be protected by a perimeter fence and a security house at the main entrance. The proximity to these facilities provides some additional physical security to the PV site.

The area shows no social or environmental issues, and it is far enough from any residential area.

The geotechnical survey that has been carried out in October 2020 evaluates moisture content, density, strength, and chemical characteristics. The obtention of these features has been based on the straight rotary drilling of sixteen boreholes which range from 5 to 15 meters depth. The location of two of these boreholes is within the proposed location and can be seen in the following figure:

Figure 7. Location of boreholes (Geotechnical Survey)

The results show that the site is mainly composed of clay and limestone. The rocks that have been found in most of the boreholes are mainly sandstones, siltstone, mudstone, and shale. Moreover, compactness is classified as medium dense/ dense material and the soil consistency is medium. Finally, the chemical aggressivity of the site is very low.

According to this report also, the site's probability of earthquakes is low. The area is classified as Zone 2B according to the Building Code of Pakistan, meaning the intensity of earthquakes would range between V and VI (MMI scale). The seismicity of the area can be seen in the following figure:

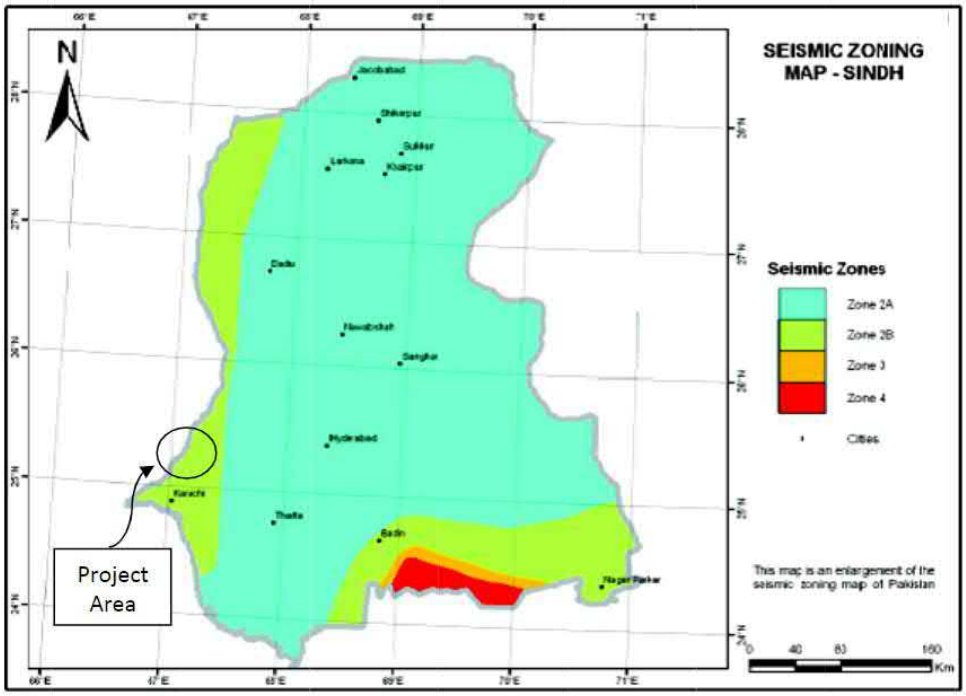


Figure 8. Seismicity of the area (Geotechnical survey)

The proposed are has not been specifically surveyed. According to the available satellite public information, the orography of the site presents very slight slopes and low cliffs; therefore, the proposed equipment will be suitable to be deployed on site.

This survey also suggests that the civil works for the construction of the PV generator will be executed without real issues. Due to the existence of rocks found in the samples examined, pre-drilling works might be necessary. This finding does not rise any serious concern on the feasibility of the plant and the variation of overall CAPEX is very limited.

All these features make this site suitable for a PV plant. The figure below shows the proposed location within the white polygon, considered to be big enough for the construction of the proposed solution:

Figure 9. Site proposal

The PV plant covers an approximated area of 11.80 ha, enclosed by a perimeter fence that includes the PV panels, inverters, power transformers, roads and all the related electrical equipment necessary for the correct operation of the power generator.

5.2. TECHNICAL PROPOSAL

Taking into account the initial information provided by KWSB (See POWER DEMAND AND CONSUMPTION PROFILES), the Consultant has decided to initially consider a PV plant with a capacity in the range of 4-5 MW to match with the maximum expected power demand. The final capacity available for consumption is 4.5 MVA, due to the different losses of the generator (See ESTIMATION OF YIELD).

Hence, the operators of the Water Plant should maximize the operation of the facilities at daylight time, when the highest yield from the PV plant is expected.

In order to compensate the operating losses, the total capacity of the PV generator was proposed to have peak capacity of 6.03 MWp (DC/AC ratio of 1.34). This is a relatively high DC/AC ratio. However, the goal is to reassure that the plant covers the maximum demand at any moment. Furthermore, if sometime, the yield of the PV plant excesses the demand, the interconnection design must be designed to evacuate this surplus to the distribution grid.

It comprises a total of 11,600 bifacial modules with a maximum power of 520 Wp. The panels will transform the energy from the sun in DC electric power.

The reason for selecting bifacial modules is the high albedo level the ground shows in the meteorological data. During the last years, the capacity of modules is steadily increasing, allowing better performance in the same available land. The capacity selected allows for a maximization of energy production in a smaller area, but similar PV modules could be used. The current range for the capacity of modules varies from 350 to 550 Wp approximately.

The proposed solution considers that modules will be installed on fixed structures with a 2V29 configuration. This type of structure requires less surface, lower CAPEX and the maintenance is simple. On the other hand, the energy production is lower compared to the tracking systems. For the scope of this generator, a fixed structure is considered more adequate, but a tracking system could also be used. This configuration means that each structure will have 58 modules (29 series wiring and 2 strings wiring parallel).

These structures have a tilt of 20º and a distance between axis of 12m. The inclination angle has been calculated based on the latitude of the location to maximize the annual production. The distance between axis or pitch ensures that the shadows between rows of structures will not be limited.

The proposed inverter is a string inverter since it requires less maintenance than central inverters. In any case, the string or central inverter solution do not significatively impact on the yield and occupation ratio. This project has a total of 20 inverters that transform the energy in DC to energy in AC.

The PV plant comprises a total of 2 blocks. Each one is formed by 10 inverters of 225 kVA (40ºC) and a power station of 2,500 kVA (40ºC), that will raise the output current from the inverters to 11 kV.

To make the interconnection to feed the rest of facilities, the output of the PV plant will be connected to the 11 kV substation located North, at the Water Pumping Station, where the energy meter is installed. The connection could be easily made through a 11kV line of about 3 km long from the switching centre al the PV plant, beside the water filtration plant. Since the voltage level is considered as medium voltage and the

length is relatively short, this interconnection might be underground, through trenches of about 1 meter width and 1 meter deep without any special requirements.

Considering the single line diagrams described in the section BACKGROUND, a partial refurbishment of the electrical facilities at the K-substation will be needed to cope with the new feeder for the energy from the solar plant. The installation of control devices for interfacing with the internal and external distribution grid will be needed as well. According to LOCAL REGULATIONS, two separate sets of unidirectional meters will be installed in order to measure the power supplied by the utility to the grid and the power received from the grid.

The construction of a brand-new K-E electrical room will clearly facilitate to arrange the new pieces of equipment. This substation should remain located in the vicinity of the interconnection to the external grid (since it will remain as main power supplier) and the major consumer (pumps). The available area at the North of the complex facility seems to be the most suitable location. Only 1 to 2 acres is more than enough surface for this room.

The following table presents the main data of the proposed PV plant:

PV Plant		
Location	Karachi, Pakistan	
Installed Power (MWp)	6.03	
Inverter Output (MVA)	4.50	
Ratio DC/AC	1.34	
Fenced area (ha)	11.80	
PV Modules	Nominal Power (Wp)	520
	Nº of modules	11,600
Inverters	Technology	String
	Nominal Power (kVA) (40ª)	225
	Nº of inverters	20
Structures	Technology	Fixed
	Pitch (Axis-to-axis distance) (m)	12
	Tilt (º)	20
	Modules configuration	2V29
	Nº of structures	200

Table 4. General characteristics

The configuration for this solution has been designed with the software AutoCAD to provide an idea of the implementation of the PV generator on the proposed site. The layout can be seen in the Appendixes. The following figure illustrates an estimated distribution of the proposed solution:

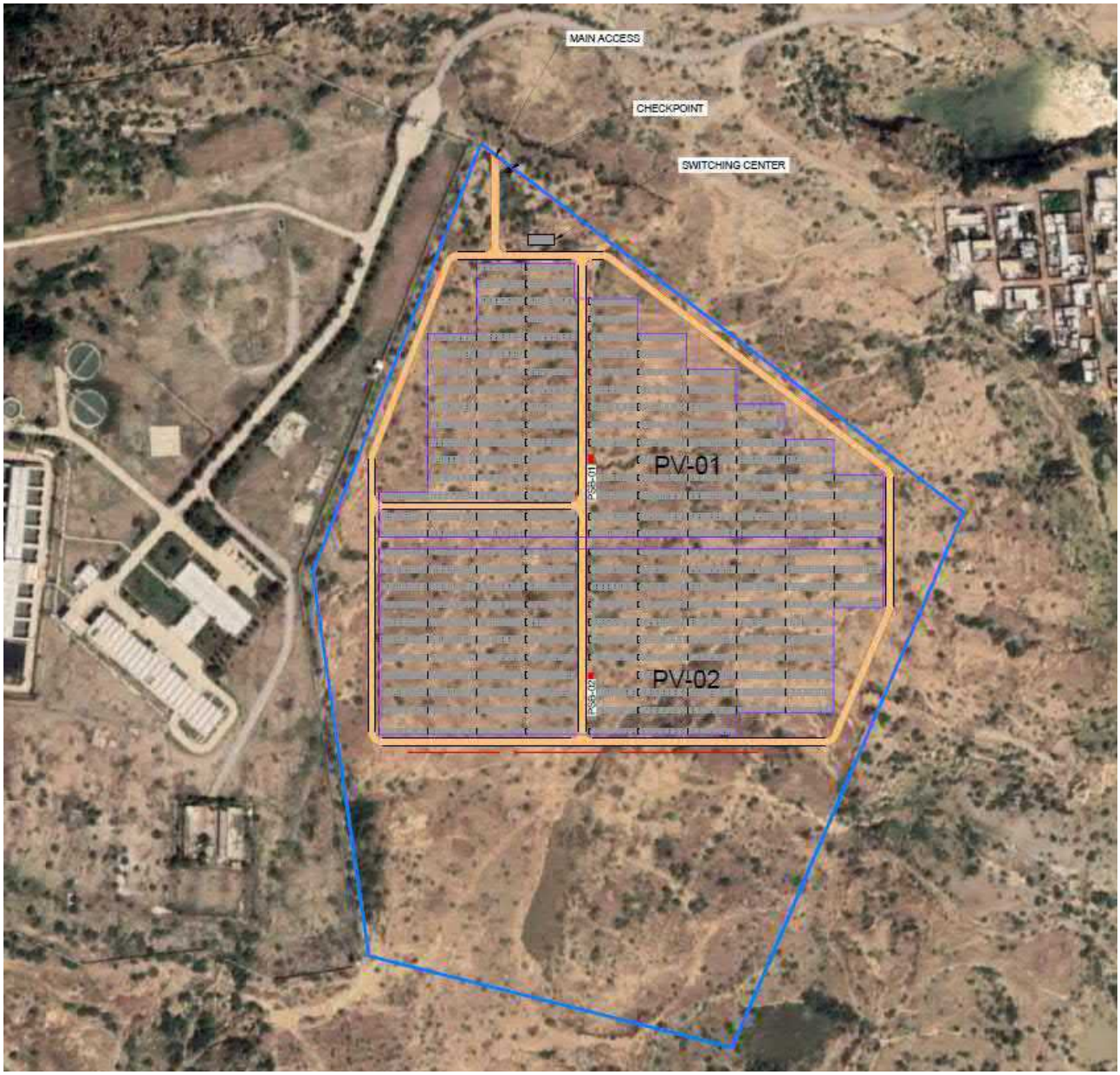
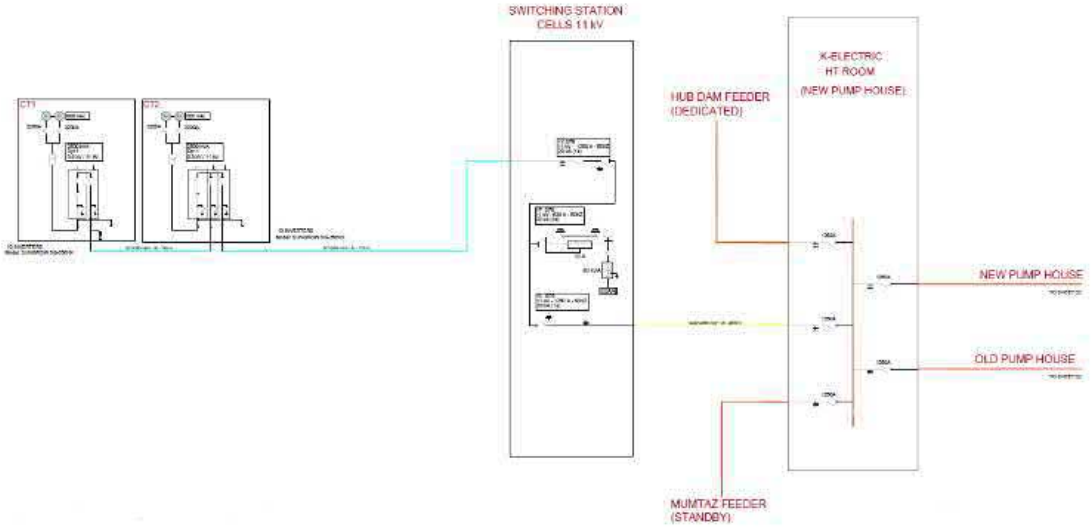


Figure 10. PV plant distribution

The main access is located at the North corner, close to the main access to the filtration plant.

The interconnection of the PV plant to the K-Electric room has also been designed with AutoCAD. It can be seen in the Appendixes.

The following figure illustrates the single line diagram:



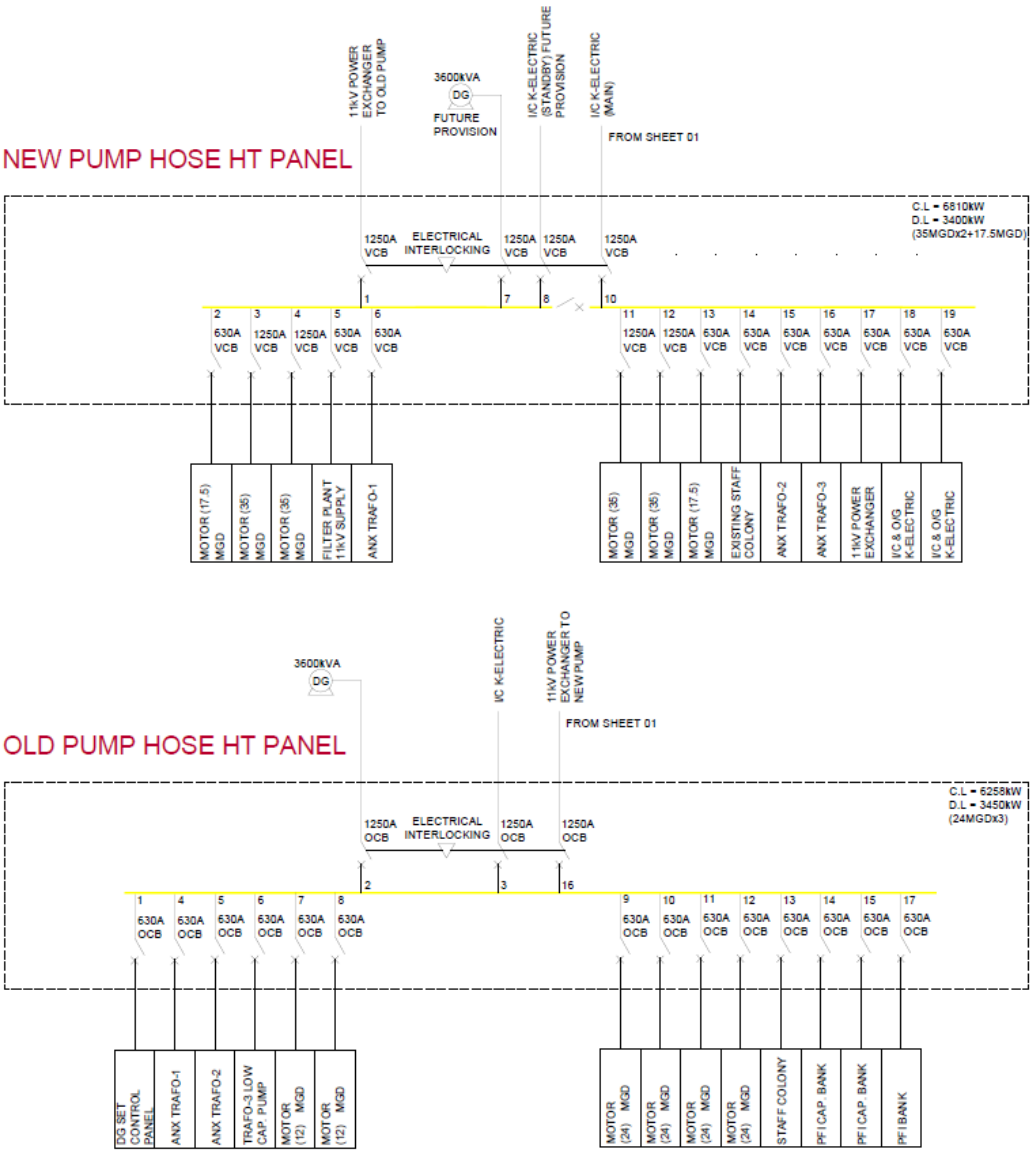


Figure 11. Single line diagram PV Plant

6. ESTIMATION OF YIELD

The yield has been estimated with a reputed software PVSyst, in the latest version (7.0.12). The results shown have been calculated for the first year of operation:

Results 1st year of operation (P50)	
Energy produced (MWh)	10,324
Specific production (kWh/kWp)	1,712
Performance Ratio (%)	80.68

Table 5. Estimated energetic production

The simulation has been carried out based on the information of the selected equipment (modules, inverters, structures) provided by the manufacturer and the characteristics of the PV plant (location, capacity, meteorological conditions). Other brands and models could be selected but the main figures would remain.

When running the simulation, several losses need to be considered to have a better approximation of the real yield of the PV plant. For this project, the following losses have been considered:

- Irradiation energy losses:
  - Far shadings: 0.08%. It refers to the horizon. This information is provided directly by PVSyst.
  - Near shadings: 0.70%. It represents the shaded fraction of the PV field with respect to the full sensitive area. It is calculated by PVSyst.
  - IAM factor on global: 1.50%. The incidence effect is defined by the software.
  - Soiling loss factor: 3.50%. An average loss is 2%. However, considering the conditions of the site, this loss has been considered higher.
- Electrical energy losses:
  - Module degradation loss: 0.27%. Every module suffers a degradation. A default value of 0.4% has been selected.
  - PV loss due to irradiance level: 0.41%. Since the module efficiency is given at standard conditions, it needs to be adjusted for lower irradiation levels.
  - PV loss due to temperature: 7.48%. It calculates the temperature of the cells and simulates this loss. Due to the high temperatures of the site, this value is within an acceptable range.
  - LID (Light Induced Degradation): 1.50%. It is related to the quality of wafer manufacture.
  - Mismatch loss, modules and stings: 0.54%. are related to the fact that the real modules in the array do not present the same I/V characteristics. The selected power loss for modules was 0.5% and 0.1% for strings (default value).

- Ohmic wiring loss: 0.36%. The ohmic resistance produces energy losses. Since the configuration is string inverter, this value is within range. The loss fraction considered for the simulation was 0.5%.
- Inverter loss during operation (efficiency): 1.31%. This loss results from the energy conversion from DC to AC.
- Inverter loss over nominal inverter power: 0.11%. This loss comes from the power limitation at inverter level. It will decrease every year due to the degradation of modules.
- AC Ohmic loss: 0.96%. It covers the losses from the inverter to the transformer. The value is within range considering that the configuration is string inverter. The loss fraction considered for the simulation was 1.7%.
- Medium voltage transformer loss: 0.95%. This loss is calculated based on default values.
- MV line ohmic loss: 0.21%. The loss fraction considered for the simulation was 0.48%.
- System unavailability: 1.75%. It is established as a fraction of time of 2% in the simulation. The system considers this and calculates the energy loss provoked by these failure hours. The periods of unavailability are created randomly.

The following figure shows a typical daily production of the PV plant at inverter level. The inverter will limit the power output when the available power from the DC field is greater than the inverter's input power. This limitation is called clipping, and it is likely to happen during the first years of operation. This effect can be seen in the figure:

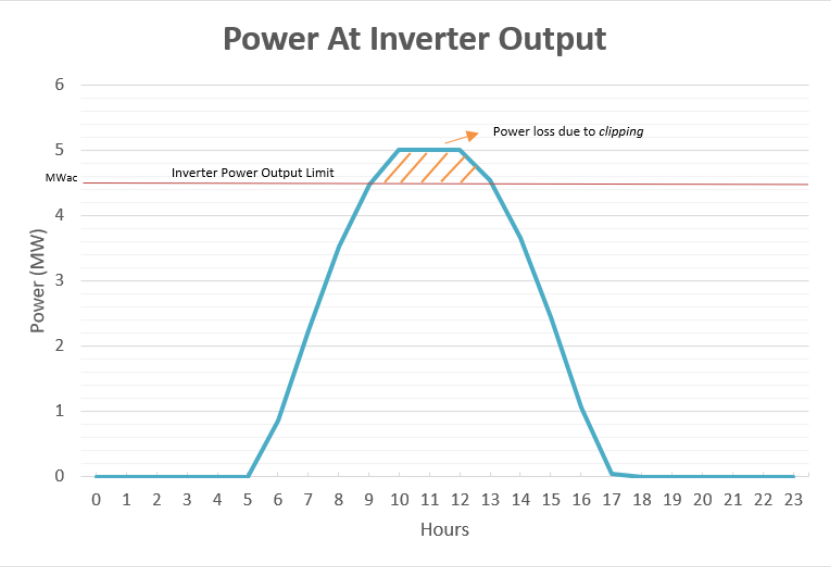


Figure 12. Estimated daily production profile

Furthermore, in the event that the PV plant produces more that the internal consumption of the complex, the interconnection will be designed to inject that excess to the distribution grid in net-metering scheme.

The table below show the estimated monthly production. As expected, the greatest energy productions occur in March and April (dry season) with a sharp drop in production during July and August (rainy season).

Estimated monthly production (MWh)	
January	876
February	889
March	1,064
April	1,051
May	1,017
June	834
July	636
August	632
September	757
October	949
November	835
December	783

Table 6. Estimated monthly production profile

According to the results obtained in the simulation, the energy produced during the year will be approximately 10,324 MWh. Comparing this result to the consumption profile of the facilities (see POWER DEMAND AND CONSUMPTION PROFILES) which estimates an annual consumption of 39,500 MWh, the PV plant will cover around 26% of the energy demand in the Hub Dam water treatment plant throughout the year.

7. IMPLEMENTATION SCHEDULE

The implementation of the solar PV plant is estimated in approximately 8 months. The following figure shows the time estimation for the different stages of the construction of the PV plant:

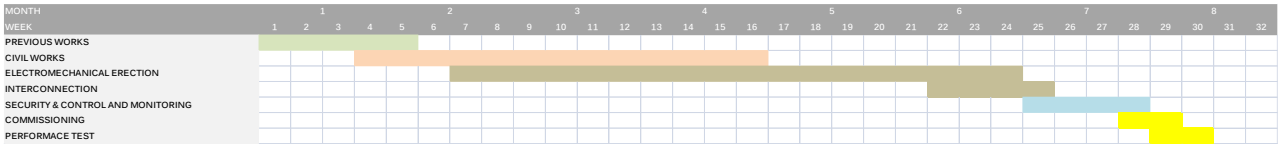


Table 7. Solar PV plant schedule

8. ECONOMIC ASSESSMENT

8.1. CAPEX

Prices in PV plants are ruled in a large extent by the price of their main components (modules, inverters, structures, MV switchyard) in the international markets. Civil works and electromechanical erection are around 15% of the total costs.

With the limited information of the proposed site, this Consultant has not identified any particular issue either civil or electromechanical that could significatively increase the international price of PV plants that are in the range of 600KUSD to 700KUSD per MWp in medium size installations.

According to NEPRA, the assumed figure of CAPEX in 2016 for solar photovoltaic projects in Pakistan between 1 MW and 20 MW was 1,185,846 $/MWp. However, in recent years the prices for PV projects throughout the world have steadily decreased. According to IRENA, the average total installed costs for solar photovoltaic projects has declined an average of around 14%/year in the period between 2014 and 2018. Considering this evolution and the forecasted reduction of costs in this technology, the value obtained from NEPRA has been adjusted with a reduction of 45% on the above prices, to reach an estimated cost of 652,239.86$/MWp.

This figure is supported by the latest CAPEX figures for Utility scale solar PV plants between 30 and 100 MWp that NEPRA has published in 2020. This value is around 591.500$/MWp. Considering that the scale of this project is smaller, the figure established for the CAPEX is adequate.

The CAPEX considers a PV plant of 6.03 MWp and has been broken down in 10 main items that cover all the features necessary for the construction of the PV plant. These items include the supply of equipment as well as the necessary works for the assembly and installation of the facility. The budget can be seen in the following table:

GENERAL BUDGET		
ITEM	COST	PERCENTAGE
Civil works	$167,152.77	4.25%
PV modules	$1,396,217.27	35.50%
Fixed structures	$1,337,222.17	34.00%
Inverters and power stations	$432,630.70	11.00%
Low voltage electrical installation	$294,975.48	7.50%
Medium voltage electrical installation	$196,650.32	5.00%
Control centre and storage	$1,966.50	0.05%
Control and monitorization	$9,832.52	0.25%
Project Management	$17,698.53	0.45%
Interconnection	$78,660.13	2.00%
TOTAL BUDGET	$3,933,006.39	100%

Table 8. Budget of the project

8.2. OPEX

NEPRA also considers an estimation of operational costs. In 2016, the estimated component for OPEX was 26,541 $/MW. Since the nominal capacity of the plant is 4.5 MW, an initial estimation is 160,042.23 $/ year.

This is a reasonable OPEX for a PV plant of medium size without associated costs for land.

However, this general figure can be adjusted considering that the PV plant is located within the water treatment complex, near the filtration plant. Thus, the same operation team could also maintain the PV plant, particularly for any electromechanical operation.

A more realistic OPEX should then, considers only very specific operations and materials for PV plants like regular module cleaning, maintenance contract for inverters, replacement of the spare parts, etc.

Considering these facts and based on projects with a similar scope, an annual OPEX in the range of $120,031 could be used for financial assessment.

9. CONCLUSIONS

The preliminary design presents an optimal solution to cover part of the energy demand at the Hub Water Supply System. The location of the project is on the outskirts of Karachi metropolitan area in the hilly zone of Hub near Manghopir in Gadap Town, Karachi.

Based on the information provided by the Karachi Water & Sewage Board (KWSB), that includes information related to the energy requirements of the facilities as well as information of the local conditions, a PV plant has been fully designed. It includes an optimal location, technical characteristics, and an estimation of the yield. An economic assessment has been carried out to estimate the costs of this implementation. The values show that the proposed solution is a viable project that could lead to important savings in the energy fee for the KWSB.

The solar photovoltaic plant presented in this report, has several features that show it as an optimal solution for the client's requests:

- The construction of a PV plant within the area within KGSB's ownership is considered to be feasible.
- The solar resource in the location selected is good for a PV plant. The irradiation levels are high, maximizing the production of the PV generator.
- Based on the provided information, no constraint for the implementation of a PV plant on main aspects like topography, geotechnical or hydrology features has been observed.
- The electrical interconnection and power supply to the facilities at the water plant can be simply made through the existing K-E room, either by some modification to add the feeders to connect from the PV plant or through the construction of a new K-E room. Either option is technically feasible with no complicated requirements.
- The consumption of the facilities is considered to remain constant 24/7 at the nominal level of approximately 4.5 MWac, which means that, under normal operating conditions, all the energy produced by the PV plant will be automatically self-consumed by the water plant. Under this operation scheme, the PV plant will cover around 26% of the total energy demanded by the water plant. The contribution of the PV plant will be during the daylight periods, particularly at noon.
- The current local regulations support and encourage this type of self-consumption facilities, improving the viability of this kind of facilities. No large excess in energy is expected due to the operating scheme of the water plant. In any case, exportation of the excess with a net billing scheme is considered. As the size of the PV generator is above 1 MW, the net billing scheme allows bidirectional energy flows, from and into the electrical network.
- The current tariff fee for the energy consumed in the facilities is 8 c$/kWh. The approximated figure of LCOE for this power generator, based on the PVSyst simulation and the current costs for similar generators, is around 2.85 c$/kWh. Therefore, the installation of a PV plant in Karachi with this configuration also shows an attractive economical feasibility.

Part II. Appendixes

1. PVSyst REPORT

Version 7.1.7

PVsyst - Simulation report

Grid-Connected System

Project: Karachi

Variant: 4,5 MW

Sheds, single array

System power: 6032 kWp

Karachi - Pakistan

Author

Tecnica y Proyectos SA (Spain)

Project: Karachi

Variant: 4,5 MW

Tecnica y Proyectos SA (Spain)

Project summary

Geographical Site
Karachi
Pakistan

Situation

Latitude	25.00 °N
Longitude	67.03 °E
Altitude	110 m
Time zone	UTC+4

Project settings

Albedo	0.20

Meteo data
Karachi
SolarGIS Monthly aver. , period not spec. - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Sheds, single array

PV Field Orientation
Fixed plane
Tilt/Azimuth 20 / 0 °

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	11600 units
Pnom total	6032 kWp

Inverters

Nb. of units	20 units
Pnom total	4500 kWac
Pnom ratio	1.340

Results summary

Produced Energy	10324 MWh/year	Specific production	1712 kWh/kWp/year	Perf. Ratio PR	80.68 %

Table of contents

Project and results summary 2
General parameters, PV Array Characteristics, System losses 3
Horizon definition 6
Near shading definition - Iso-shadings diagram 7
Main results 8
Loss diagram 9
Special graphs 10
CO_2 Emission Balance 11

General parameters

Grid-Connected System

Sheds, single array

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	20 / 0 °

Sheds configuration		
Nb. of sheds	20	units
Single array		
Sizes		
Sheds spacing	12.0	m
Collector width	4.53	m
Ground Cov. Ratio (GCR)	37.8	%
Top inactive band	0.02	m
Bottom inactive band	0.02	m
Shading limit angle		
Limit profile angle	11.4	°

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon

Average Height	0.8 °

Near Shadings

Linear shadings

User's needs

Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Longi Solar
Model	LR5-72 HBD 520 M Bifacial
(Original PVsyst database)	
Unit Nom. Power	520 Wp
Number of PV modules	11600 units
Nominal (STC)	6032 kWp
Modules	400 Strings x 29 In series
At operating cond. (50°C)	
Pmpp	5514 kWp
U mpp	1066 V
I mpp	5172 A

Inverter

Manufacturer	Sungrow
Model	SG250HX_karachi
(Custom parameters definition)	
Unit Nom. Power	225 kWac
Number of inverters	20 units
Total power	4500 kWac
Operating voltage	600-1500 V
Max. power (=>30°C)	250 kWac
Pnom ratio (DC:AC)	1.34

Total PV power

Nominal (STC)	6032 kWp
Total	11600 modules
Module area	29650 m²
Cell area	26893 m²

Total inverter power

Total power	4500 kWac
Nb. of inverters	20 units
Pnom ratio	1.34

Array losses

Array Soiling Losses

Loss Fraction	3.5 %

Thermal Loss factor

Module temperature according to irradiance	
Uc (const)	29.0 W/m²K
Uv (wind)	0.0 W/m²K/m/s

DC wiring losses

Global array res.	1.1 mΩ
Loss Fraction	0.5 % at STC

LID - Light Induced Degradation

Loss Fraction	1.5 %

Module Quality Loss

Loss Fraction	-0.4 %

Module mismatch losses

Loss Fraction	0.5 % at MPP

Strings Mismatch loss

Loss Fraction	0.1 %

Module average degradation

Year no	1
Loss factor	0.5 %/year
Mismatch due to degradation	
Imp RMS dispersion	0.4 %/year
Vmp RMS dispersion	0.4 %/year

PVsyst V7.1.7
VC4, Simulation date:
22/03/21 15:24
with v7.1.7

Array losses

IAM loss factor

Incidence effect (IAM): User defined profile

0°	25°	45°	60°	65°	70°	75°	80°	90°
1.000	1.000	0.995	0.962	0.936	0.903	0.851	0.754	0.000

PVsyst V7.1.7
VC4, Simulation date:
22/03/21 15:24
with v7.1.7

System losses

Unavailability of the system

Time fraction	2.0 %
	7.3 days,
	3 periods

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	1.7 % at STC

Inverter: SG250HX_karachi

Wire section (20 Inv.)	Copper 20 x 3 x 150 mm²
Average wires length	285 m

MV line up to Injection

MV Voltage	11 kV
Wires	Copper 3 x 300 mm²
Length	1150 m
Loss Fraction	0.4 % at STC

AC losses in transformers

MV transfo

Grid Voltage	11 kV

Operating losses at STC

Nominal power at STC (PNomac)	5948 kVA
Iron loss (24/24 Connexion)	5.95 kW
Loss Fraction	0.1 % at STC
Coils equivalent resistance	3 x 0.86 mΩ
Loss Fraction	0.8 % at STC

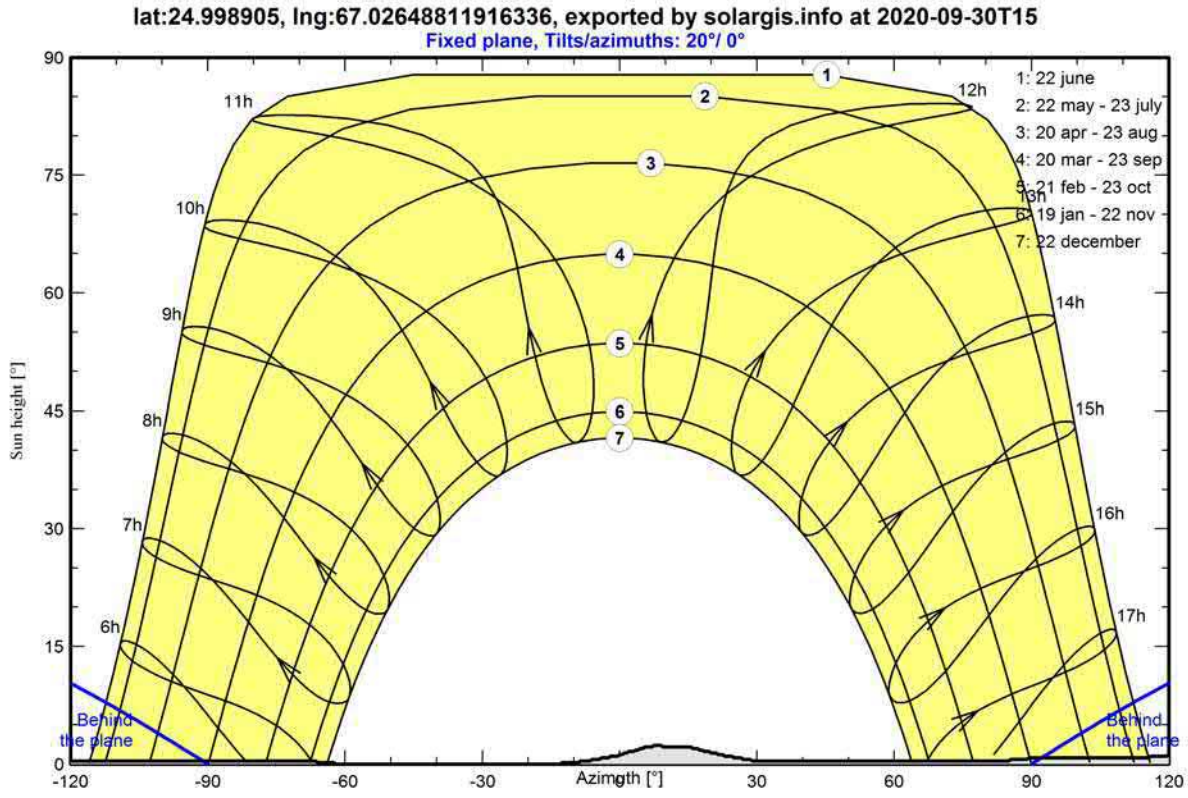
Horizon definition

Average Height	0.8 °	Albedo Factor	0.97
Diffuse Factor	1.00	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-177	-169	-165	-157	-145	-141	-133	-129	-120	-109	-105	-97	-93	-85
Height [°]	1.6	1.2	1.2	1.2	0.8	0.8	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Azimuth [°]	-73	-69	-61	-57	-49	-37	-33	-25	-21	-13	-9	-1	-1	0
Height [°]	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.2
Azimuth [°]	1	7	11	19	23	31	35	43	47	55	59	67	71	83
Height [°]	1.4	2.2	2.2	1.6	1.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Azimuth [°]	91	95	103	107	119	127	131	139	143	155	163	167	175	179
Height [°]	0.8	0.8	0.8	0.8	1.0	1.4	1.4	1.4	1.6	1.8	1.8	1.8	1.8	1.8

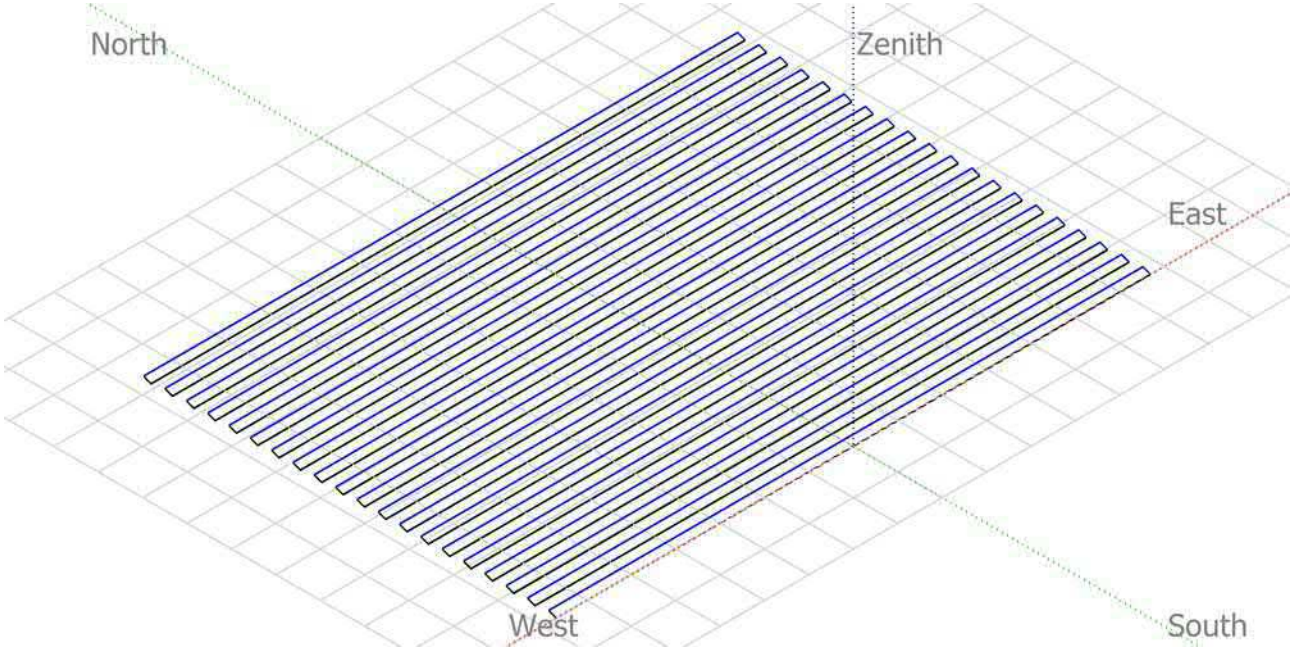
Sun Paths (Height / Azimuth diagram)



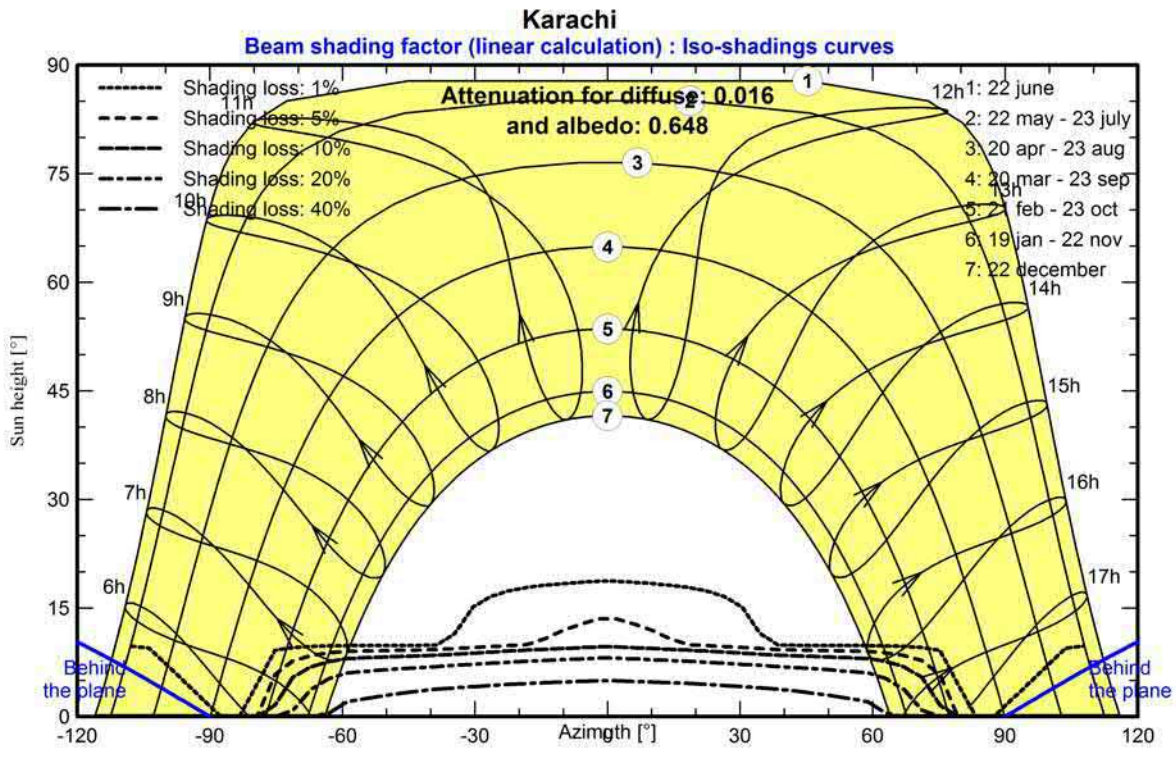
PVsyst V7.1.7
VC4, Simulation date:
22/03/21 15:24
with v7.1.7

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



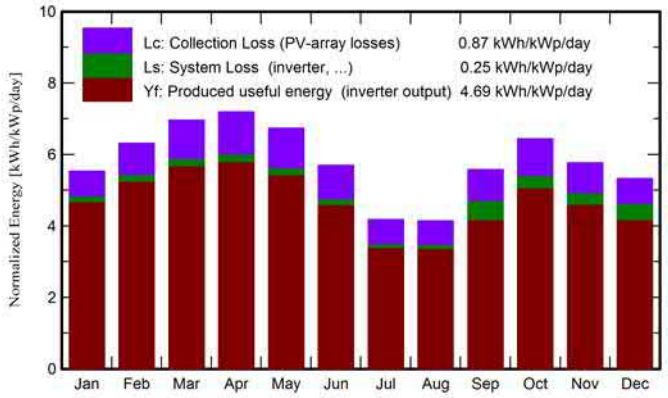
PVsyst V7.1.7
VC4, Simulation date:
22/03/21 15:24
with v7.1.7

Main results

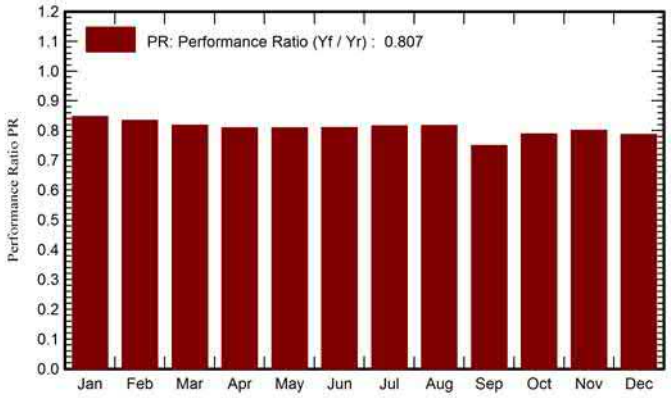
System Production

Produced Energy	10324 MWh/year	Specific production	1712 kWh/kWp/year
		Performance Ratio PR	80.68 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

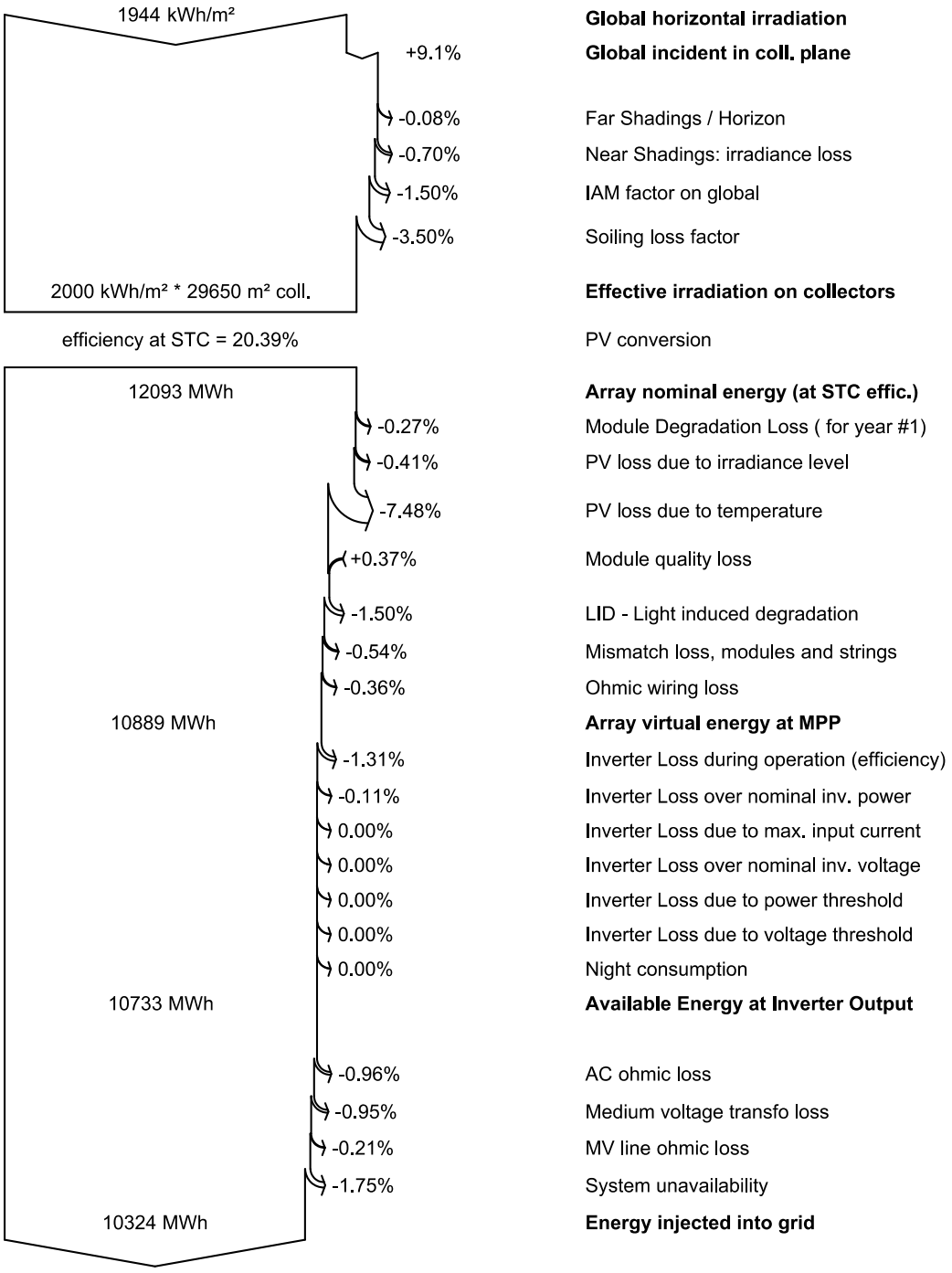
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	134.0	50.5	18.80	171.5	162.2	907	876	0.847
February	147.4	53.2	21.20	176.8	167.5	921	889	0.833
March	194.8	71.9	24.70	215.6	203.9	1103	1064	0.818
April	210.3	84.0	27.80	215.6	203.7	1090	1051	0.808
May	216.8	100.1	30.20	208.6	196.2	1053	1017	0.809
June	180.6	102.3	31.30	170.6	160.2	863	834	0.811
July	135.1	97.0	30.40	129.3	120.8	657	636	0.815
August	130.3	91.5	29.20	128.4	120.0	654	632	0.816
September	158.7	84.0	28.80	167.4	157.5	855	757	0.750
October	171.7	65.7	27.80	199.5	188.8	1013	949	0.788
November	137.9	52.8	24.20	173.0	163.6	894	835	0.801
December	126.4	47.4	20.39	165.1	156.2	868	783	0.786
Year	1944.0	900.4	26.25	2121.4	2000.5	10876	10324	0.807

Legends

GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse irradiation
T_Amb	Ambient Temperature
GlobInc	Global incident in coll. plane
GlobEff	Effective Global, corr. for IAM and shadings
EArray	Effective energy at the output of the array
E_Grid	Energy injected into grid
PR	Performance Ratio

PVsyst V7.1.7
VC4, Simulation date:
22/03/21 15:24
with v7.1.7

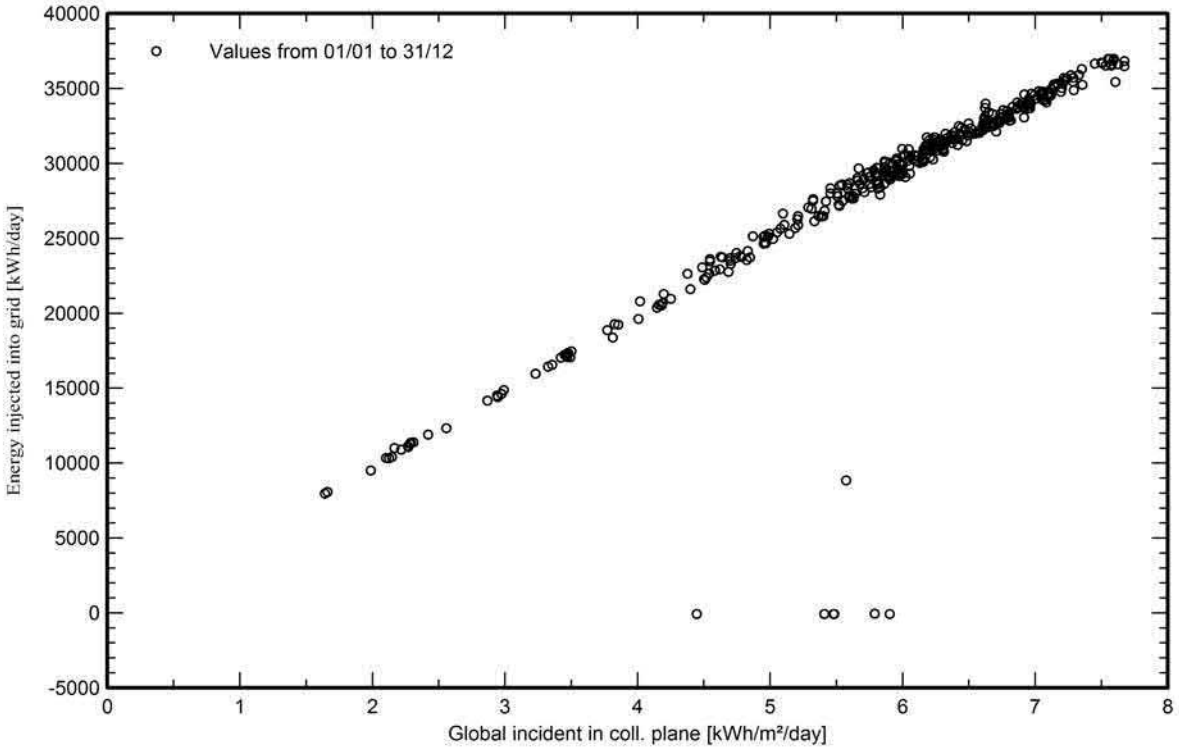
Loss diagram



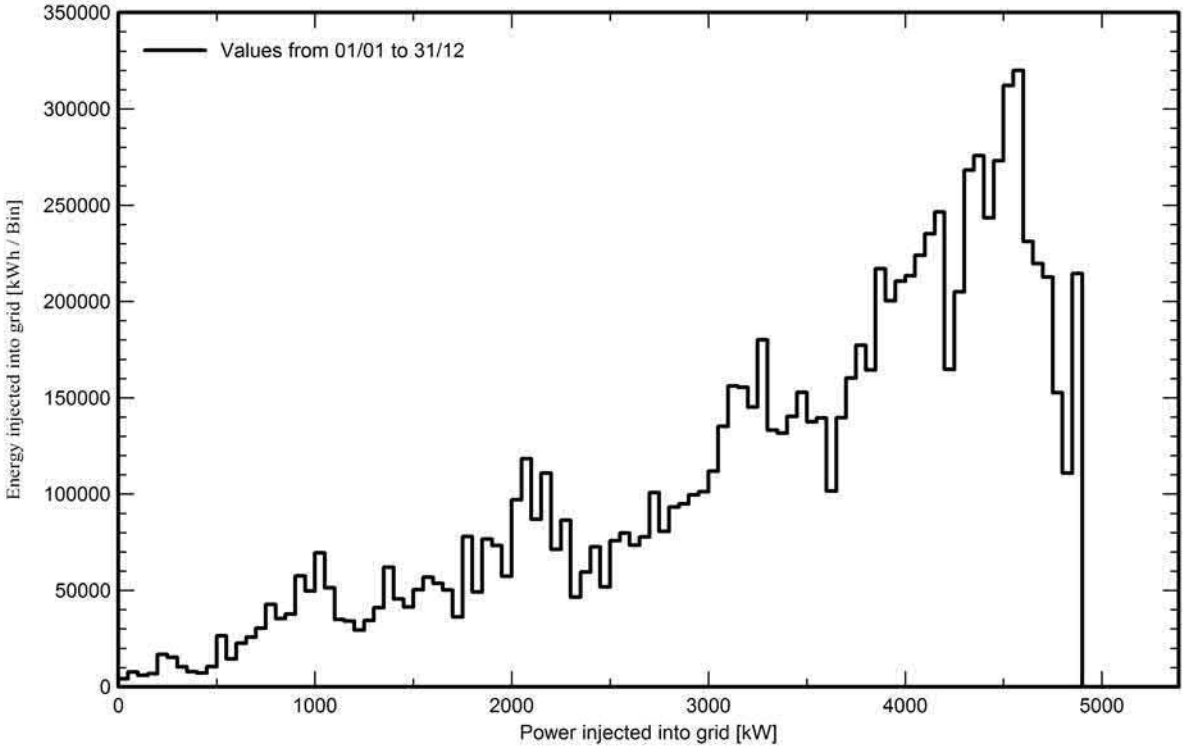
PVsyst V7.1.7
VC4, Simulation date:
22/03/21 15:24
with v7.1.7

Special graphs

Daily Input/Output diagram



System Output Power Distribution



PVsyst V7.1.7
VC4, Simulation date:
22/03/21 15:24
with v7.1.7

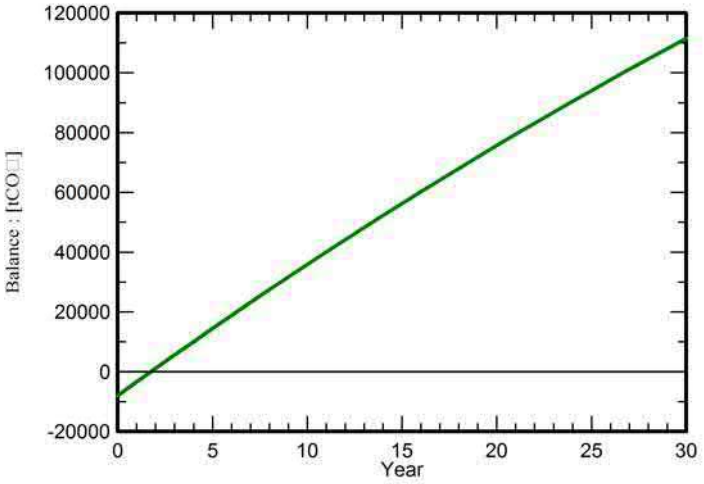
CO_2 Emission Balance

Total: 111573.8 tCO_2

Generated emissions
Total: 8012.16 tCO_2
Source: Detailed calculation from table below:

Replaced Emissions
Total: 137824.9 tCO_2
System production: 10323.96 MWh/yr
Grid Lifecycle Emissions: 445 gCO_2/kWh
Source: IEA List
Country: Pakistan
Lifetime: 30 years
Annual degradation: 1.0 %

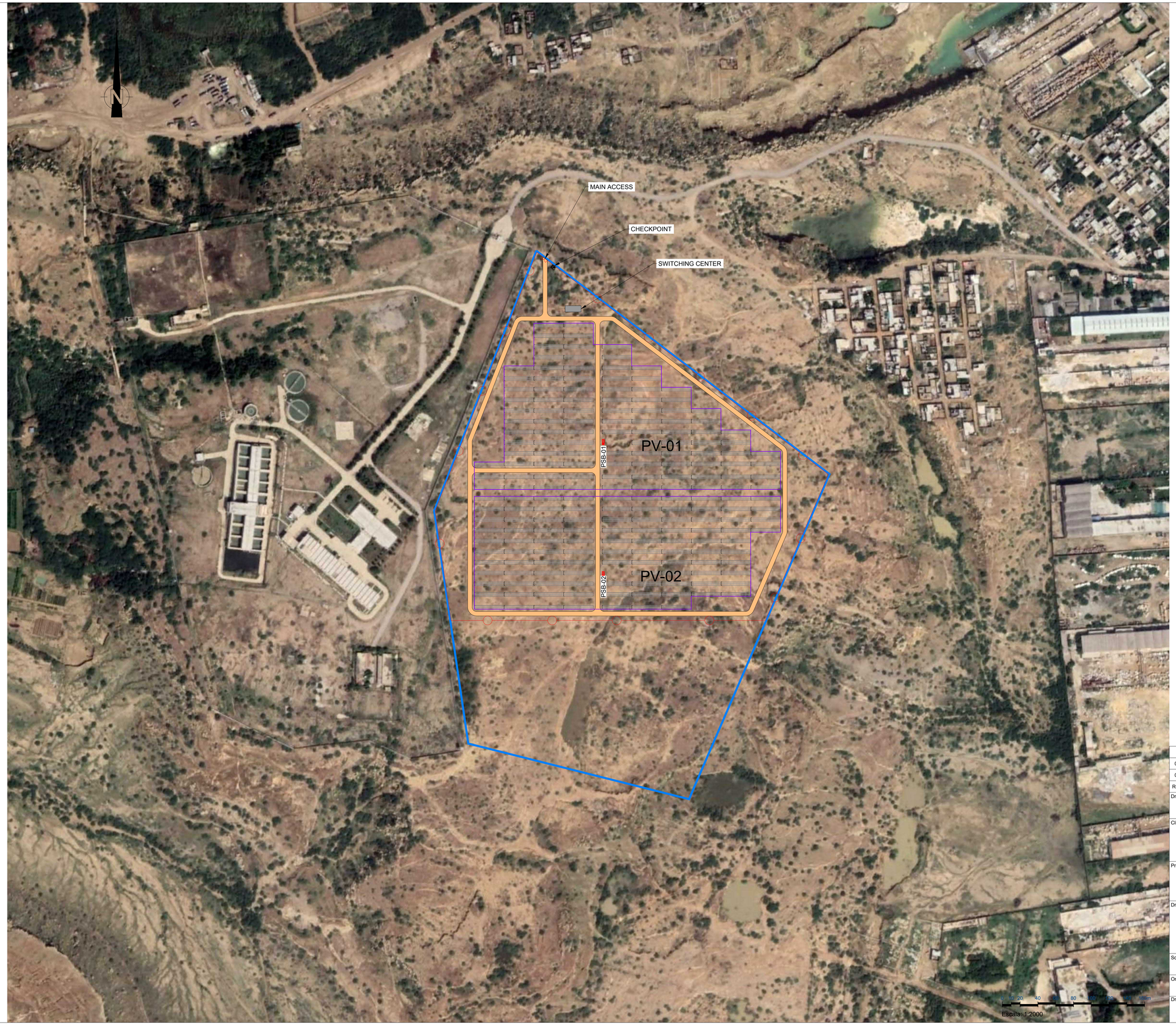
Saved CO_2 Emission vs. Time



System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[$kgCO_2$]
Modules	1713 kgCO2/kWp	4524 kWp	7748345
Supports	2.97 kgCO2/kg	87000 kg	258229
Inverters	294 kgCO2/	19.0	5587

2. LAYOUT AND SINGLE-LINE DIAGRAM



PROJECT DATA

Total Peak Power:	6.03 MWp
Total Nominal AC Power:	4.50 MW @40º COS PHI=1
Ratio DC/AC:	1.34
PV Module:	LONGI LR5-72HBD-520M 520W
Technology:	BIFACIAL
No. of modules:	11600
No. of modules per string:	29
No. total of strings:	400
Structure type:	FIXED, 2V29, Tilt 20º
Number of structures:	272
Orientation:	South 0º Azimuth
Pitch:	12.0 m
Inverter type:	SUNGROW SG250HX
Inverter rating:	225.00 kW (40ºC cos PHI =1)
Number total of inverters:	20
Number of Power Blocks:	2 (2xBlock 1)
Block 1:	
AC power:	3,016.00 kW (40ºC cos PHI =1)
Peak Power:	4,100.00 kWp
Number of Inverters:	10
No. of modules:	5800
No. of strings:	200
Fence length:	1,380 m
Fenced area:	11.83 ha
Length of internal roads:	1,731 m

LEGEND

- PLOT LIMIT
- PERIMETER FENCE
- ACCESS DOOR
- WIDTH PATH 5 m
- FIXED STRUCTURE 2V 29
- POWER STATION BUILDING
- BLOCK 1 OF 136 STRUCTURES (2)

Rev.	Date	Designed	Drawn	Checked	Approved	Description
01	MAR-2021	LRT	JMN	LRT	LRT	SECOND DESIGN
00	OCT-2020	LRT	EJGM	LRT	LRT	FIRST ISSUE

Drawing Status:

Client: IFC International Finance Corporation — Creating Markets, Creating Opportunities

Engineering: TYPSA INGENIEROS CONSULTORES Y ARQUITECTOS

Project:

SOLAR PHOTOVOLTAIC PLANT KARACHI (PAKISTAN)

Drawing Title:

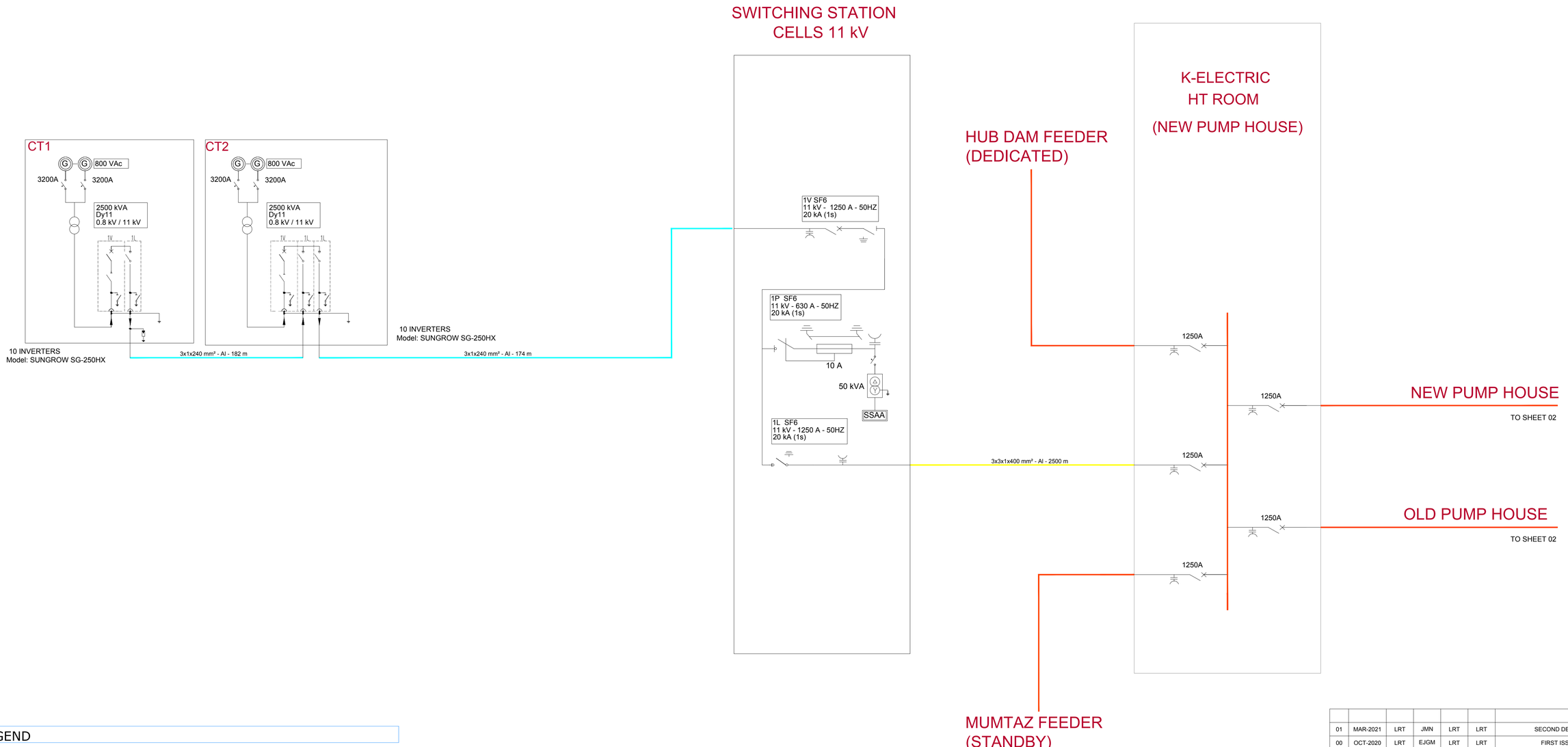
LAYOUT GENERAL

Scale:	Designed:	Drawn:	Checked:	Approved:
1/2000	LRT	JMN	LRT	LRT
Original Size:	**Date:**	**Date:**	**Date:**	**Date:**
A1	MAR-2021	MAR-2021	MAR-2021	MAR-2021

Drawing Code: HY6602-TYP-SP-KARACHI PV PLANT-LAYOUT-D02

Drawing Number: 01

Sheet: 01 OF 01



LEGEND

- INVERTERS
- TRANSFORMER Dy11
- MV PLUG–IN CONNECTOR
- EARTHING SWITCH
- VACUUM CIRCUIT BREAKER
- LINE DISCONNECTOR SWITCH (LBS)
- LINE DISCONNECTOR SWITCH
- TRIP COIL
- SURGE ARRESTER CLASS II – 10KA WHERE APPLICABLE
- TRANSFORMER AUX SERVICES
- LINE DISCONNECTOR SWITCH WITH FUSE

MV CIRCUITS

- CT.2 - CT.1 - CS
- CS - SET

Rev.	Date	Designed	Drawn	Checked	Approved	Description
01	MAR-2021	LRT	JMN	LRT	LRT	SECOND DESIGN
00	OCT-2020	LRT	EJGM	LRT	LRT	FIRST ISSUE

Drawing Status:

Client: IFC International Finance Corporation — Creating Markets, Creating Opportunities

Engineering: TYPSA INGENIEROS CONSULTORES Y ARQUITECTOS

Project:

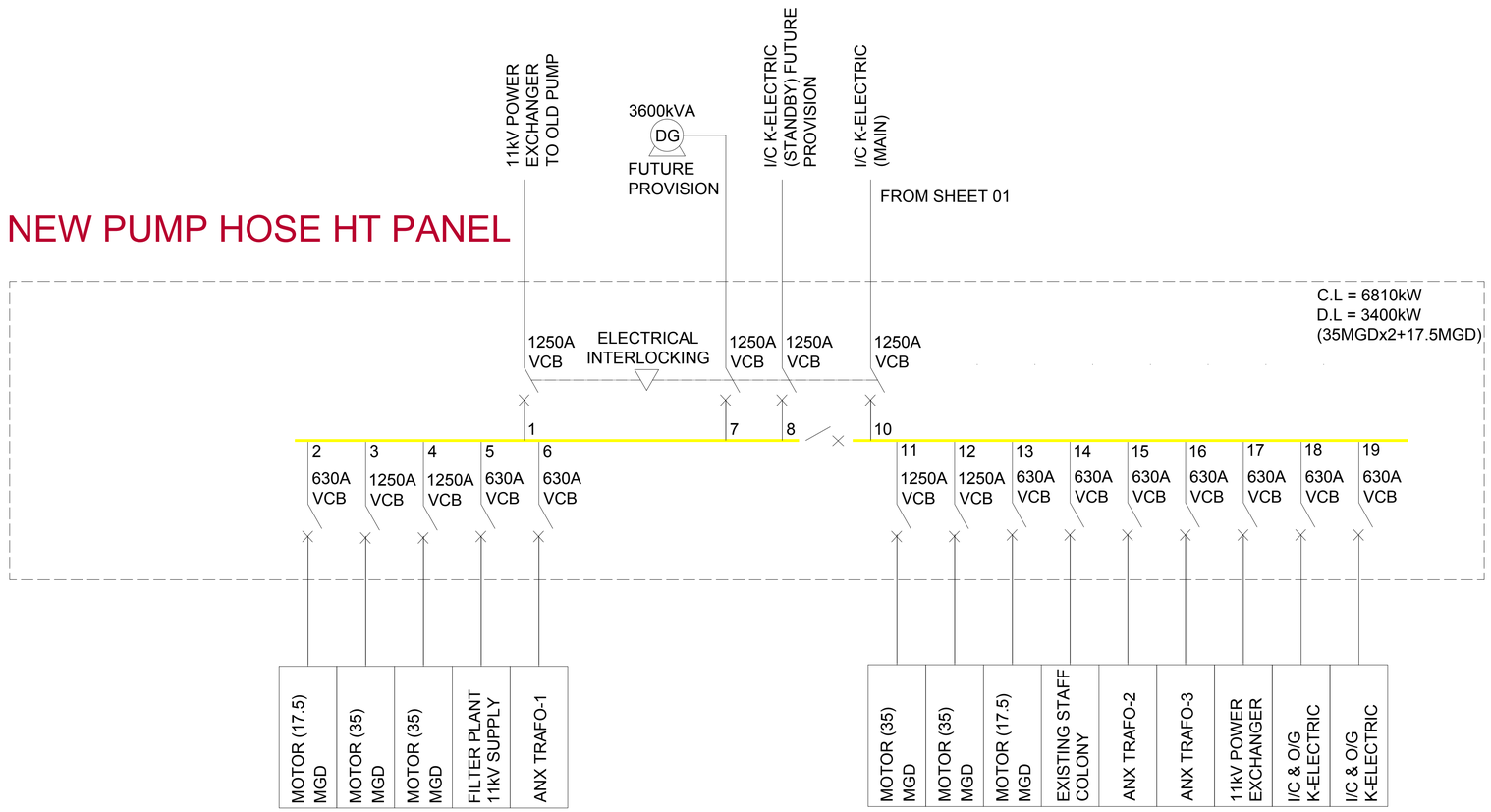
SOLAR PHOTOVOLTAIC PLANT
KARACHI (PAKISTAN)

Drawing Title:

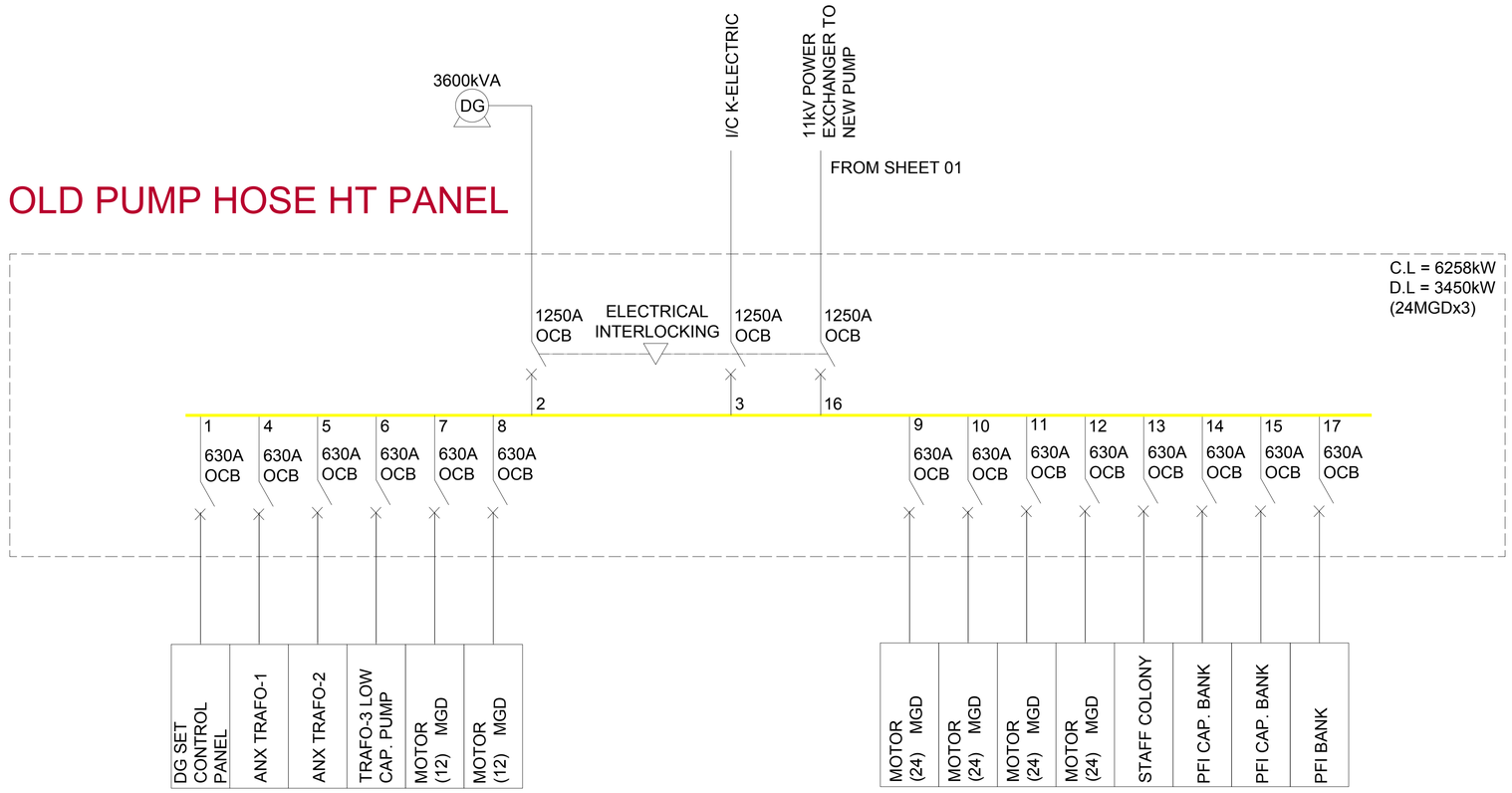
MV SLD

Scale:	Designed:	Drawn:	Checked:	Approved:
N / S	LRT	JMN	LRT	LRT
Original Size: A1	Date: MAR-2021	Date: MAR-2021	Date: MAR-2021	Date: MAR-2021
Drawing Code:			Drawing Number:	Sheet: 01 OF 02

NEW PUMP HOSE HT PANEL



OLD PUMP HOSE HT PANEL



Rev.	Date	Designed	Drawn	Checked	Approved	Description
01	MAR-2021	LRT	JMN	LRT	LRT	SECOND DESIGN
00	OCT-2020	LRT	EJGM	LRT	LRT	FIRST ISSUE

Drawing Status:

Client: IFC International Finance Corporation — Creating Markets, Creating Opportunities

Engineering: TYPSA Ingenieros Consultores y Arquitectos

Project:

SOLAR PHOTOVOLTAIC PLANT
KARACHI (PAKISTAN)

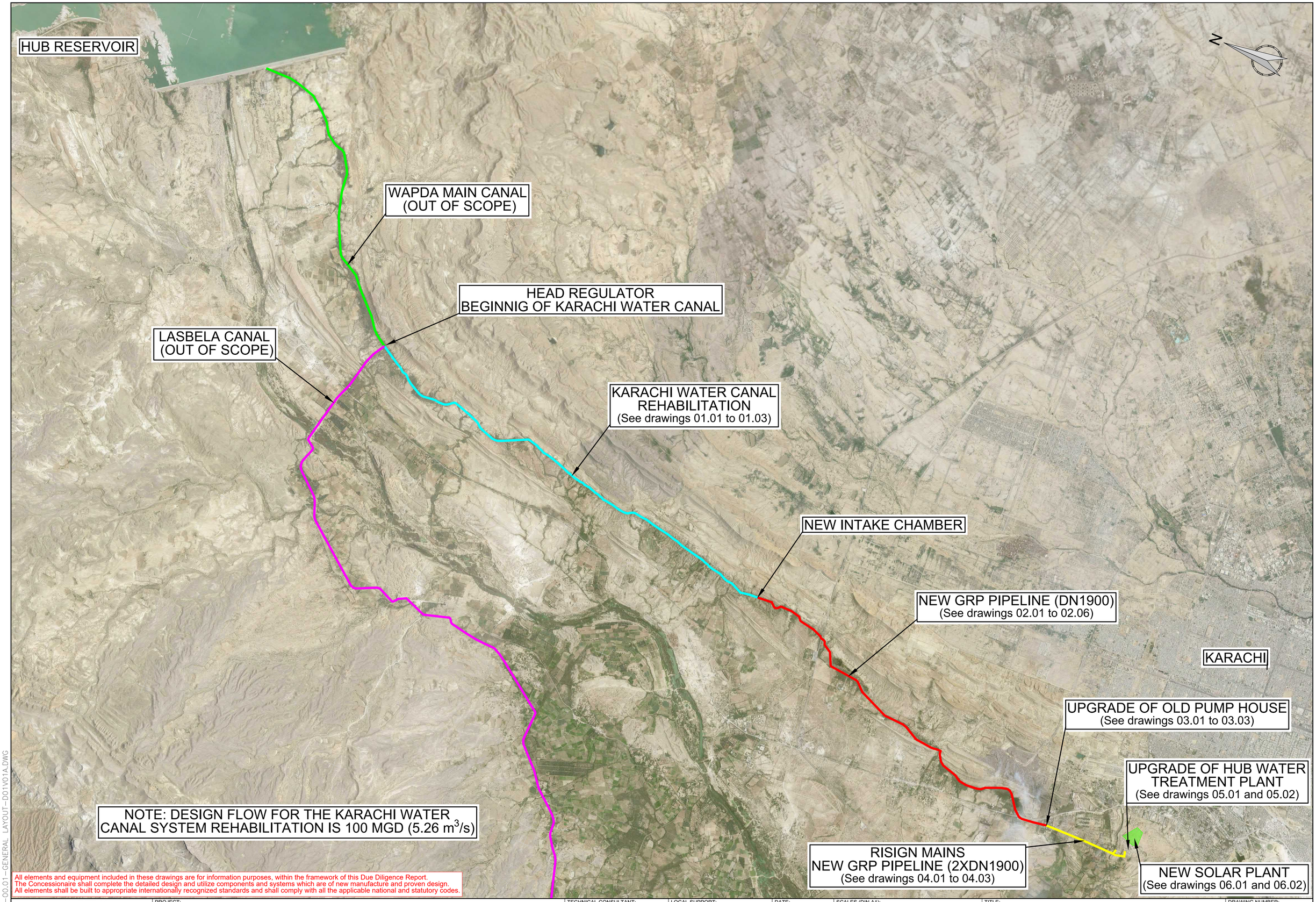
Drawing Title:

MV SLD

Scale:	Designed:	Drawn:	Checked:	Approved:
N / S	LRT	JMN	LRT	LRT
Original Size: A1	Date: MAR-2021	Date: MAR-2021	Date: MAR-2021	Date: MAR-2021
Drawing Code:			Drawing Number:	Sheet: 02 OF 02

Annex 3. Proposed Design Drawings

CONSULTING SERVICES KARACHI WATER CANAL PPP



All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 0.5 0 0.5 1 1.5 2 km SCALE 1:40.000	TITLE: GENERAL LAYOUT	DRAWING NUMBER: 00.01 SHEET: 1 of 1

HY6602_DR_00.01_GENERAL LAYOUT_D01V01A.DWG

HUB RESERVOIR

FLOW MEASUREMENT SENSOR

FLOW MEASUREMENT SENSOR

RADIO NODE

FLOW MEASUREMENT SENSOR

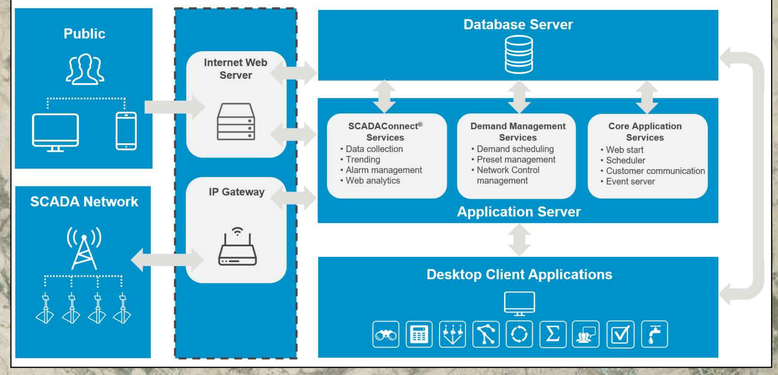
KARACHI

IP GATEWAY RADIO NODE

FLOW MEASUREMENT SENSORS

N

SCADA ARCHITECTURE



All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

HY66602-DR-00.02-METERING & SCADA SYSTEM-D01V01A.DWG

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

SCALES (DIN A1): 0.5 0 0.5 1 1.5 2 km — SCALE 1:40.000

TITLE: GENERAL LAYOUT METERING & SCADA SYSTEM

DRAWING NUMBER: 00.02

SHEET: 1 of 1

RIGHT-OF-WAY AND LAND ACQUISITION COMMENTS

- **CANAL REHABILITATION** WILL REMAIN WITHIN THE EXISTING KWSB RIGHT-OF-WAY (ROW), WHICH ENCOMPASSES 30 M (100 FT) CENTERED AROUND THE CANAL AXIS.
- **NEW PIPELINE** SHOULD BE ALIGNED WITHIN THE EXISTING KWSB ROW (SEE DRAWING 02.02).
- **PUMPING STATION:** ALL REHABILITATION WORKS REMAIN WITHIN THE EXISTING KWSB PERIMETER (SEE DRAWING 03.01).
- **RISING MAINS & POWER TRANSMISSION LINE:** IT IS ASSUMED THAT THE SAME CANAL ROW OF 30 M IS IN FORCE (SEE DRAWING 04.02).
- **WATER TREATMENT PLANT:** ALL REHABILITATION WORKS SHALL TAKE PLACE WITHIN THE EXISTING KWSB PERIMETER. (SEE DRAWING 05.01)
- **SOLAR PV PLANT** IS PROPOSED TO BE LOCATED NEXT TO THE EXISTING WATER TREATMENT PLANT, IN AN AREA WHICH HAS NO CURRENT USES AND SHOULD BE AVAILABLE (SEE DRAWING 06.01).

OFFTAKES ALONG THE EXISTING KWSB HUB CANAL

- **HAMDARD UNIVERSITY CONNECTION:** THIS IS A PUMPING STATION AND AN 8" DIAMETER PIPE.
- **SIND SMALL INDUSTRY CORPORATION CONNECTION:** THIS IS A 12” DIAMETER PIPE STEMMING FROM THE WATER TREATMENT PLANT (15 MGD), ALTHOUGH IT IS NOT IN OPERATION BECAUSE THE AREA IS STILL UNDER DEVELOPMENT AND IT IS OUT OF THE PPP SCOPE.
- **OTHER WATER CONNECTIONS FROM THE CANAL THAT ARE ILLEGAL AND ARE GATHERED IN THE E&S SCOPING REPORT.**

OTHER UTILITIES ALONG THE EXISTING KWSB HUB CANAL

- TRANSFORMERS, HEAVY TRANSMISSION LINES AND ELECTRIC 132 KV HIGH TENSION LINES AND ELECTRICITY POLES SITUATED WITHIN 200 M AT BOTH SIDES OF THE CANAL, PARTICULARLY IN THE AREA ADJACENT TO THE NORTHERN BYPASS ROAD (SEE DRAWINGS 01.02 AND 02.02)
- TWO GAS PIPELINES OF 20” AND 18” DIAMETER CROSSING THE CANAL: **SUI SOUTHERN GAS COMPANY LIMITED (SSGCL)** (SEE DRAWING 02.02).
- UNDERGROUND CRUDE OIL LINE OWNED BY **HUBCO/SUPARCO** OF 12” TO 18” DIAMETER (SEE DRAWING 02.02).

HUB RESERVOIR

N

TRANSMISSION LINE CROSSING

PATAI BROHI GOTH ILEGAL PUMP STATION

GAS PIPES CROSSING

KARACHI

OIL LINE CROSSING

TRANSMISSION LINE CROSSING

SIND SMALL INDUSTRY LEGAL CONNECTION

HAMDARD UNIVERSITY LEGAL CONNECTION

TRANSMISSION LINE CROSSING

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

SCALES (DIN A1): 0.5 0 0.5 1 1.5 2 km — SCALE 1:40.000

TITLE: GENERAL LAYOUT ROW & UTILITIES

DRAWING NUMBER: 00.03

SHEET: 1 of 1

HY6602_DR_00.03_ROW & UTILITIES_D01V01A.DWG

WAPDA MAIN CANAL (OUT OF SCOPE)

HEAD REGULATOR
BEGINNIG OF KARACHI WATER CANAL

AQUEDUCT REHABILITATION

SHEET 1

SHEET 2

SHEET 3

SHEET 4

SHEET 5

SHEET 6

SHEET 7

SHEET8

LASBELA CANAL (OUT OF SCOPE)

AQUEDUCT REHABILITATION

AQUEDUCT REHABILITATION

AQUEDUCT REHABILITATION

KARACHI WATER CANAL REHABILITATION ACCORDING DRAWING Nº 01.03

NEW INTAKE CHAMBER

NEW GRP PIPELINE (DN1900)

AQUEDUCT REHABILITATION		
	CHAINAGE	LENGTH (m)
AQUEDUCT 1	0+385	50
AQUEDUCT 2	0+550	30
AQUEDUCT 3	0+686	35
AQUEDUCT 4	1+905	32
AQUEDUCT 5	2+427	25
AQUEDUCT 6	2+775	50
AQUEDUCT 7	4+450	48
AQUEDUCT 8	5+570	38
AQUEDUCT 9	7+630	75
AQUEDUCT 10	10+587	30

CULVERTS REHABILITATION		
	CHAINAGE	LENGTH (m)
CULVERT 1	0+947	27
CULVERT 2	3+912	23
CULVERT 3	4+941	28
CULVERT 4	6+388	40
CULVERT 5	9+174	29
CULVERT 6	9+633	34
CULVERT 7	9+824	12
CULVERT 8	9+890	28
CULVERT 9	9+988	31
CULVERT 10	10+284	32
CULVERT 11	11+025	29
CULVERT 12	11+638	26

SHEETS 1 TO 8 CAN BE FOUND WITHIN DRAWING 01.02, WICH INCLUDES THE LONGITUDINAL PROFILE OF THE CANAL REHABILITATION

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

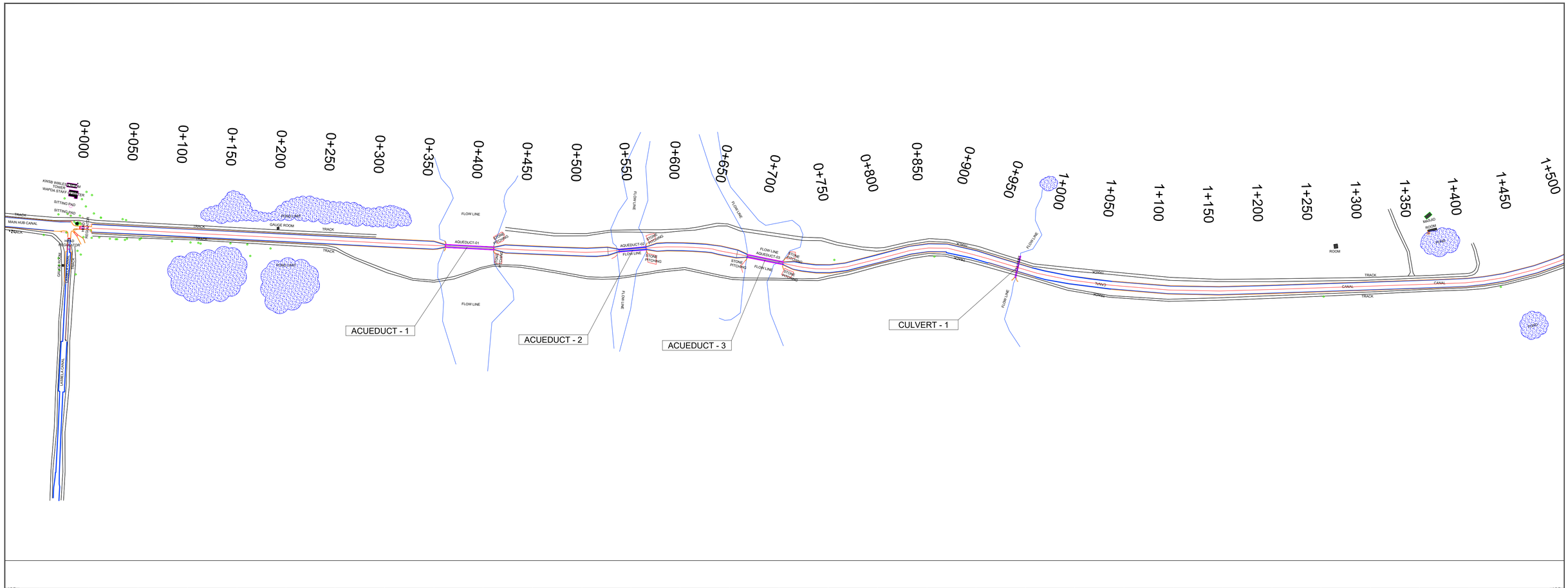
SCALES (DIN A1): 0.2 0 0.2 0.4 0.6 0.8 1 km — SCALE 1:15.000

TITLE: CANAL REHABILITATION GENERAL PLAN

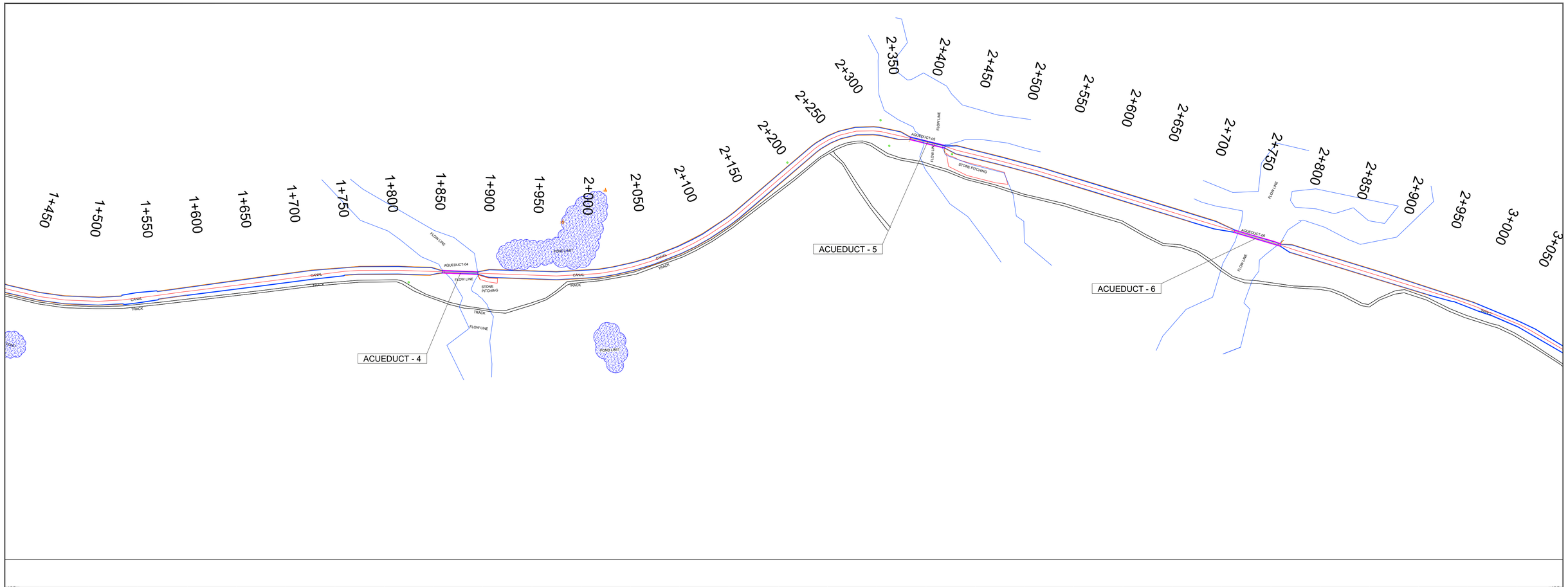
DRAWING NUMBER: 01.01

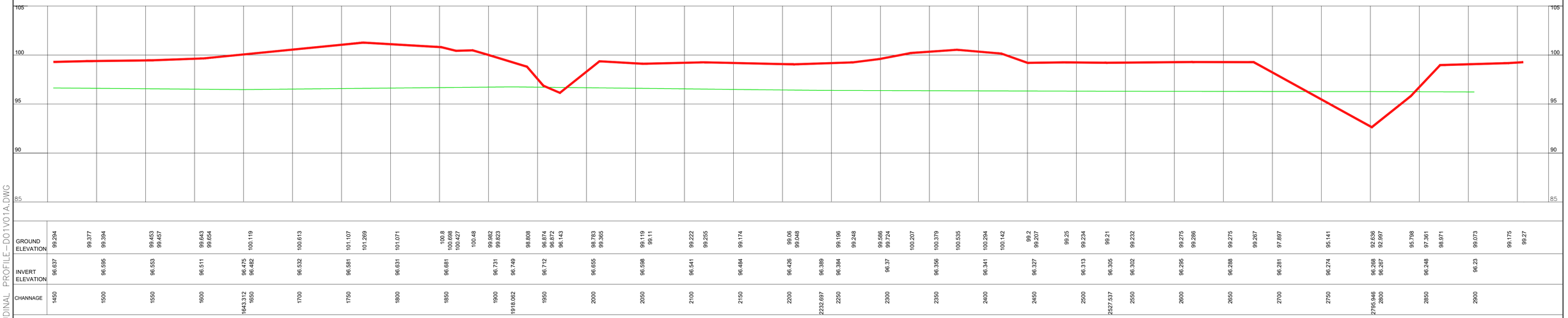
SHEET: 1 of 1

HY6602-DR-01.01-CANAL REHABILITATION GENERAL PLAN-D01V01A.DWG

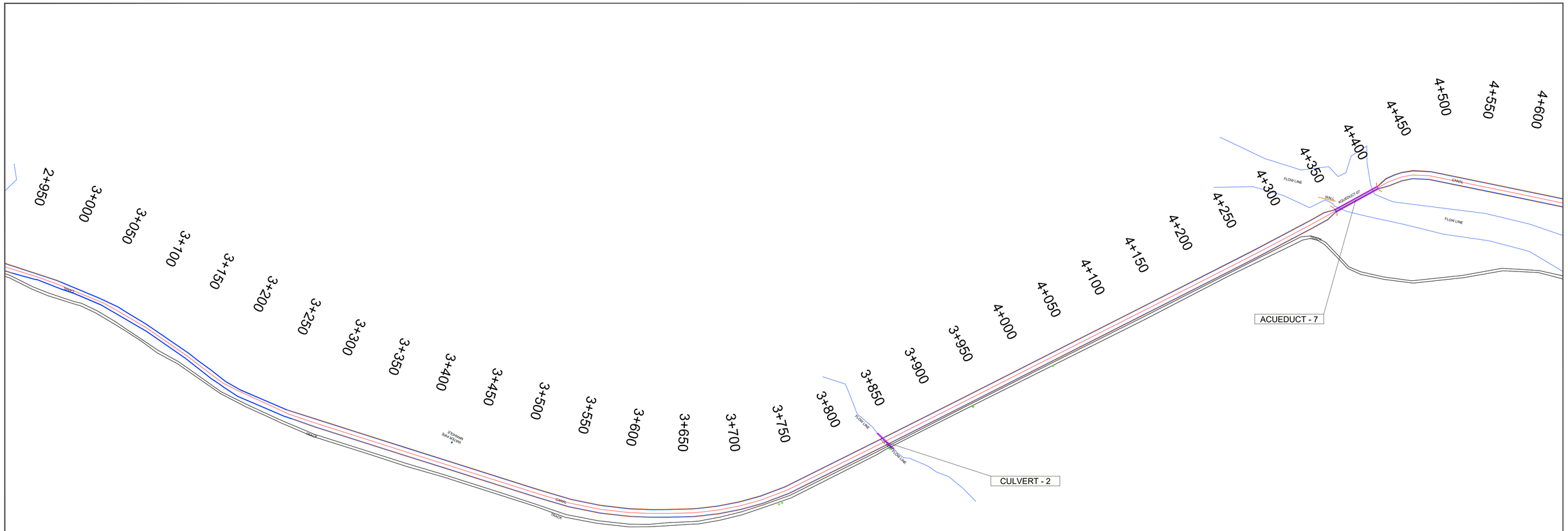

0+000
0+050
0+100
0+150
0+200
0+250
0+300
0+350
0+400
0+450
0+500
0+550
0+600
0+650
0+700
0+750
0+800
0+850
0+900
0+950
1+000
1+050
1+100
1+150
1+200
1+250
1+300
1+350
1+400
1+450
1+500
KWSB WIRELESS ROOM
TOWER
WAPDA STAFF WATER
SITTING PAD
SITTING PAD
TRACK
MAIN HUB CANAL
TRACK
PAD
GAUGE ROOM
GAUGE ROOM
TRACK
TRACK
TRACK
POND / PIT
GAUGE ROOM
TRACK
ROAD / UNIT
TRACK
FLOW LINE
AQUEDUCT-01
STONE PITCHING
STONE PITCHING
FLOW LINE
ACUEDUCT - 1
AQUEDUCT-02
FLOW LINE
STONE PITCHING
STONE PITCHING
FLOW LINE
ACUEDUCT - 2
FLOW LINE
FLOW LINE
AQUEDUCT-03
STONE PITCHING
STONE PITCHING
STONE PITCHING
FLOW LINE
ACUEDUCT - 3
ROAD
ROAD
CULVERT - 1
FLOW LINE
FLOW LINE
ROAD
ROAD
TRACK
CANAL
CANAL
TRACK
MASJID
ROOM
POND
ROOM
POND
105
100
95
90
85

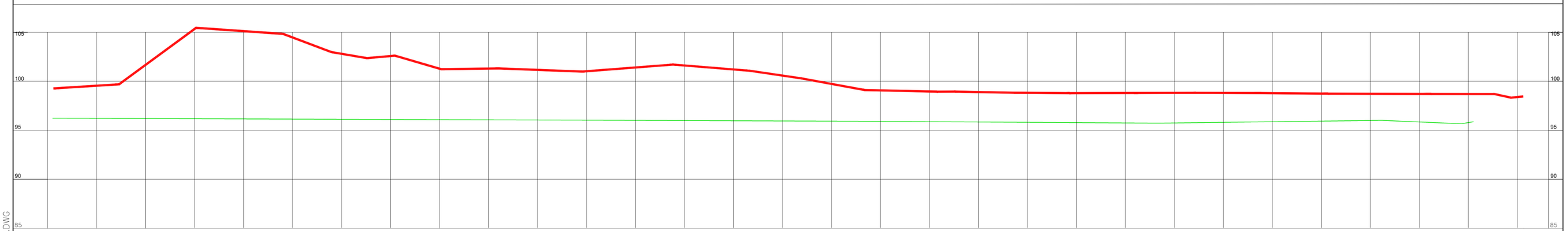
| | | |


1+450
1+500
1+550
1+600
1+650
1+700
1+750
1+800
1+850
1+900
1+950
2+000
2+050
2+100
2+150
2+200
2+250
2+300
2+350
2+400
2+450
2+500
2+550
2+600
2+650
2+700
2+750
2+800
2+850
2+900
2+950
3+000
3+050
ACUEDUCT - 4
ACUEDUCT - 5
ACUEDUCT - 6
AQUEDUCT-04
AQUEDUCT-05
AQUEDUCT-06
CANAL
TRACK
FLOW LINE
STONE PITCHING
POND LIMIT
POND

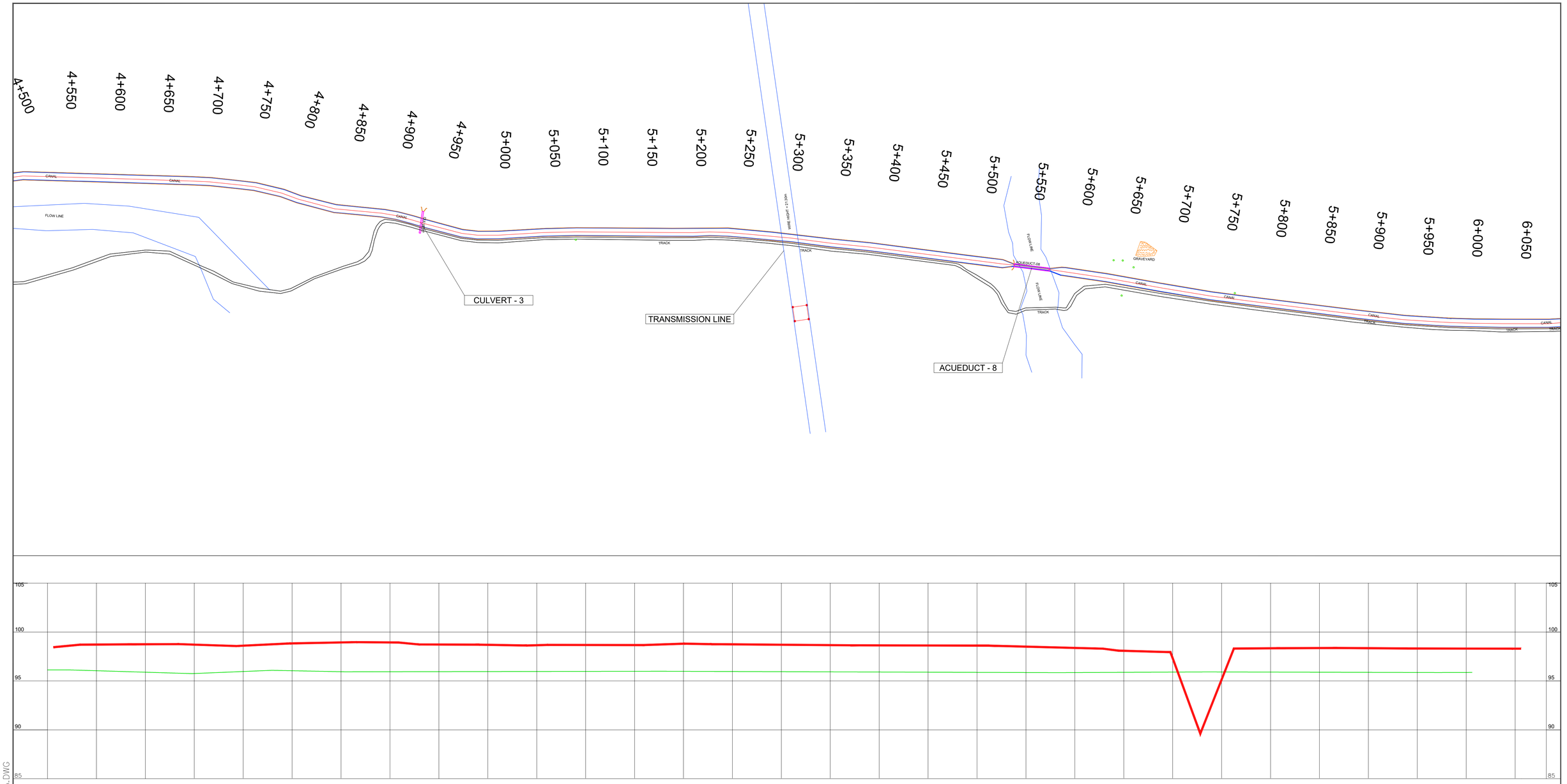

105
100
95
90
85

| | | |

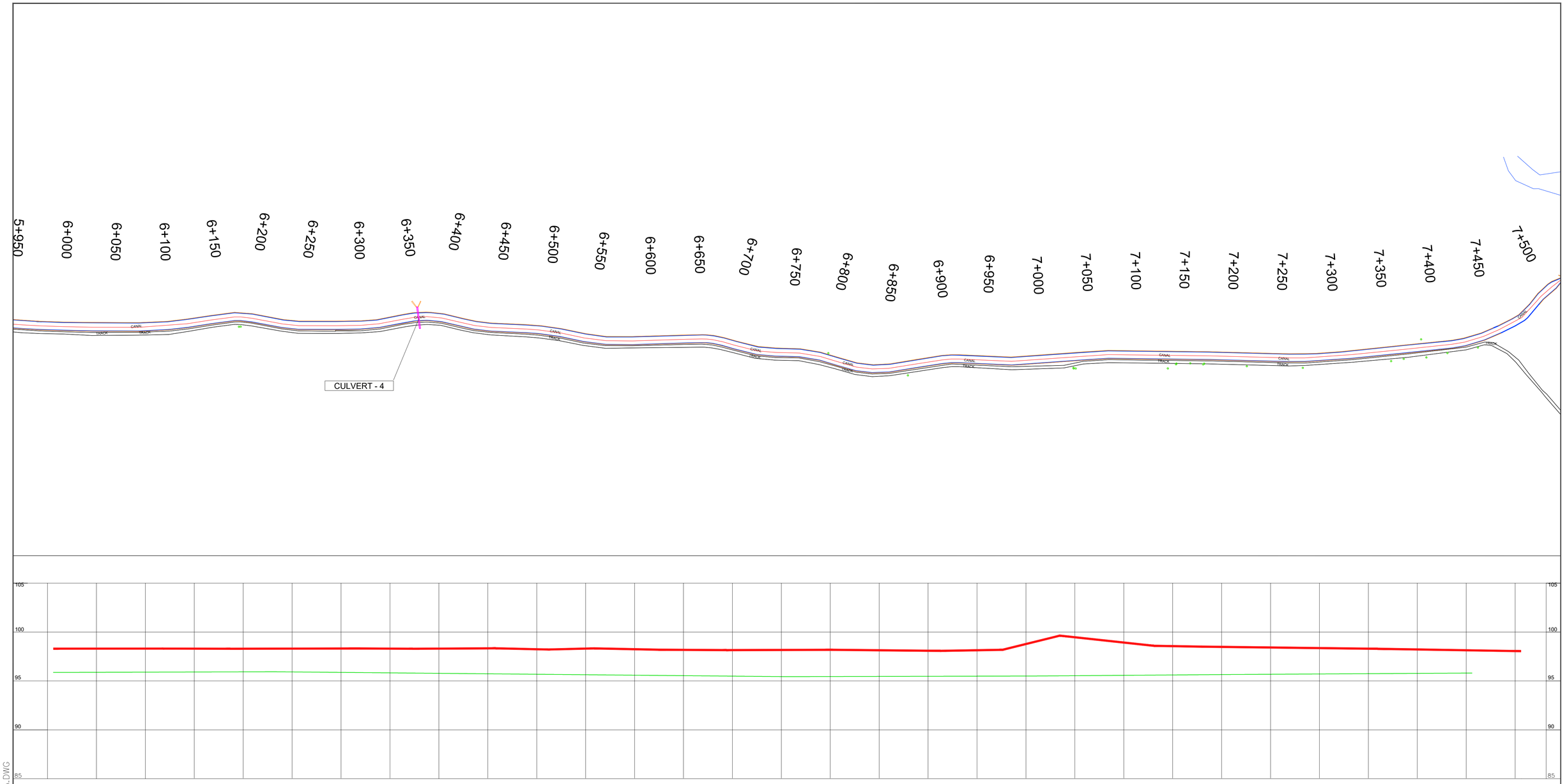

2+950
3+000
3+050
3+100
3+150
3+200
3+250
3+300
3+350
3+400
3+450
3+500
3+550
3+600
3+650
3+700
3+750
3+800
3+850
3+900
3+950
4+000
4+050
4+100
4+150
4+200
4+250
4+300
4+350
4+400
4+450
4+500
4+550
4+600
CANAL
TRACK
WATER PIPE
MANHOLE
FLOW LINE
CULVERT - 2
WALL
ACUEDUCT-07
ACUEDUCT - 7


105
100
95
90
85

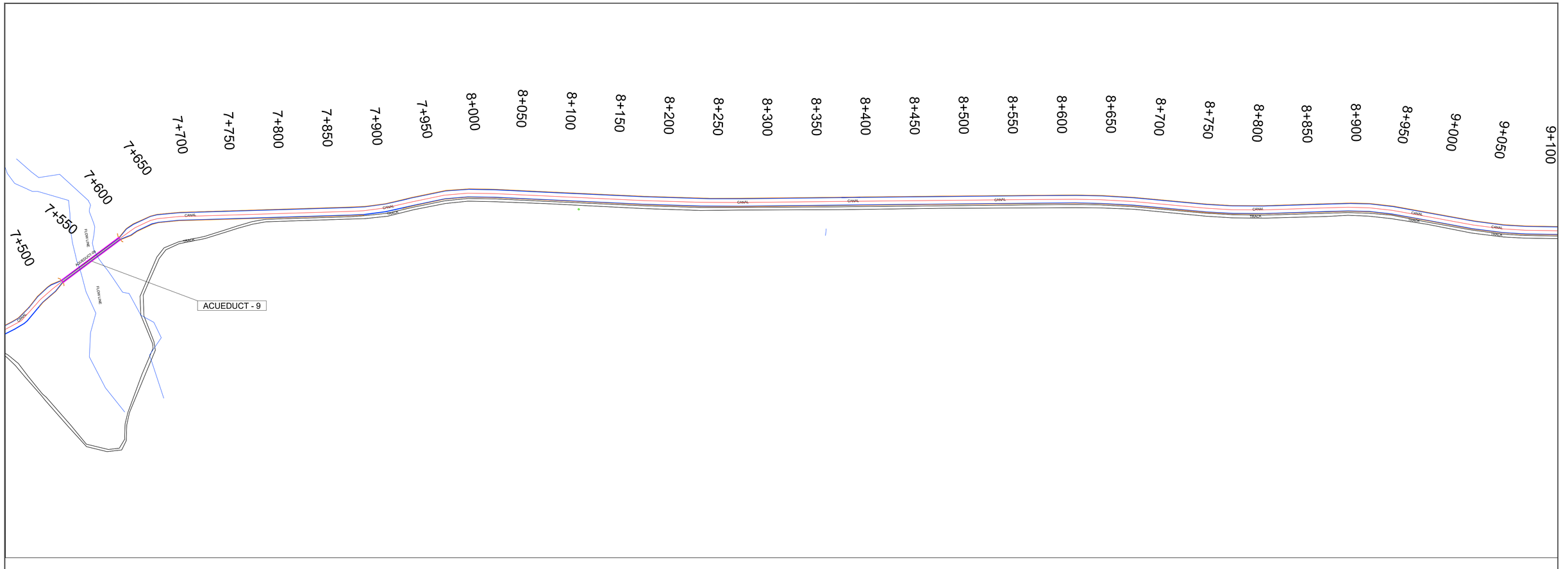
| | | |

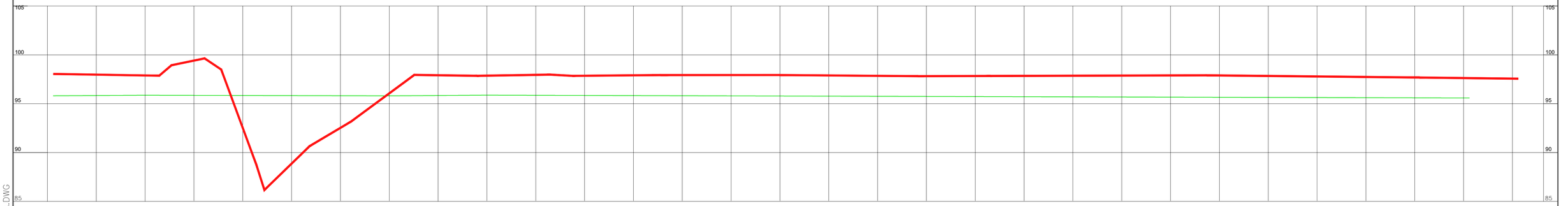

4+500
4+550
4+600
4+650
4+700
4+750
4+800
4+850
4+900
4+950
5+000
5+050
5+100
5+150
5+200
5+250
5+300
5+350
5+400
5+450
5+500
5+550
5+600
5+650
5+700
5+750
5+800
5+850
5+900
5+950
6+000
6+050
CANAL
FLOW LINE
TRACK
CULVERT - 3
TRANSMISSION LINE
ACUEDUCT - 8
GRAVEYARD
105
100
95
90
85

| | | |

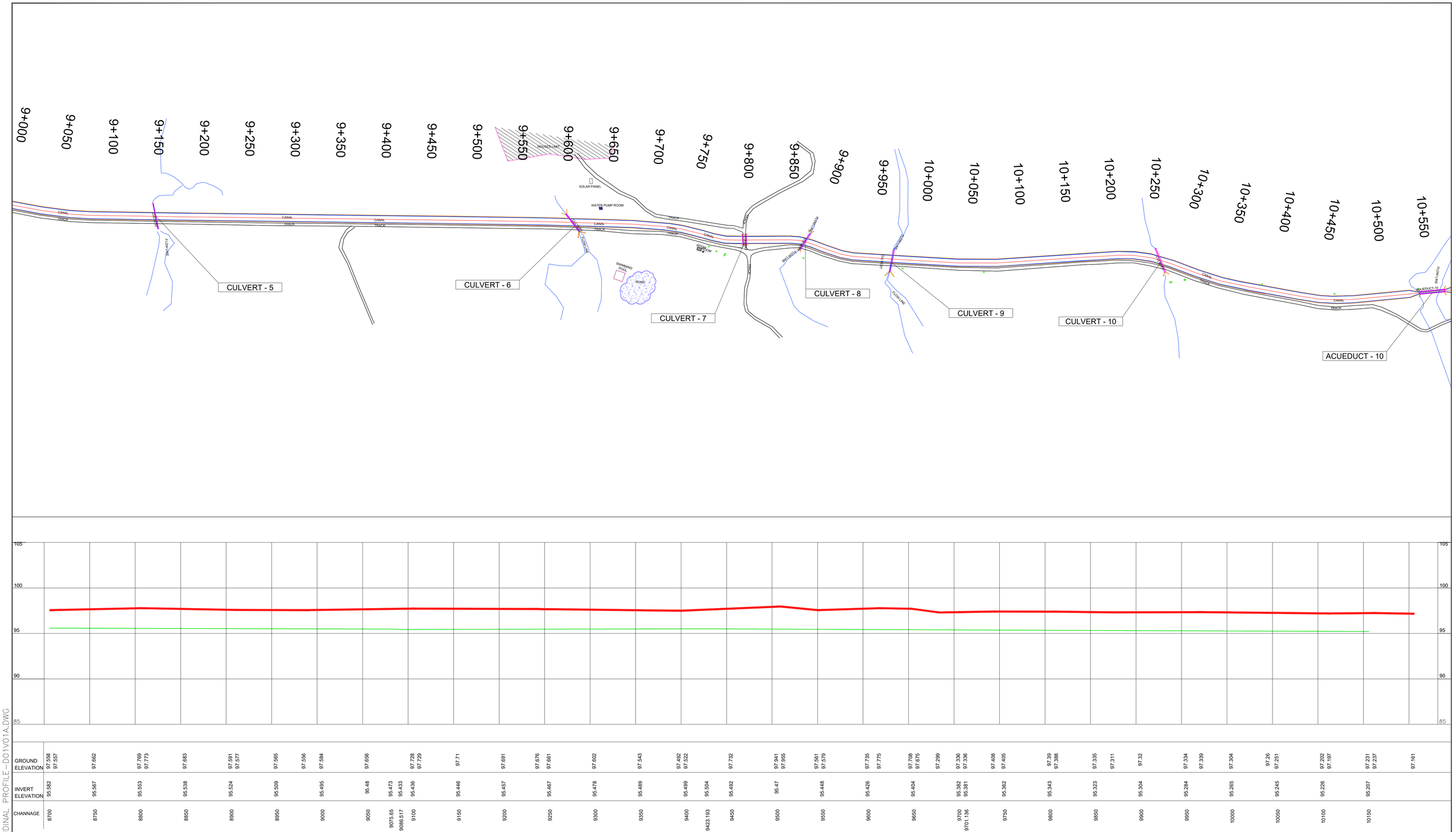

5+950
6+000
6+050
6+100
6+150
6+200
6+250
6+300
6+350
6+400
6+450
6+500
6+550
6+600
6+650
6+700
6+750
6+800
6+850
6+900
6+950
7+000
7+050
7+100
7+150
7+200
7+250
7+300
7+350
7+400
7+450
7+500
CANAL
TRACK
CULVERT - 4
105
100
95
90
85

| | | |

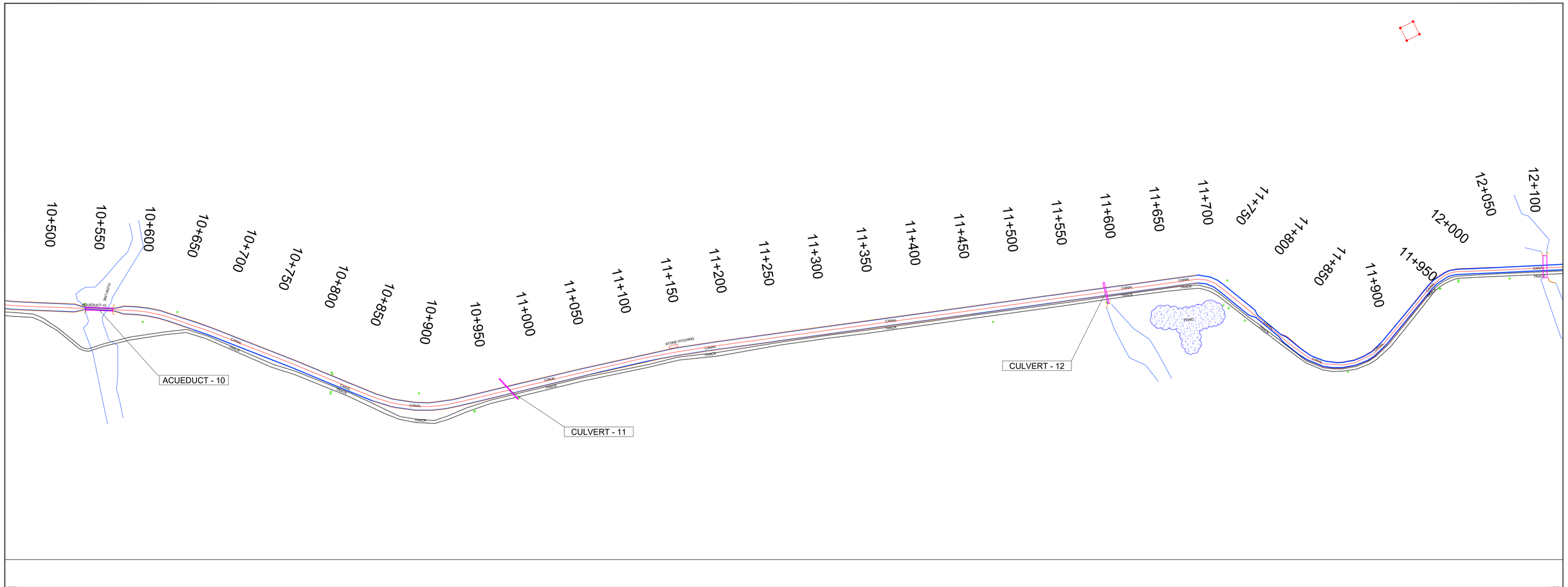

7+500
7+550
7+600
7+650
7+700
7+750
7+800
7+850
7+900
7+950
8+000
8+050
8+100
8+150
8+200
8+250
8+300
8+350
8+400
8+450
8+500
8+550
8+600
8+650
8+700
8+750
8+800
8+850
8+900
8+950
9+000
9+050
9+100
CANAL
TRACK
FLOW LINE
AQUEDUCT
ACUEDUCT - 9


105
100
95
90
85

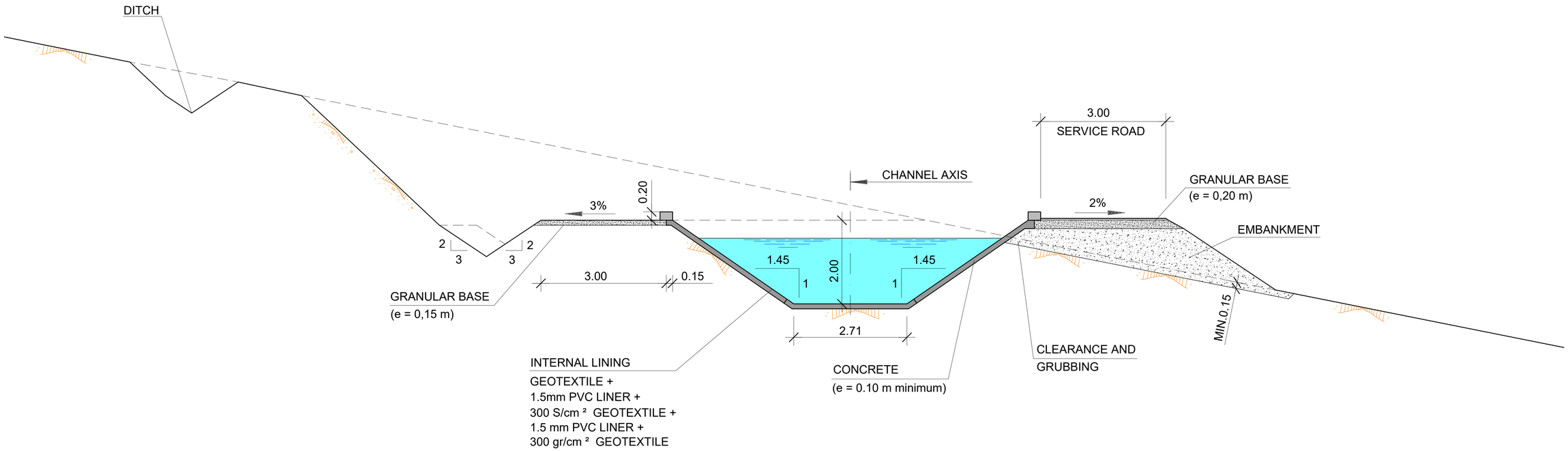
| | | |


9+000
9+050
9+100
9+150
9+200
9+250
9+300
9+350
9+400
9+450
9+500
9+550
9+600
9+650
9+700
9+750
9+800
9+850
9+900
9+950
10+000
10+050
10+100
10+150
10+200
10+250
10+300
10+350
10+400
10+450
10+500
10+550
HOUSES LIMIT
SOLAR PANEL
WATER PUMP ROOM
CANAL
TRACK
FLOW LINE
SWIMMING POOL
POND
CULVERT - 5
CULVERT - 6
CULVERT - 7
CULVERT - 8
CULVERT - 9
CULVERT - 10
ACUEDUCT - 10
105
100
95
90
85

| | | |


10+500
10+550
10+600
10+650
10+700
10+750
10+800
10+850
10+900
10+950
11+000
11+050
11+100
11+150
11+200
11+250
11+300
11+350
11+400
11+450
11+500
11+550
11+600
11+650
11+700
11+750
11+800
11+850
11+900
11+950
12+000
12+050
12+100
ACUEDUCT-10
ACUEDUCT - 10
CULVERT - 11
CULVERT - 12
STONE PITCHING
CANAL
TRACK
POND
100
95
90
85
80

| | | |



All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 0.5 0 0.5 1 1.5 2 2.5 m SCALE 1:50	TITLE: CANAL REHABILITATION TYPICAL CROSS SECTION	DRAWING NUMBER: 01.03 SHEET: 1 of 1

HY6602-DR-01.03-CANAL REHABILITATION TYPICAL CROSS SECTION-D01V01A.DWG

HUB RESERVOIR

N

WAPDA MAIN CANAL
(OUT OF SCOPE)

HEAD REGULATOR
BEGINNIG OF KARACHI WATER CANAL

LASBELA CANAL
(OUT OF SCOPE)

KARACHI WATER CANAL
REHABILITATION

NEW INTAKE CHAMBER

NEW GRP PIPELINE (DN1900)

SHEET 1

SHEET 2

SHEET 3

SHEET 4

SHEET 5

SHEET 6

SHEET 7

KARACHI

UPGRADE OF OLD PUMP HOUSE

UPGRADE OF HUB WATER
TREATMENT PLANT

RISIGN MAINS
NEW GRP PIPELINE (2XDN1900)

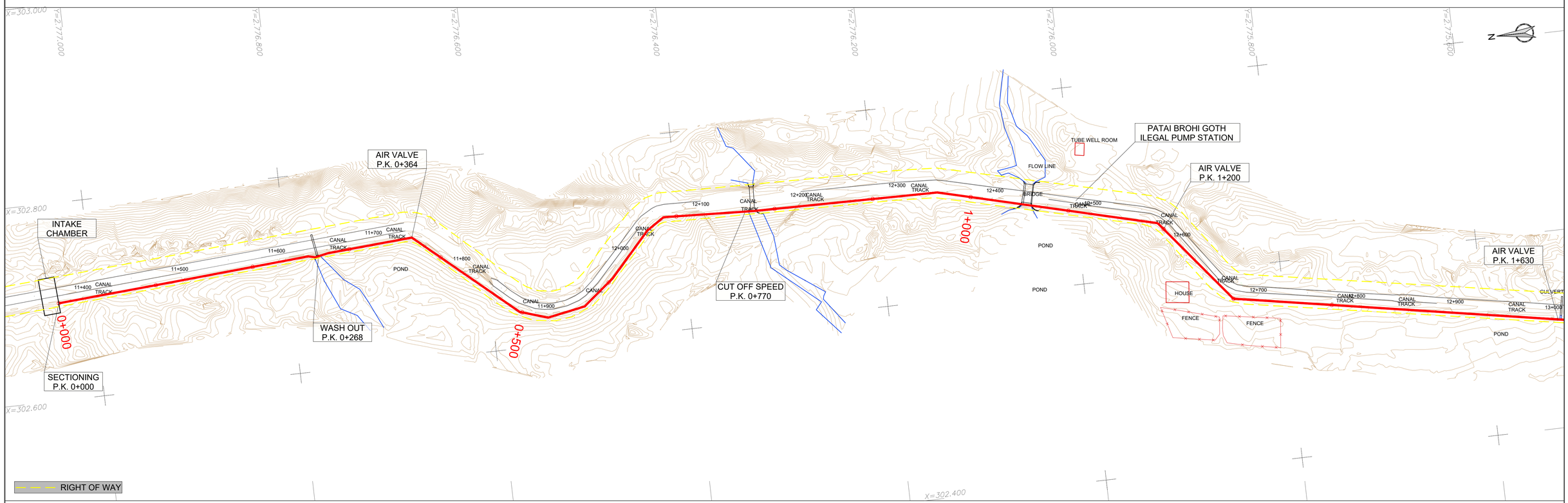
NEW SOLAR PLANT

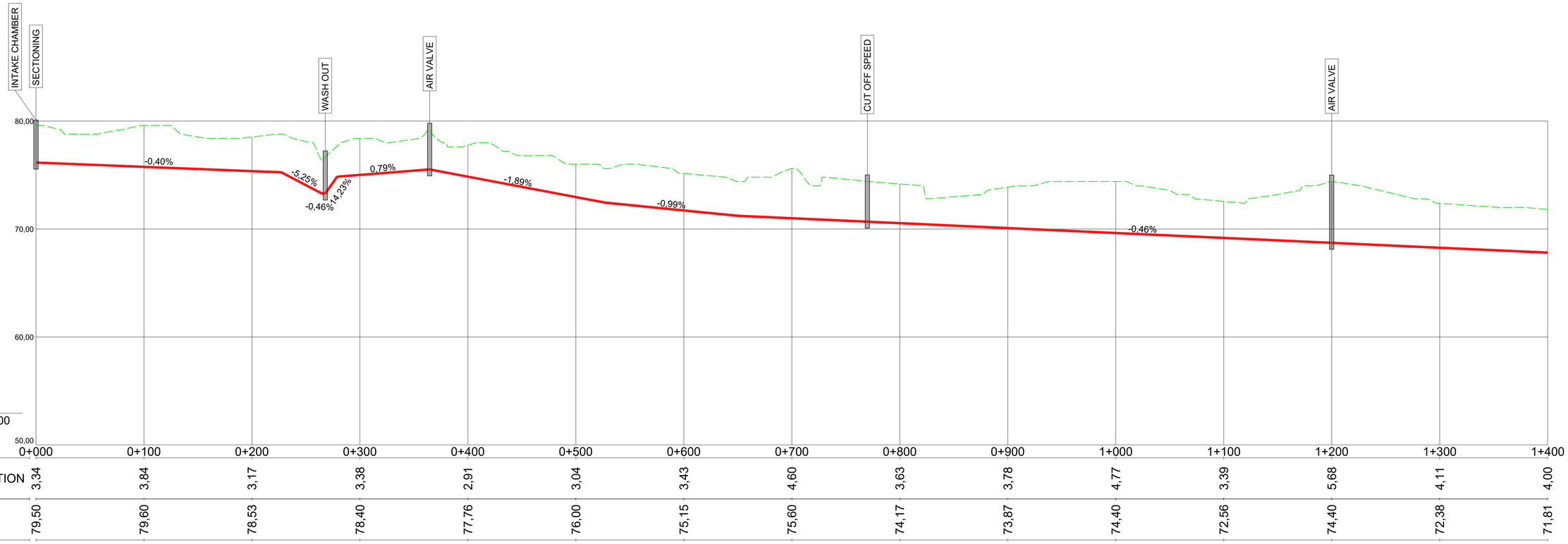
SHEETS 1 TO 7 CAN BE FOUND WITHIN DRAWING 02.02,
WICH INCLUDES THE LONGITUDINAL PROFILE OF THE NEW PIPELINE

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

HY6602-DR-02.01-NEW PIPELINE GENERAL PLAN-D01V01A.DWG

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 0.5 0 0.5 1 1.5 2 km SCALE 1:40.000	TITLE: NEW PIPELINE GENERAL PLAN	DRAWING NUMBER: 2.1 SHEET: 1 of 1

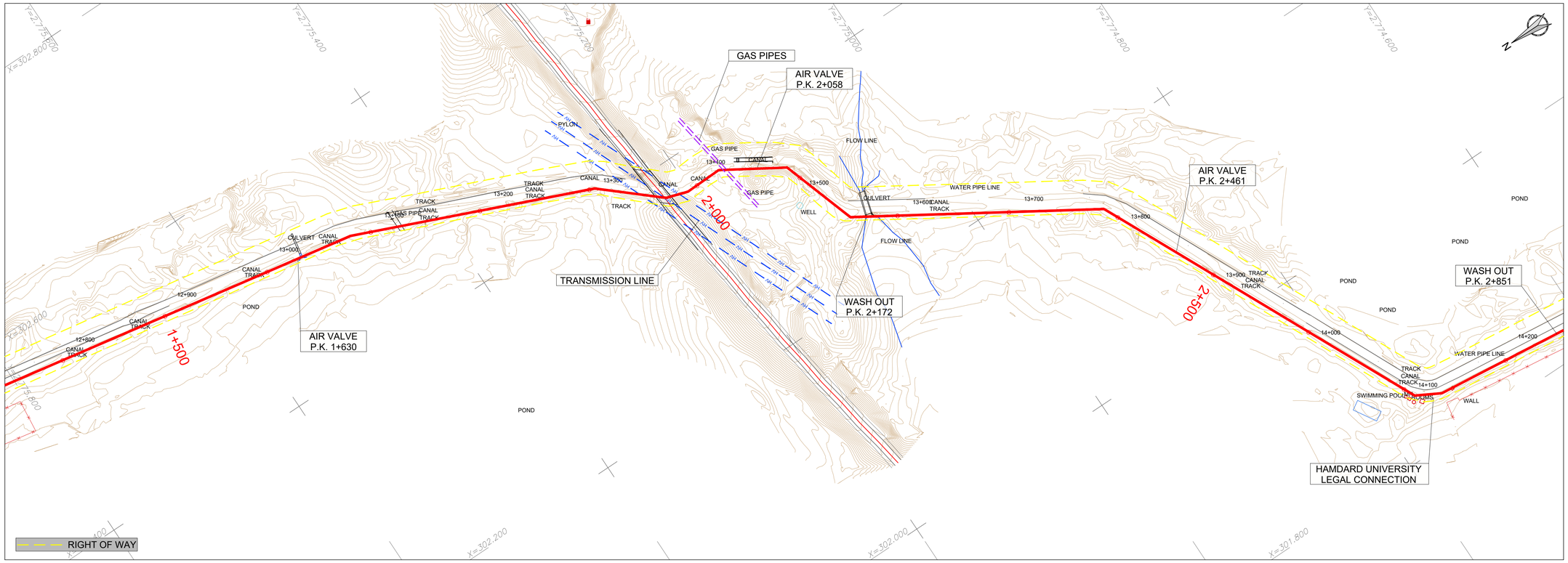


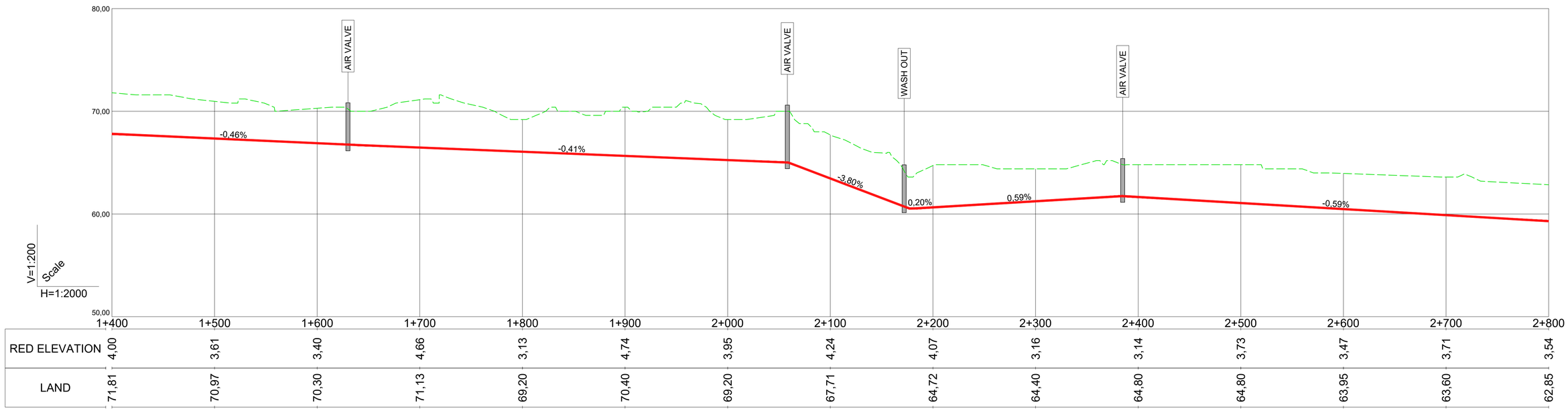


All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 50 0 50 100 m SCALE 1:2.000; 5 0 5 10 m SCALE 1:200	TITLE: NEW PIPELINE LONGITUDINAL PROFILE	DRAWING NUMBER: 02.02; SHEET: 1 of 7

HY6602-DR-02.02-NEW PIPELINE LONGITUDINAL PROFILE-D01V01A.DWG





RED ELEVATION	4,00	3,61	3,40	4,66	3,13	4,74	3,95	4,24	4,07	3,16	3,14	3,73	3,47	3,71	3,54
LAND	71,81	70,97	70,30	71,13	69,20	70,40	69,20	67,71	64,72	64,40	64,80	64,80	63,95	63,60	62,85

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

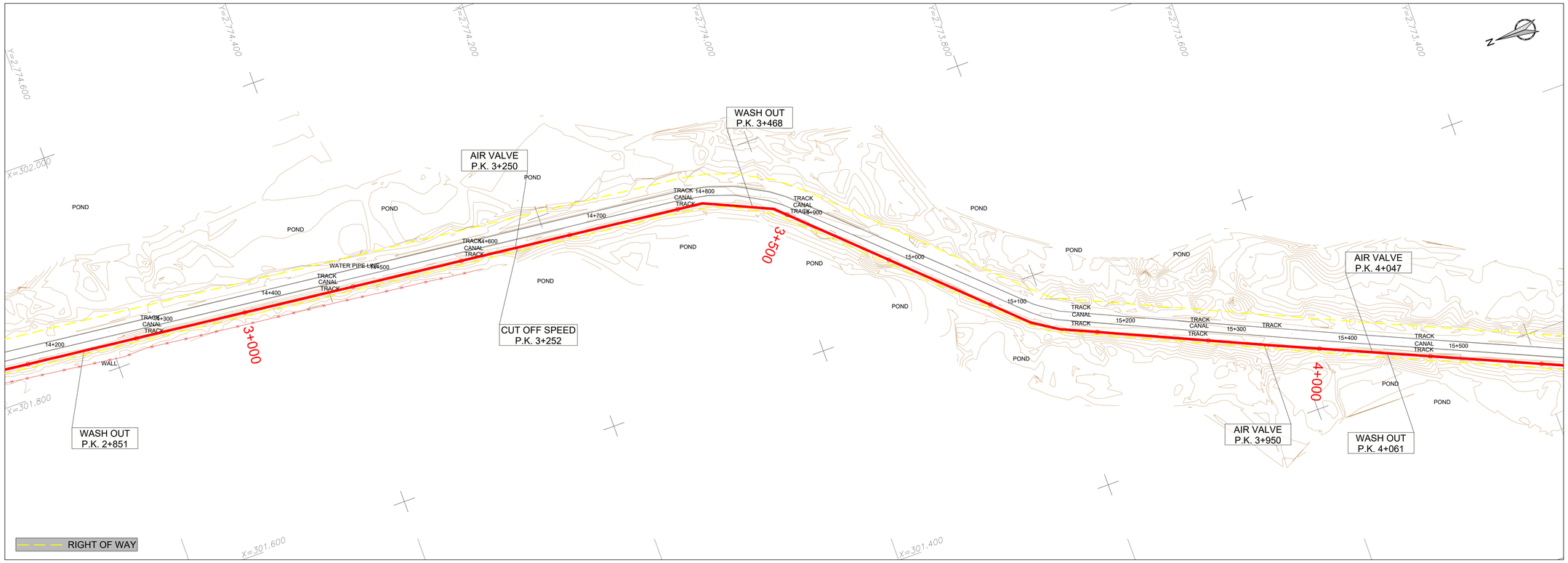
SCALES (DIN A1): 50 0 50 100 m — SCALE 1:2.000; 5 0 5 10 m — SCALE 1:200

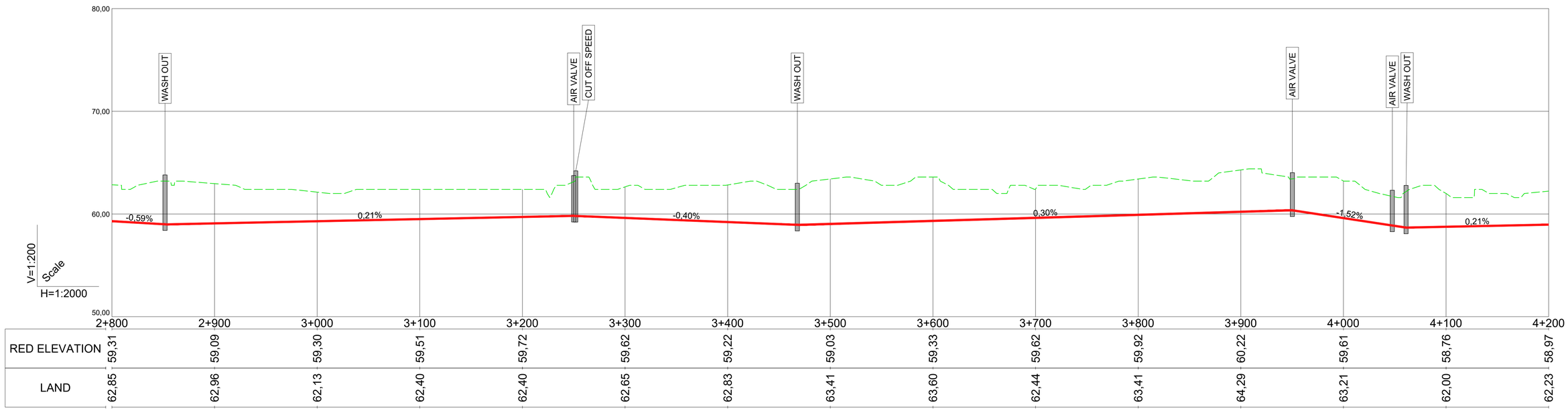
TITLE: NEW PIPELINE LONGITUDINAL PROFILE

DRAWING NUMBER: 02.02

SHEET: 2 of 7

HY6602-DR-02.02-NEW PIPELINE LONGITUDINAL PROFILE-D01V01A.DWG



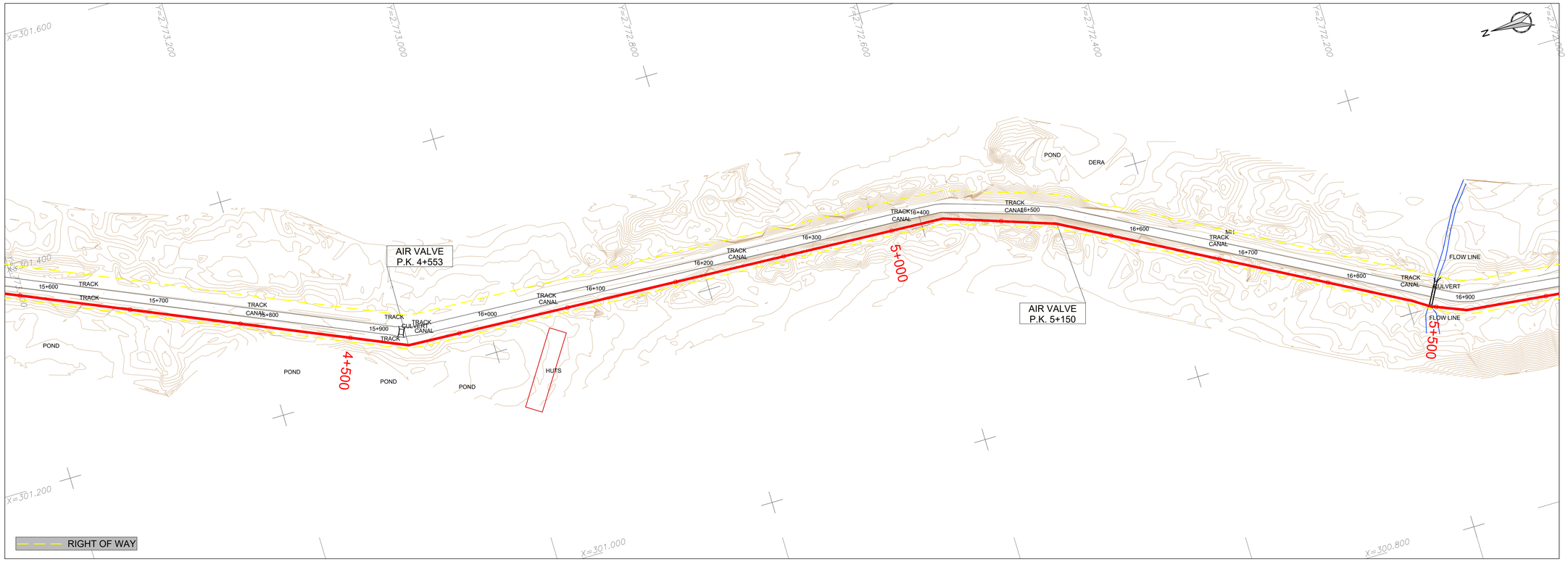


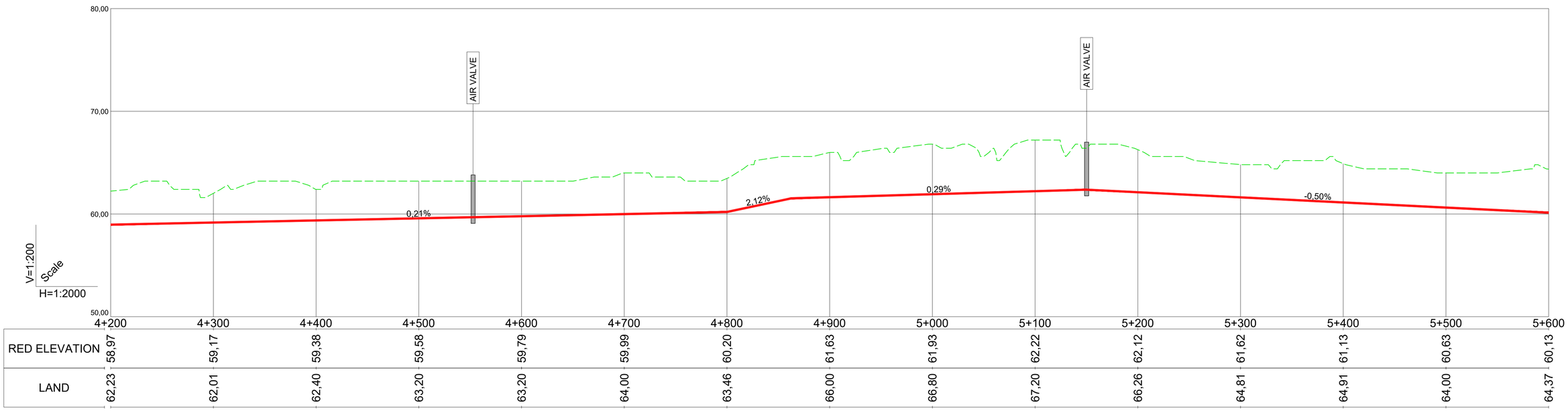
	2+800	2+900	3+000	3+100	3+200	3+300	3+400	3+500	3+600	3+700	3+800	3+900	4+000	4+100	4+200
RED ELEVATION	59,31	59,09	59,30	59,51	59,72	59,62	59,22	59,03	59,33	59,62	59,92	60,22	59,61	58,76	58,97
LAND	62,85	62,96	62,13	62,40	62,40	62,65	62,83	63,41	63,60	62,44	63,41	64,29	63,21	62,00	62,23

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 50 0 50 100 m SCALE 1:2.000; 5 0 5 10 m SCALE 1:200	TITLE: NEW PIPELINE LONGITUDINAL PROFILE	DRAWING NUMBER: 02.02 SHEET: 3 of 7

HY6602-DR-02.02-NEW PIPELINE LONGITUDINAL PROFILE-D01V01A.DWG



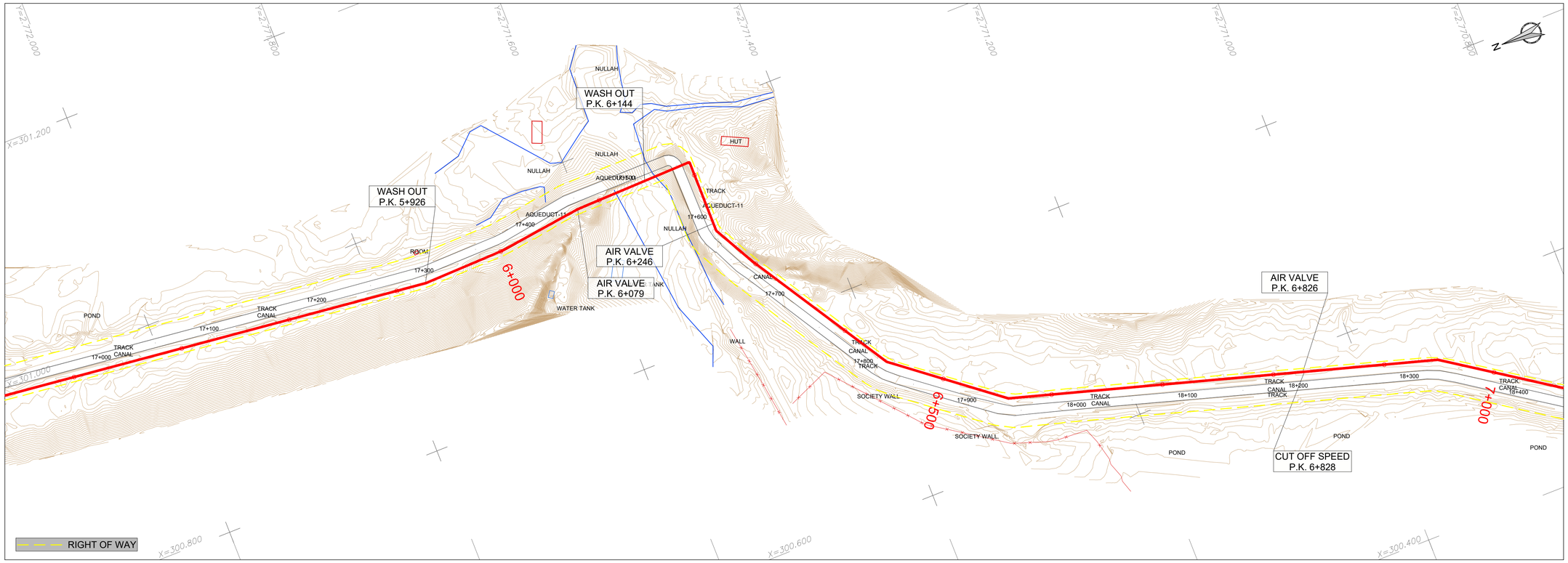


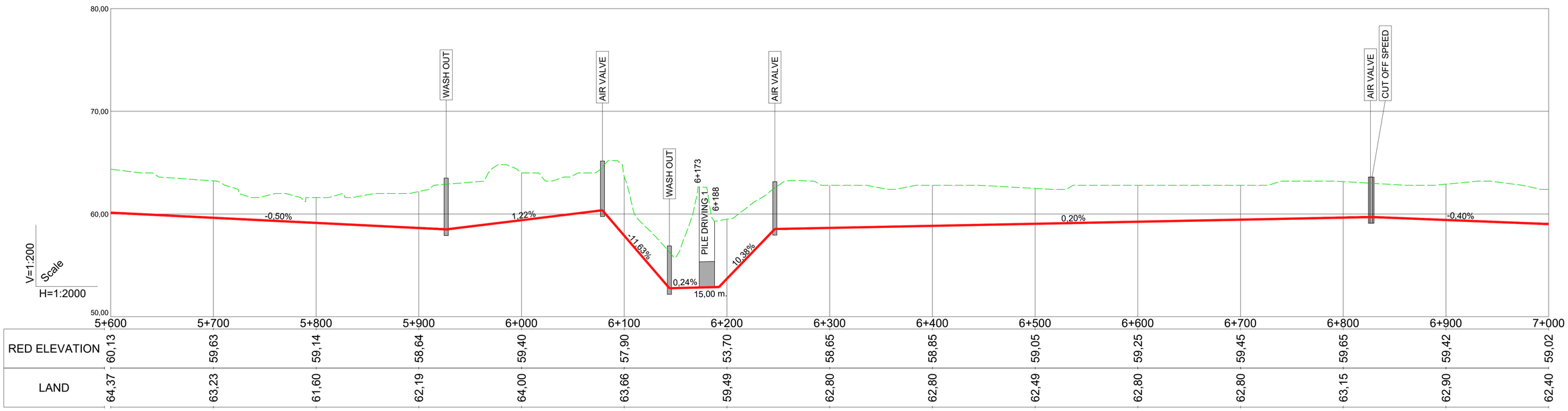
	4+200	4+300	4+400	4+500	4+600	4+700	4+800	4+900	5+000	5+100	5+200	5+300	5+400	5+500	5+600
RED ELEVATION	58,97	59,17	59,38	59,58	59,79	59,99	60,20	61,63	61,93	62,22	62,12	61,62	61,13	60,63	60,13
LAND	62,23	62,01	62,40	63,20	63,20	64,00	63,46	66,00	66,80	67,20	66,26	64,81	64,91	64,00	64,37

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): SCALE 1:2.000 / SCALE 1:200	TITLE: NEW PIPELINE LONGITUDINAL PROFILE	DRAWING NUMBER: 02.02 / SHEET: 4 of 7

HY6602-DR-02.02-NEW PIPELINE LONGITUDINAL PROFILE-D01V01A.DWG





RED ELEVATION	60,13	59,63	59,14	58,64	59,40	57,90	53,70	58,65	58,85	59,05	59,25	59,45	59,65	59,42	59,02
LAND	64,37	63,23	61,60	62,19	64,00	63,66	59,49	62,80	62,80	62,49	62,80	62,80	63,15	62,90	62,40

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

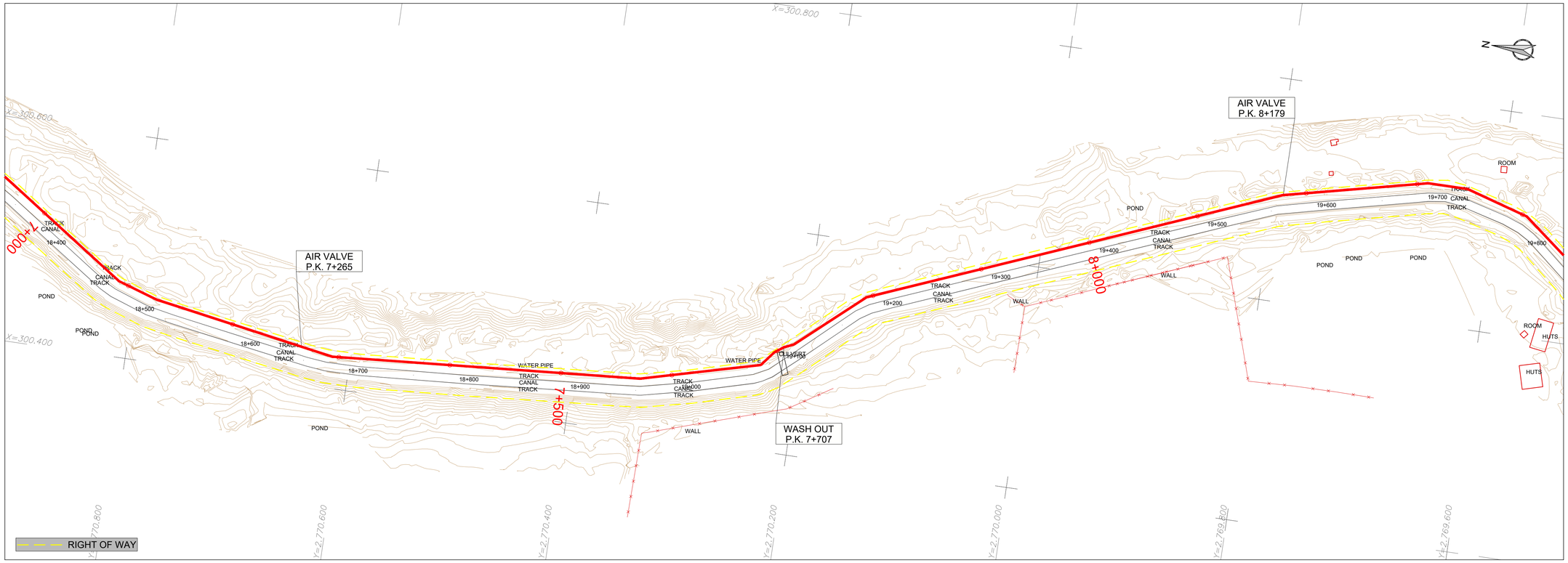
SCALES (DIN A1): 50 0 50 100 m — SCALE 1:2.000; 5 0 5 10 m — SCALE 1:200

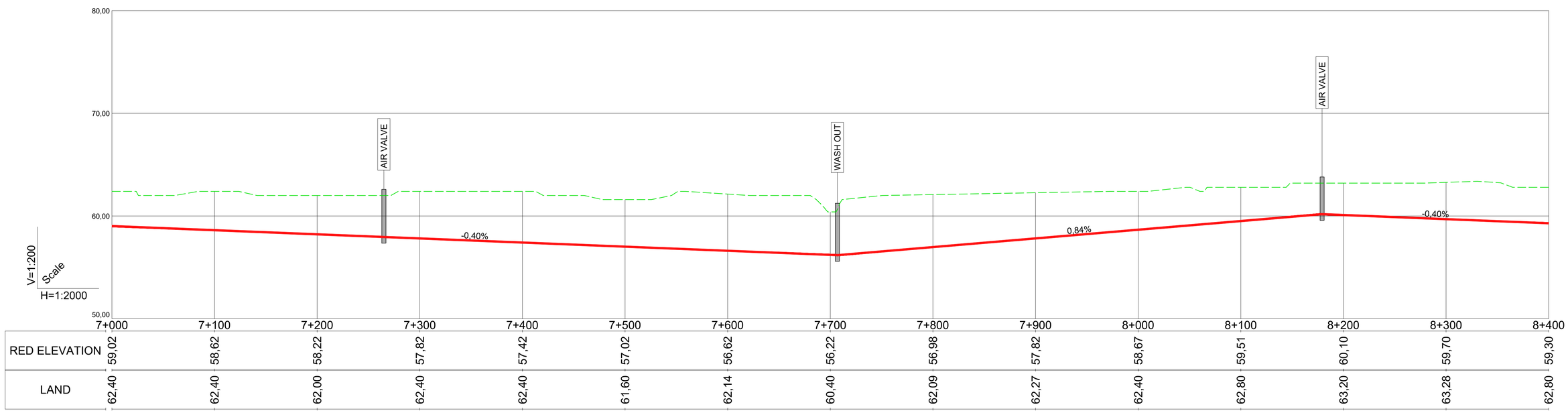
TITLE: NEW PIPELINE LONGITUDINAL PROFILE

DRAWING NUMBER: 02.02

SHEET: 5 of 7

HY6602-DR-02.02-NEW PIPELINE LONGITUDINAL PROFILE-D01V01A.DWG





	7+000	7+100	7+200	7+300	7+400	7+500	7+600	7+700	7+800	7+900	8+000	8+100	8+200	8+300	8+400
RED ELEVATION	59,02	58,62	58,22	57,82	57,42	57,02	56,62	56,22	56,98	57,82	58,67	59,51	60,10	59,70	59,30
LAND	62,40	62,40	62,00	62,40	62,40	61,60	62,14	60,40	62,09	62,27	62,40	62,80	63,20	63,28	62,80

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

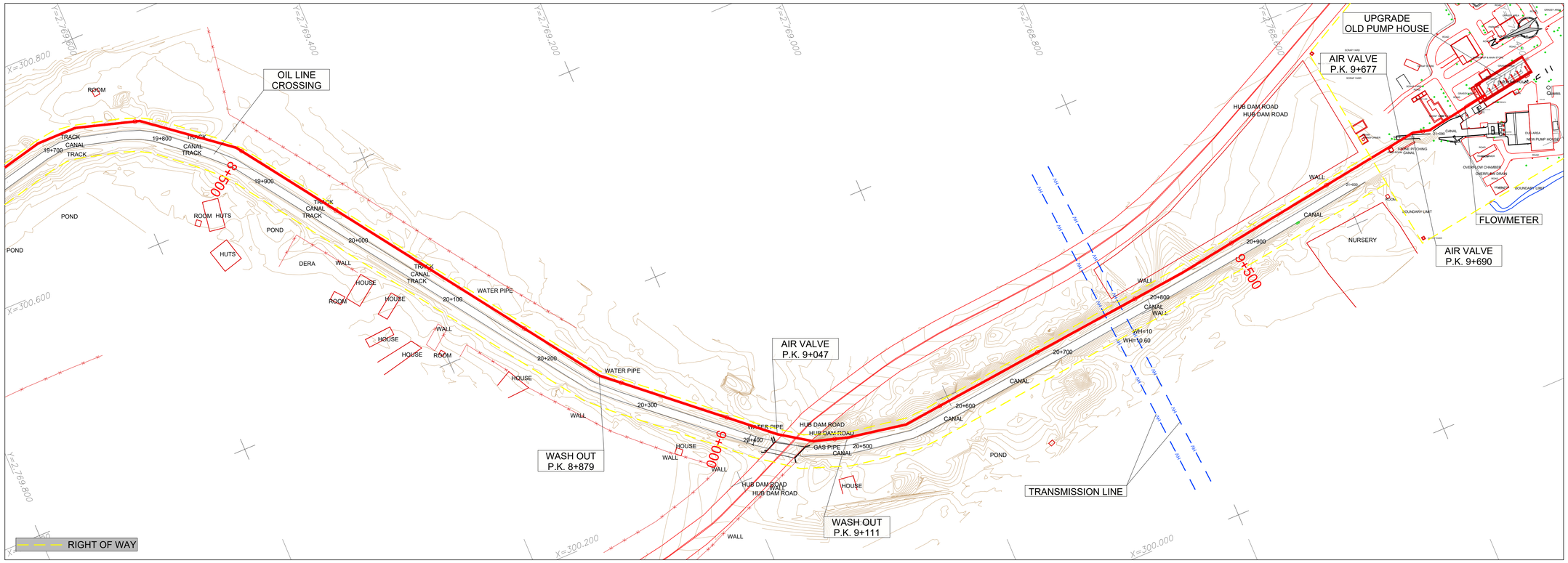
SCALES (DIN A1): 50 0 50 100 m — SCALE 1:2.000; 5 0 5 10 m — SCALE 1:200

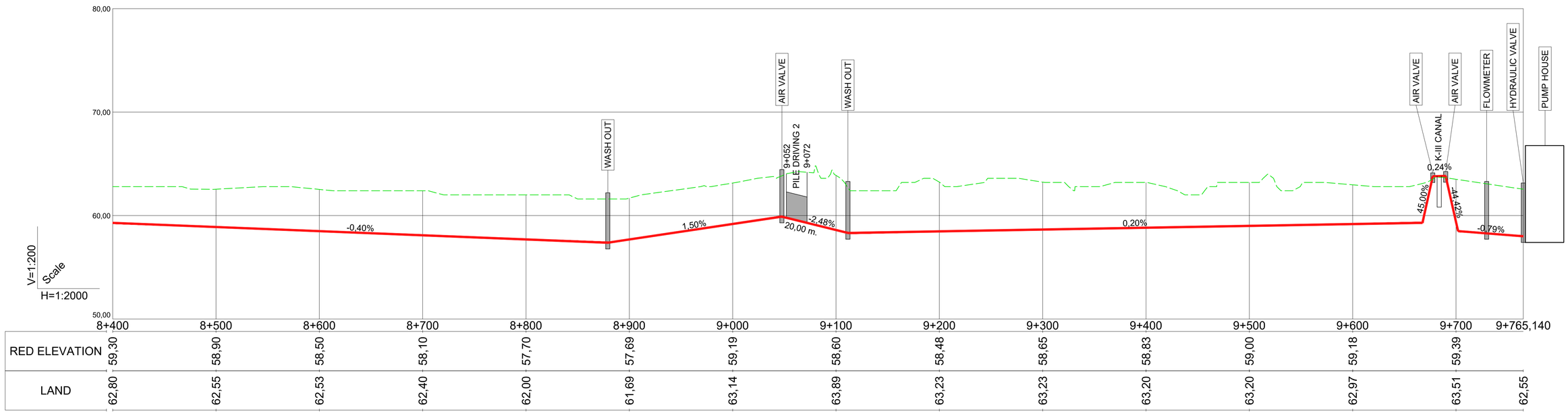
TITLE: NEW PIPELINE LONGITUDINAL PROFILE

DRAWING NUMBER: 02.02

SHEET: 6 of 7

HY6602-DR-02.02-NEW PIPELINE LONGITUDINAL PROFILE-D01V01A.DWG

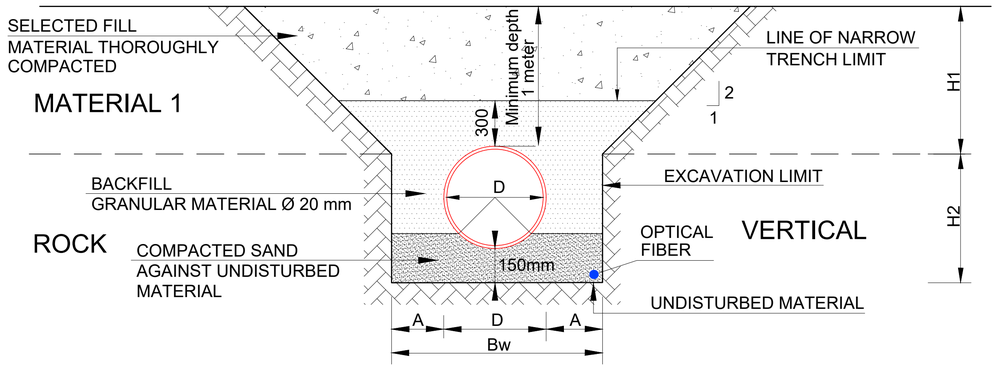




All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

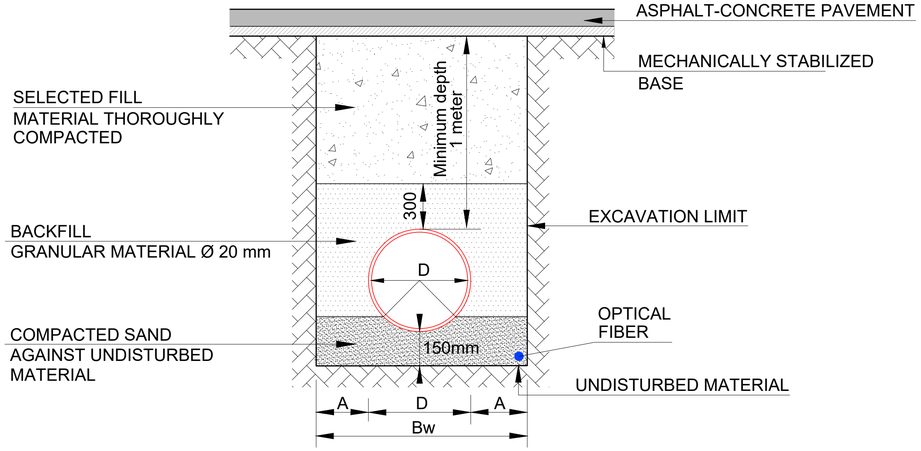
IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 50 0 50 100 m SCALE 1:2.000; 5 0 5 10 m SCALE 1:200	TITLE: NEW PIPELINE LONGITUDINAL PROFILE	DRAWING NUMBER: 02.02; SHEET: 7 of 7

HY6602-DR-02.02-NEW PIPELINE LONGITUDINAL PROFILE-D01V01A.DWG



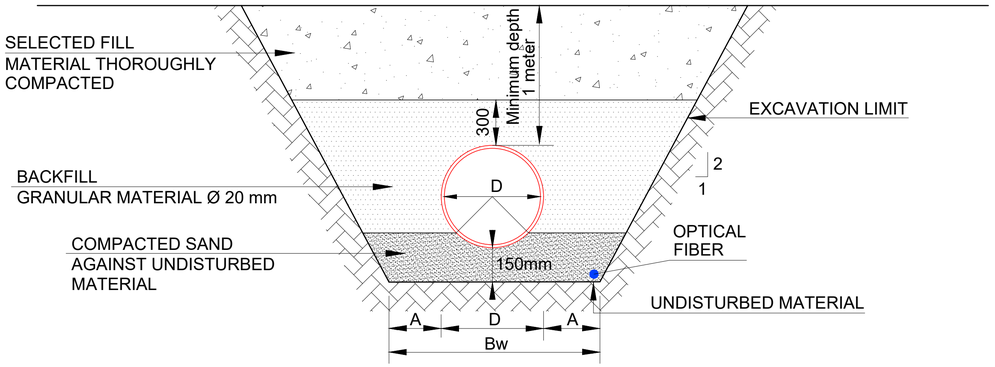
TRENCH TYPE 1 (IN ROCK)

N.T.S



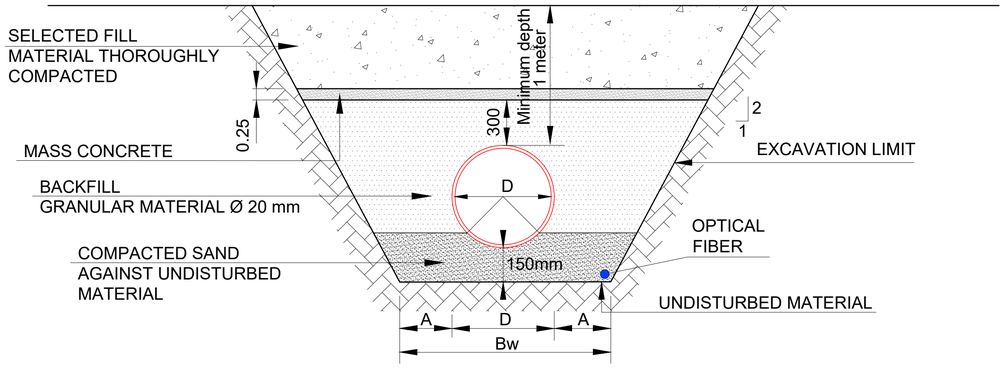
TRENCH TYPE 3 (IN ROAD)

N.T.S



TRENCH TYPE 2

N.T.S



TRENCH TYPE 4 (IN STREAM)

N.T.S

TYPICAL TRENCH SECTIONS

TABLE 1 : MINIMUM TRENCH WIDTH		
PIPE DIAMETER	SIDE CLEARANCE	BOTTOM TRENCH WIDTH
D(mm)	A (mm)	BW(mm)
1900	450	2800

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

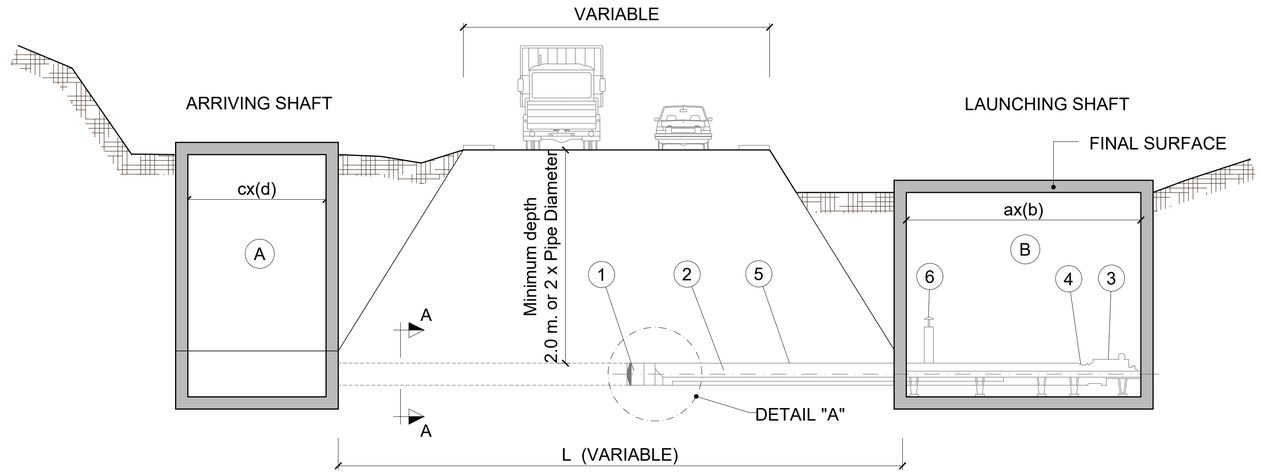
SCALES (DIN A1): N/S

TITLE: NEW PIPELINE TRENCH CROSS SECTION

DRAWING NUMBER: 02.03

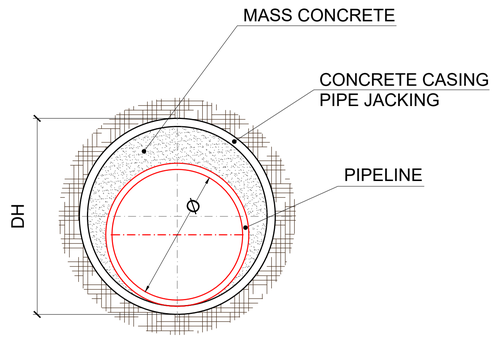
SHEET: 1 of 1

HY6602-DR-02.03-NEW PIPELINE PILE TRENCH CROSS SECT-D01V01A.DWG



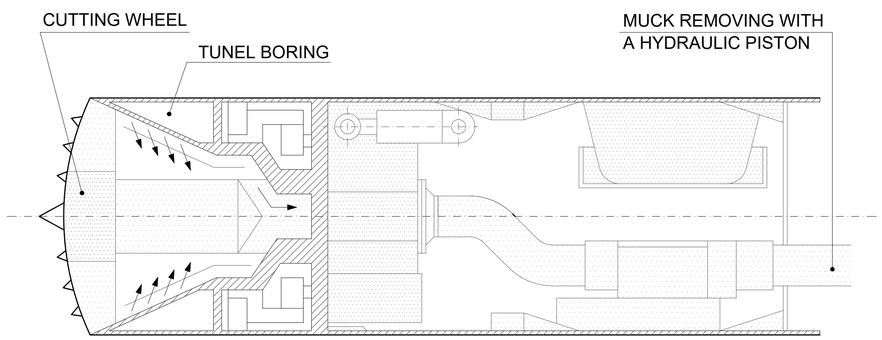
PIPE JACKING WITH SHIELD AND ENCASING REINFORCED CONCRETE PIPE

WITHOUT SCALE



SECTION A-A

WITHOUT SCALE



DETAIL "A"

WITHOUT SCALE

LEGEND	
A	ARRIVING SHAFT
B	LAUNCHING SHAFT
1	CUTTING WHEEL
2	MUCK REMOVING WITH HYDRAULIC PISTON
3	HYDRAULIC UNIT
4	PULLING HEAD
5	CASING PIPE
6	SPINDE TO FIX THE LEVEL

INITIAL CHAINAGE	FINAL CHAINAGE	LENGTH (m)	a (m)	b (m)	c (m)	d (m)	DIAMETER (mm)	PIPE-JACKING (mm)	CLASS
6+173	6+188	15	10.5	4.0	2.5	3.0	1,900	2,500	CONCRETE
9+052	9+072	20	10.5	4.0	2.5	3.0	1,900	2,500	CONCRETE

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

SCALES (DIN A1): N/S

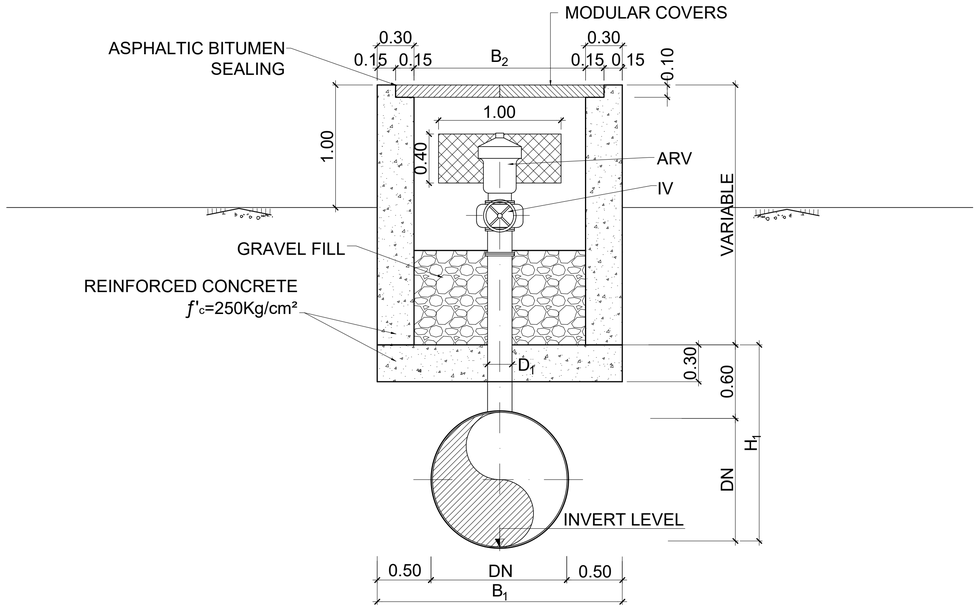
TITLE: NEW PIPELINE PILE DRIVING PLAN

DRAWING NUMBER: 02.04

SHEET: 1 of 1

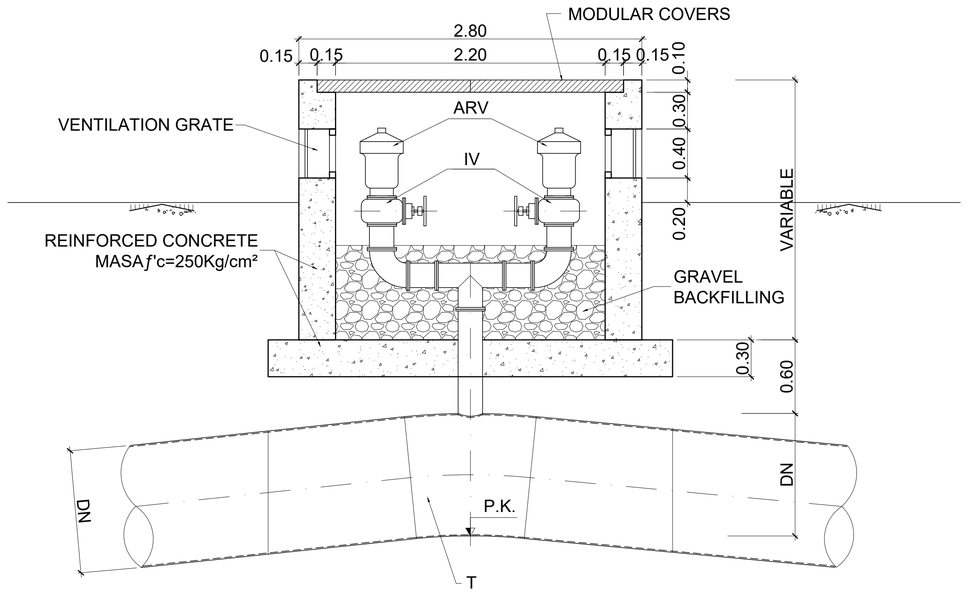
HY6602--DR--02.04--NEW PIPELINE PILE DRIVING PLAN--D01V01A.DWG

AIR VALVE MANHOLE DIMENSION



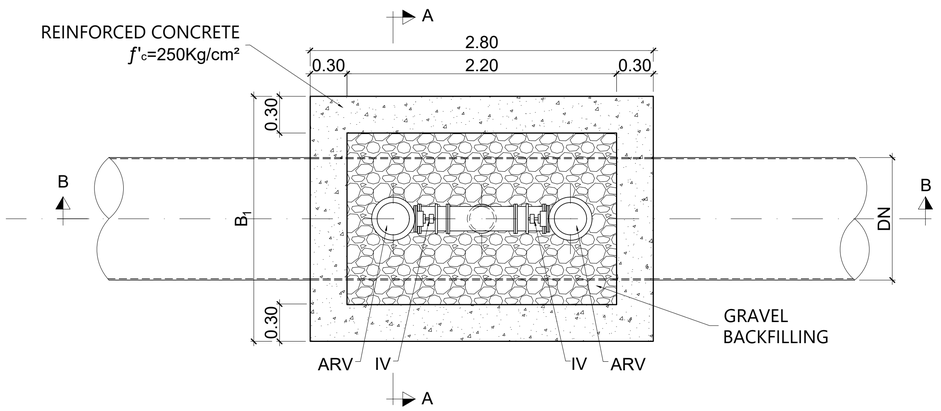
SECTION A-A

SCALE 1:25



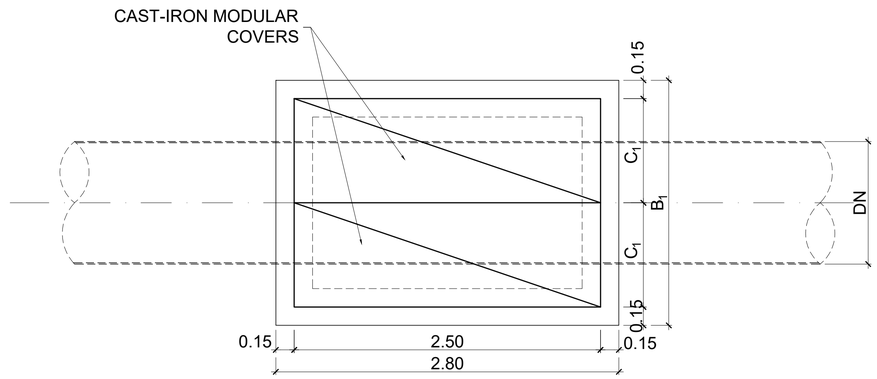
SECTION B-B

SCALE 1:25



SECTIONAL PLAN

SCALE 1:25



SECTIONAL COVER PLAN VIEW

SCALE 1:25

NOMINAL DIAMETER (mm)	OUTSIDE DIAMETER (mm)	AIR VALVE BRANCH DIAMETER (mm)	B1 (mm)	B2 (mm)	H1 (mm)	C1 (mm)
1,900	1,943	150	2,943	2,343	2,543	1,322

NOTES

1-ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED.
2-ALL PIPES FITTINGS SHOWN ON THIS DRAWING ARE NOT TO SCALE.
3-IT IS REPONSIBILITY OF THE CONTRACTOR TO VERIFY THE PIPES DIMENSIONS AND POSITION.

LEGEND

ARV - AIR RELEASE VALVE
IV - ISOLATING VALVE

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

SCALES (DIN A1): 0.5 0 0.5 1 m — SCALE 1:25

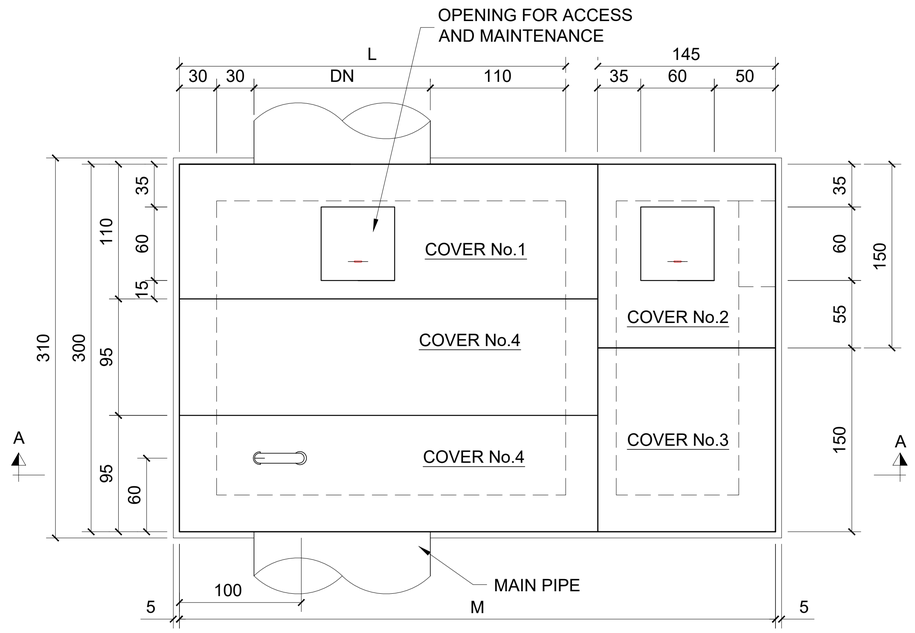
TITLE: NEW PIPELINE AIR VALVE

DRAWING NUMBER: 02.05

SHEET: 1 of 1

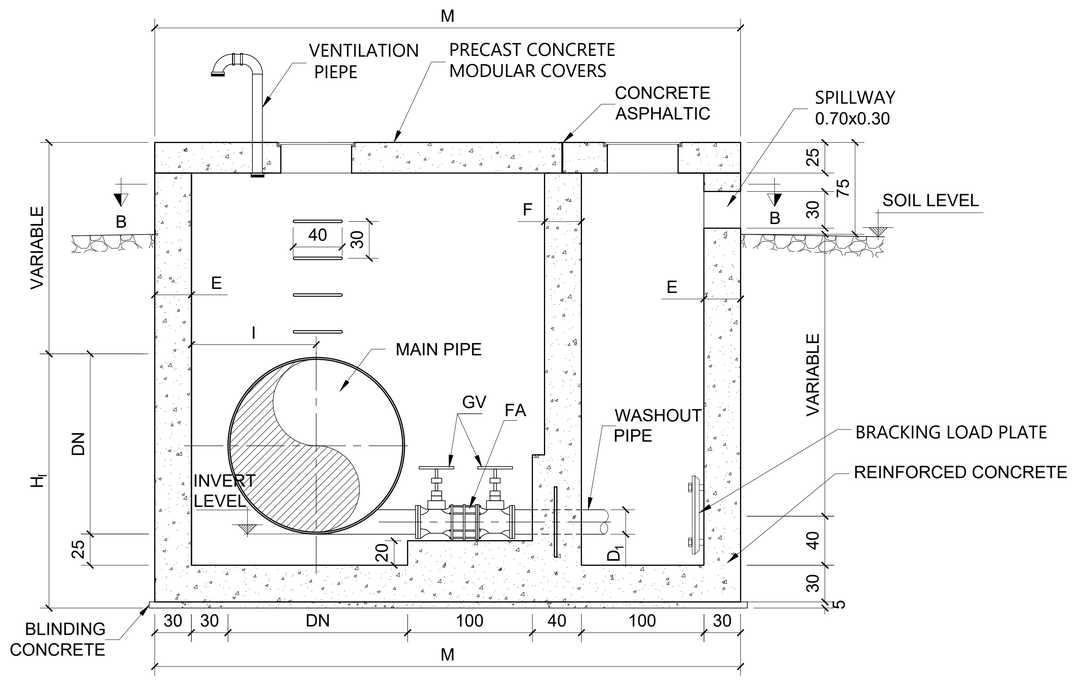
HY6602-DR-02.05-NEW PIPELINE AIR VALVE-D01V01A.DWG

WASHOUT MANHOLE DIMENSION



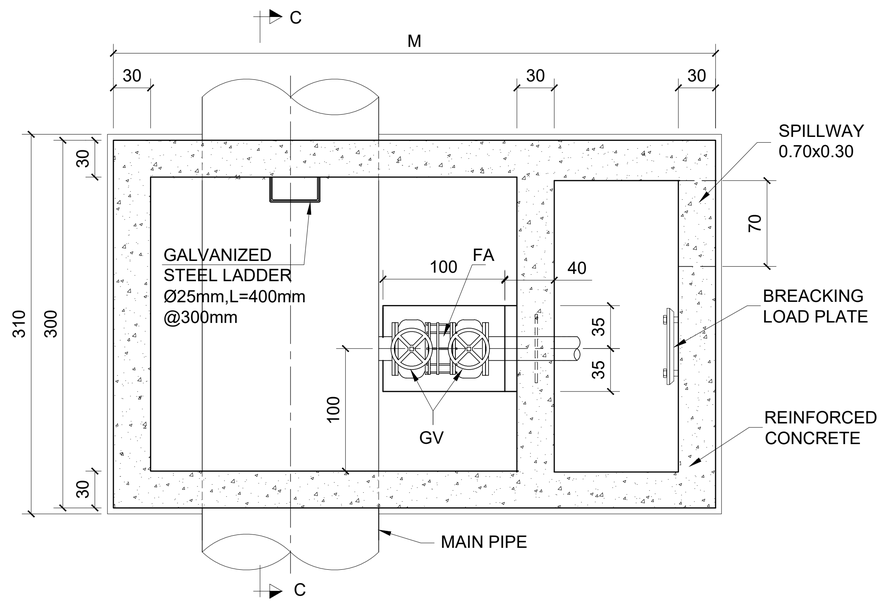
SECTIONAL PLAN VIEW

SCALE 1:25



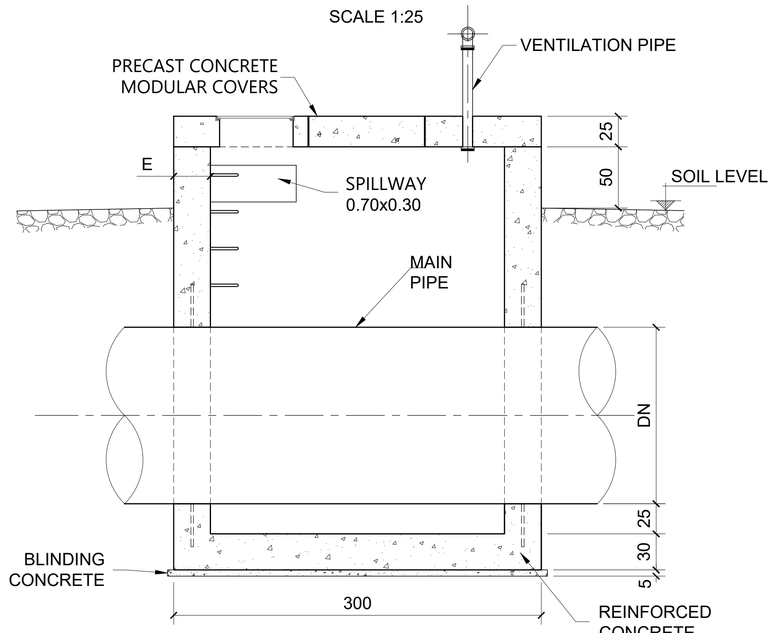
SECTION A - A

SCALE 1:25



SECTION B - B

SCALE 1:25



SECTION C - C

SCALE 1:25

LEGEND

GV - GATE VALVE
FA - FLANGE ADAPTER

NOTES

1-ALL DIMENSIONS ARE IN CENTIMETERS UNLESS OTHERWISE NOTED.
2-ALL PIPES FITTINGS SHOWN ON THIS DRAWING ARE NOT TO SCALE.
3-IT IS REPONSIBILITY OF THE CONTRACTOR TO VERIFY THE PIPES DIMENSIONS AND POSITION.

NOMINAL DIAMETER (mm)	OUTSIDE DIAMETER (mm)	WASHOUT BRANCH DIAMETER D1 (mm)	L (mm)	M (mm)	H1 (mm)	I (mm)
1,900	1,943	300	3,643	5,443	2,543	1,272

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

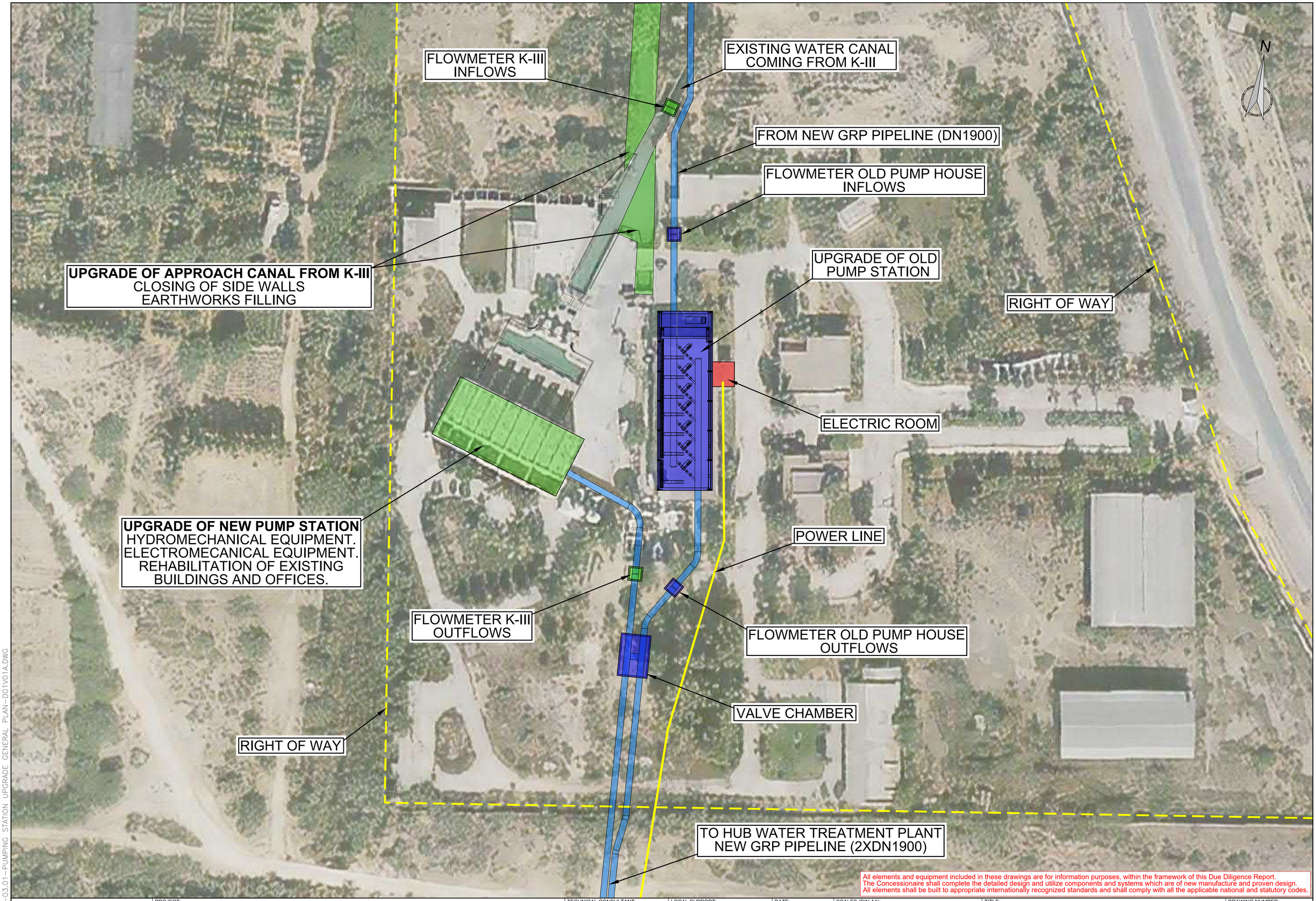
SCALES (DIN A1): 0.5 0 0.5 1 m — SCALE 1:25

TITLE: NEW PIPELINE WASHOUT

DRAWING NUMBER: 02.06

SHEET: 1 of 1

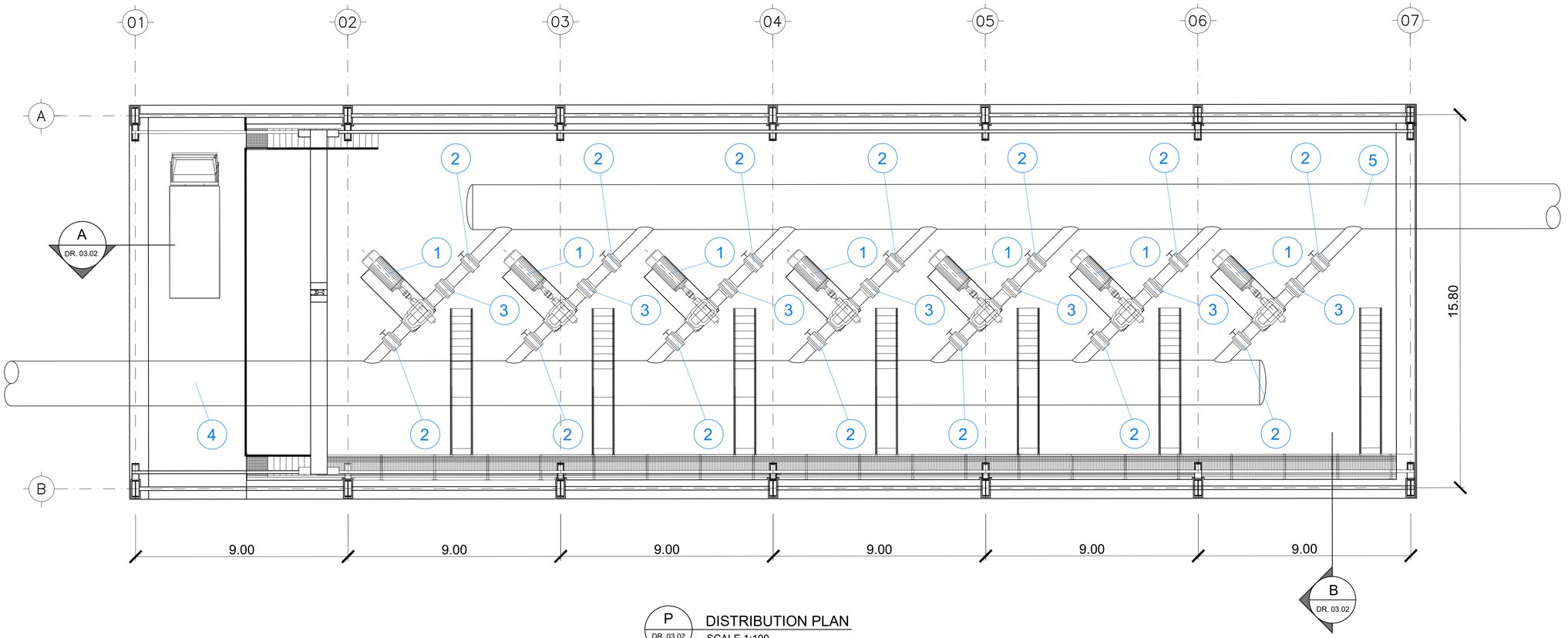
HY6602-DR-02.06-NEW PIPELINE WASHOUT-D01V01A.DWG



All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 5 0 5 10 15 20 25 m SCALE 1:500	TITLE: PUMPING STATION UPGRADE: GENERAL PLAN	DRAWING NUMBER: 03.01 SHEET: 1 of 2

HY6602-DR-03.01-PUMPING STATION UPGRADE GENERAL PLAN-D01V01A.DWG



P
DR. 03.02

DISTRIBUTION PLAN
SCALE 1:100

MARK	DESCRIPTION
1	PUMP
2	BUTERFLY VALVE
3	CHEK VALVE
4	SUCTION MAINFLOD DN 1900
5	DISCHARGE PIPELINE DN 1900

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

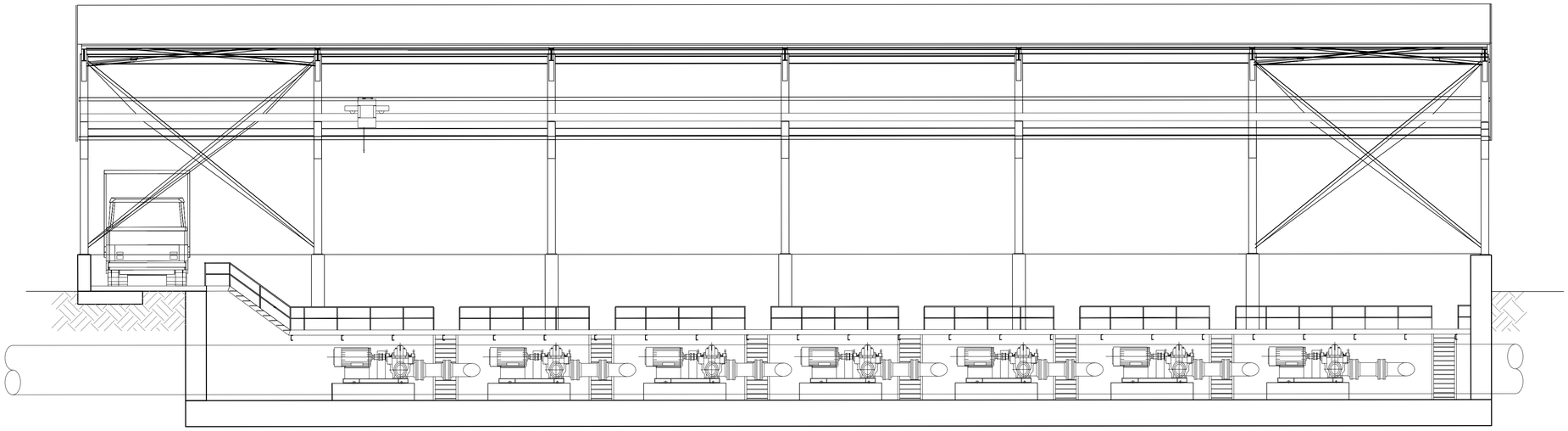
SCALES (DIN A1): 1 0 1 2 3 4 5 m — SCALE 1:100

TITLE: PUMPING STATION UPGRADE: GENERAL PLAN

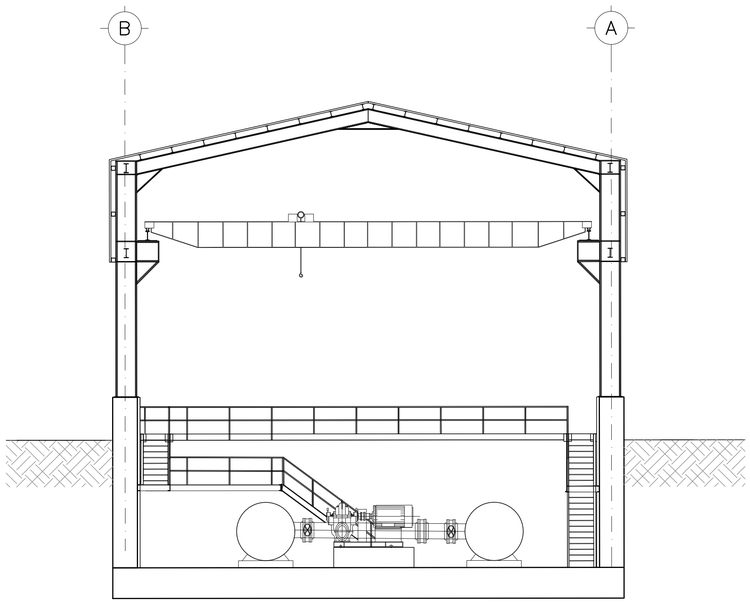
DRAWING NUMBER: 03.01

SHEET: 2 of 2

HY6602-DR-03.01-PUMPING STATION UPGRADE GENERAL PLAN-D01V01A.DWG



A
DR. 03.01
SECTION
SCALE 1:100



B
DR. 03.01
SECTION
SCALE 1:100

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

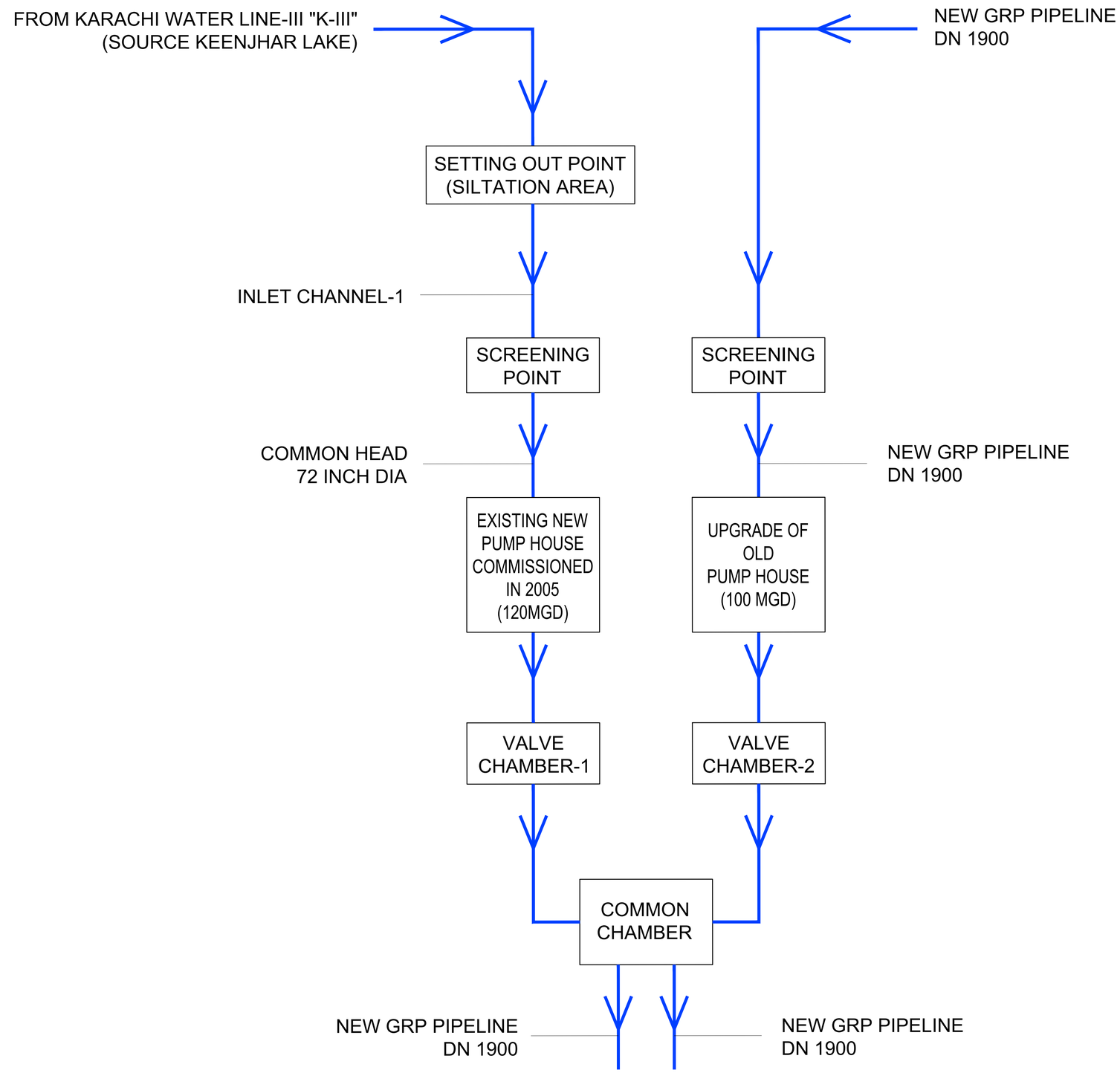
SCALES (DIN A1): 1 0 1 2 3 4 5 m — SCALE 1:100

TITLE: PUMPING STATION UPGRADE: SECTIONS

DRAWING NUMBER: 03.02

SHEET: 1 of 1

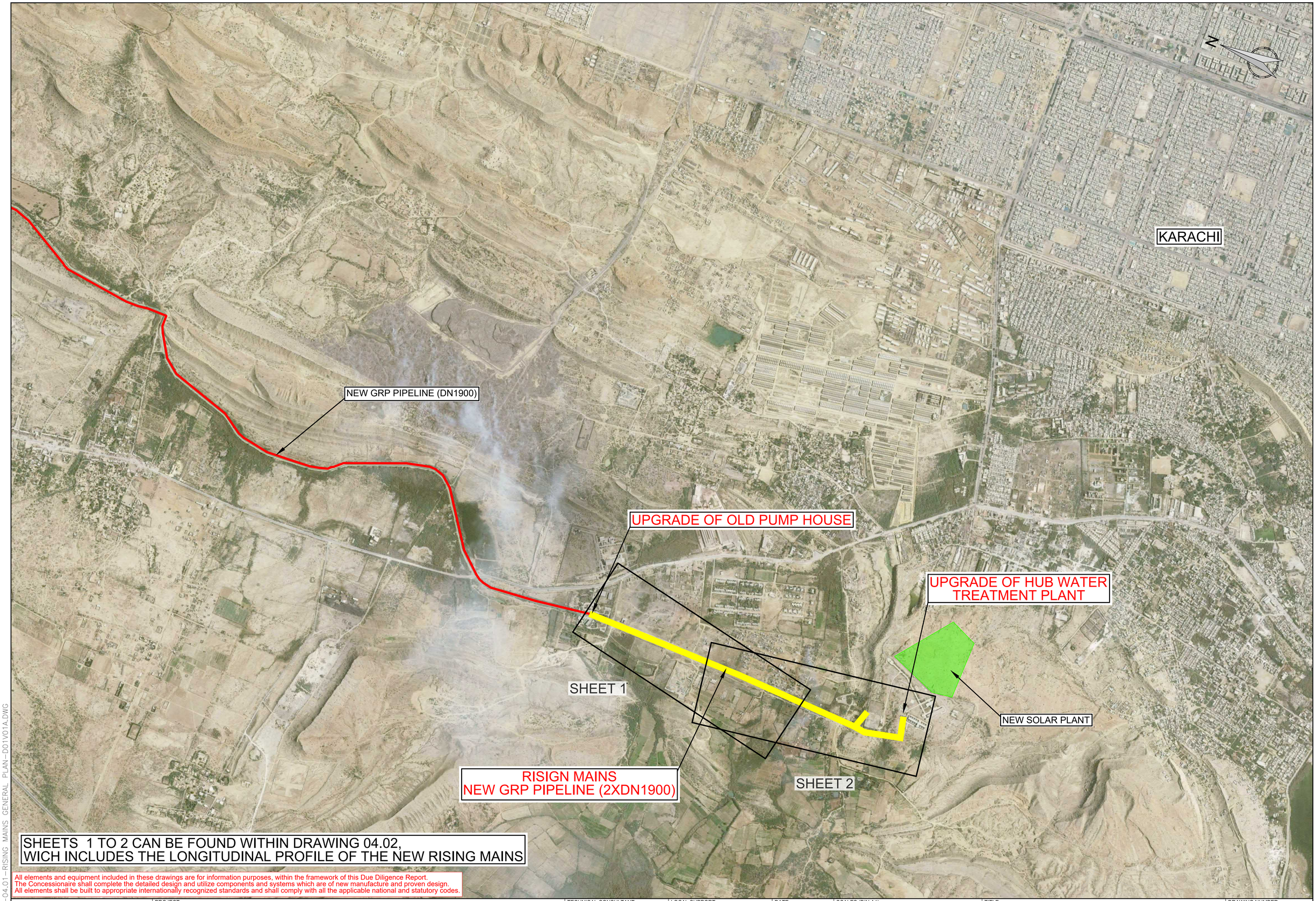
HY6602-DR-03.02-PUMPING STATION UPGRADE SECTIONS-D01V01A.DWG



All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1):	TITLE: NEW HUB PUMPING STATION INTERACTION WITH K-III	DRAWING NUMBER: 03.03 SHEET: 1 of 1

HY6602-DR-03.03-NEW HUB PUMPING STATION INTERACTION WITH K-III.DWG

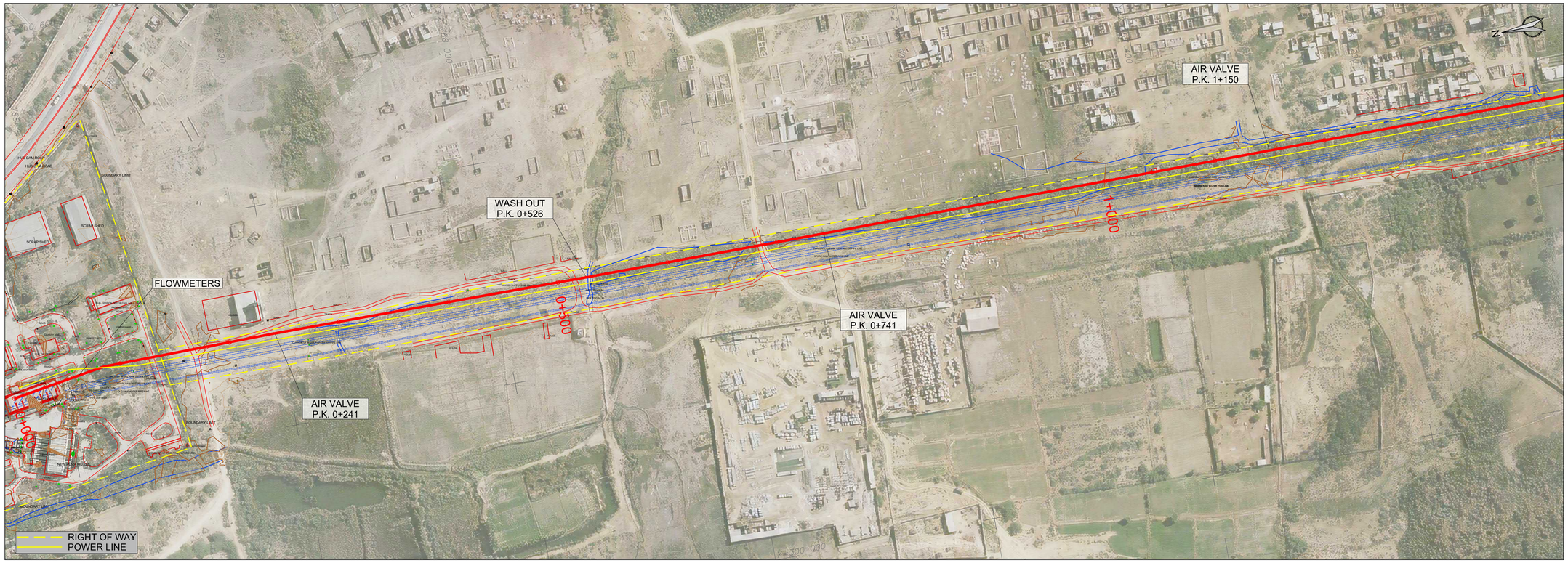


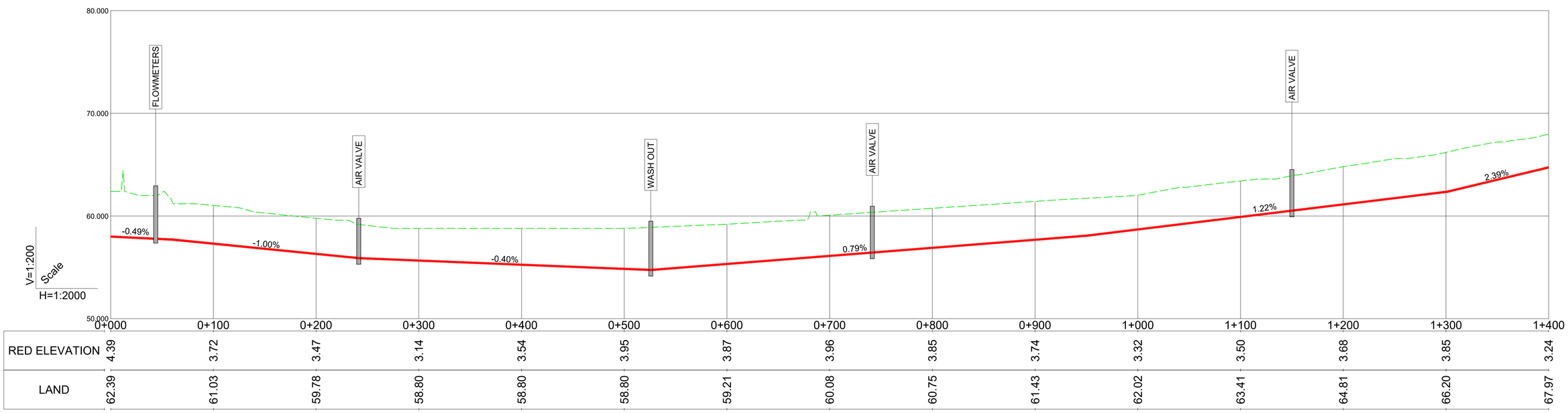
SHEETS 1 TO 2 CAN BE FOUND WITHIN DRAWING 04.02,
WICH INCLUDES THE LONGITUDINAL PROFILE OF THE NEW RISING MAINS

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 100 0 100 200 300 400 500 m SCALE 1:10.000	TITLE: RISING MAINS GENERAL PLAN	DRAWING NUMBER: 04.01 SHEET: 1 of 1

HY6602_DR_04.01_RISING MAINS GENERAL PLAN_D01V01A.DWG





	0+000	0+100	0+200	0+300	0+400	0+500	0+600	0+700	0+800	0+900	1+000	1+100	1+200	1+300	1+400
RED ELEVATION	4.39	3.72	3.47	3.14	3.54	3.95	3.87	3.96	3.85	3.74	3.32	3.50	3.68	3.85	3.24
LAND	62.39	61.03	59.78	58.80	58.80	58.80	59.21	60.08	60.75	61.43	62.02	63.41	64.81	66.20	67.97

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

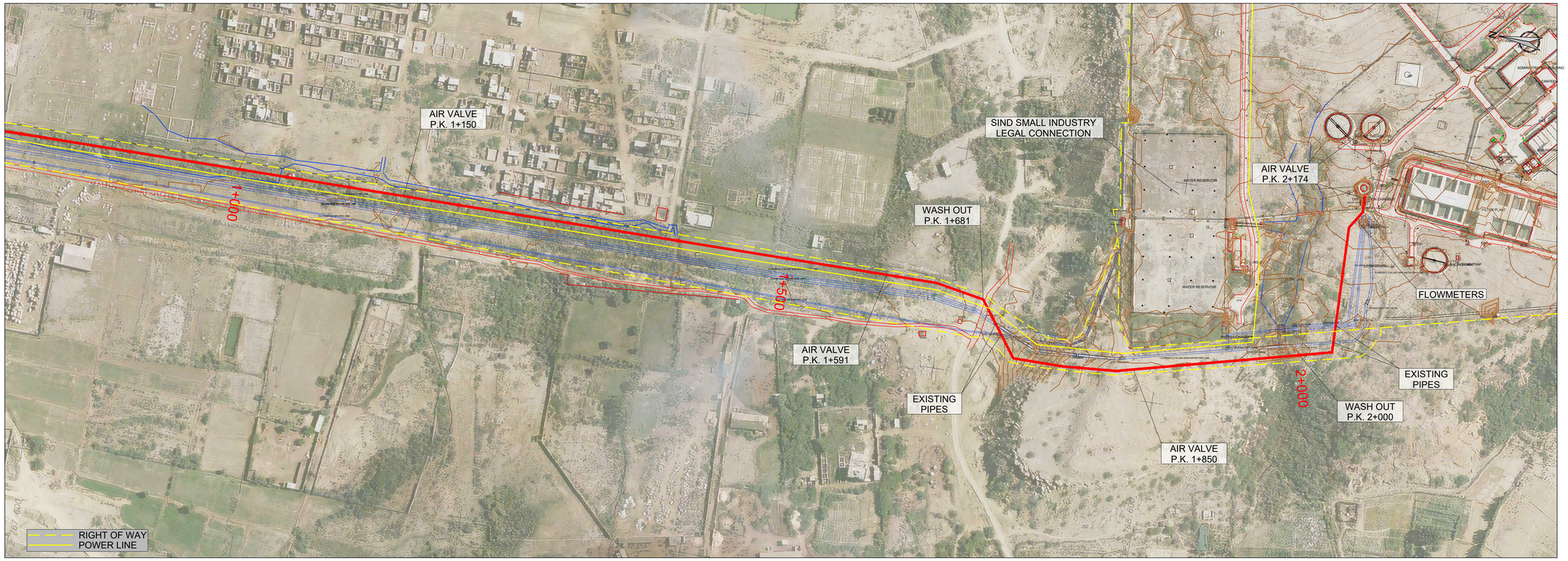
SCALES (DIN A1): SCALE 1:2.000 (50 0 50 100 m); SCALE 1:200 (5 0 5 10 m)

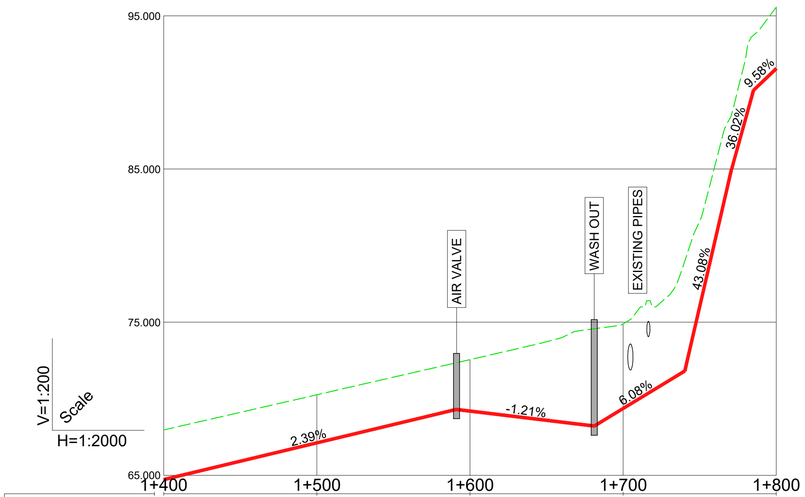
TITLE: RISING MAINS UPGRADE LONGITUDINAL PROFILE

DRAWING NUMBER: 04.02

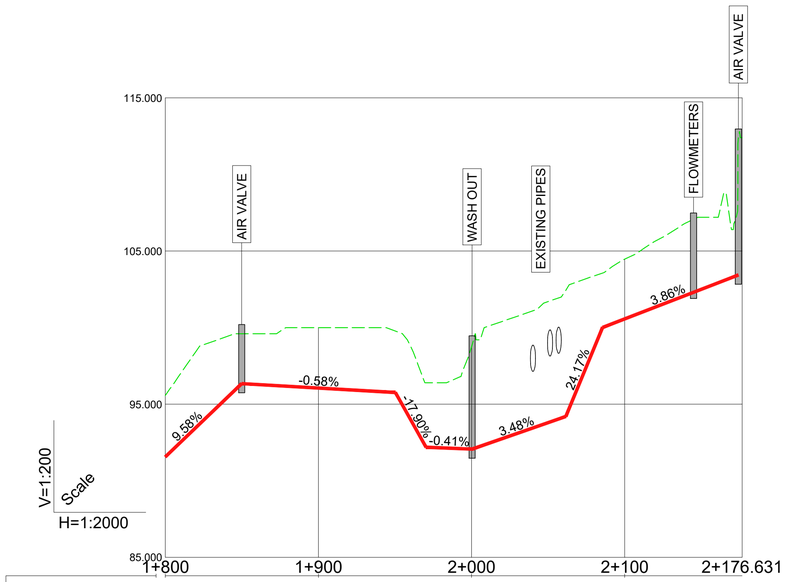
SHEET: 1 of 2

HY6602-DR-04.02-RISING MAINS UPGRADE LONGITUDINAL PROFILE-D01V01A.DWG





RED ELEVATION	3.24	3.14	3.36	5.52	4.01
LAND	67.97	70.26	72.56	74.89	95.57



RED ELEVATION	4.01	3.94	6.68	3.90	
LAND	95.57	100.00	98.75	104.47	112.40

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

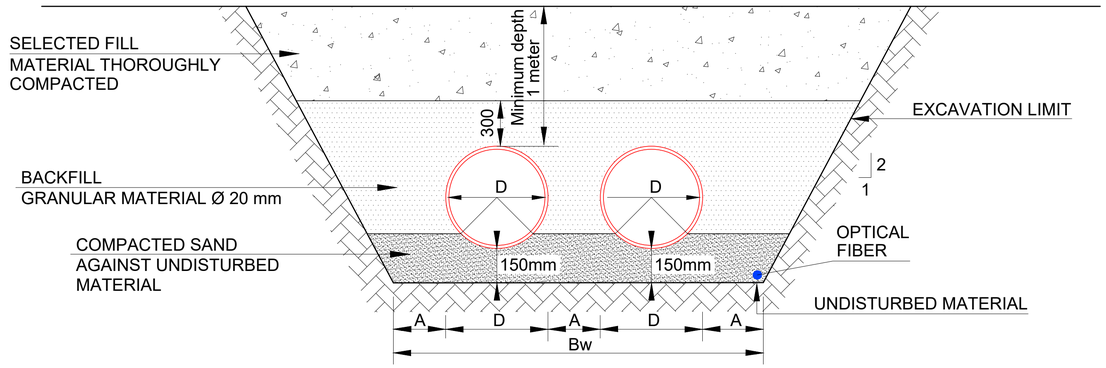
SCALES (DIN A1): SCALE 1:2.000; SCALE 1:200

TITLE: RISING MAINS UPGRADE LONGITUDINAL PROFILE

DRAWING NUMBER: 04.02

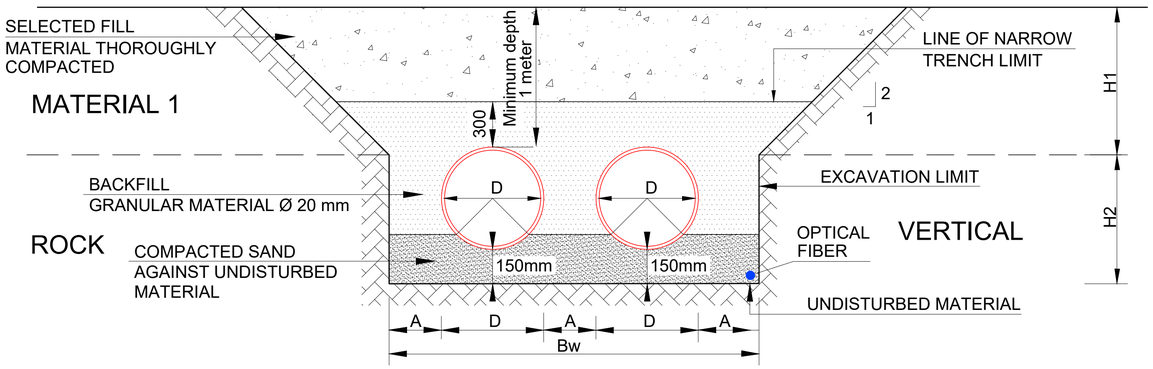
SHEET: 2 of 2

HY6602-DR-04.02-RISING MAINS UPGRADE LONGITUDINAL PROFILE-D01V01A.DWG



TRENCH TYPE 1

N.T.S



TRENCH TYPE 2 (IN ROCK)

N.T.S

TYPICAL TRENCH SECTIONS

TABLE 1 : MINIMUM TRENCH WIDTH		
PIPE DIAMETER	SIDE CLEARANCE	BOTTOM TRENCH WIDTH
D(mm)	A (mm)	BW(mm)
1900	450	5150

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

SCALES (DIN A1): N/S

TITLE: RISING MAINS UPGRADE TYPICAL CROSS SECTION

DRAWING NUMBER: 04.03

SHEET: 1 of 1

HY6602-DR-04.03-RISING MAINS UPGRADE TYPICAL CROSS SECTION-D01V01A.DWG

EXISTING FLOWMETER

RESERVOIR

SLUDGE THICKENERS

NEW SLUDGE BUILDING (CENTRIFUGES)

POWER LINE

NEW RISING MAINS

EXISTING INTAKE

EXISTING CHLORINATING BUILDING

NEW FLOWMETERS

EXISTING FLOWMETERS

DISTRIBUTION CHAMBER

BALANCING TANK

SAND FILTERS

4 NEW FILTERS

GENERATOR BUILDING

RIGHT OF WAY

ADMINISTRATION BUILDING

CHEMICAL BUILDING

NEW SOLAR PLANT

N

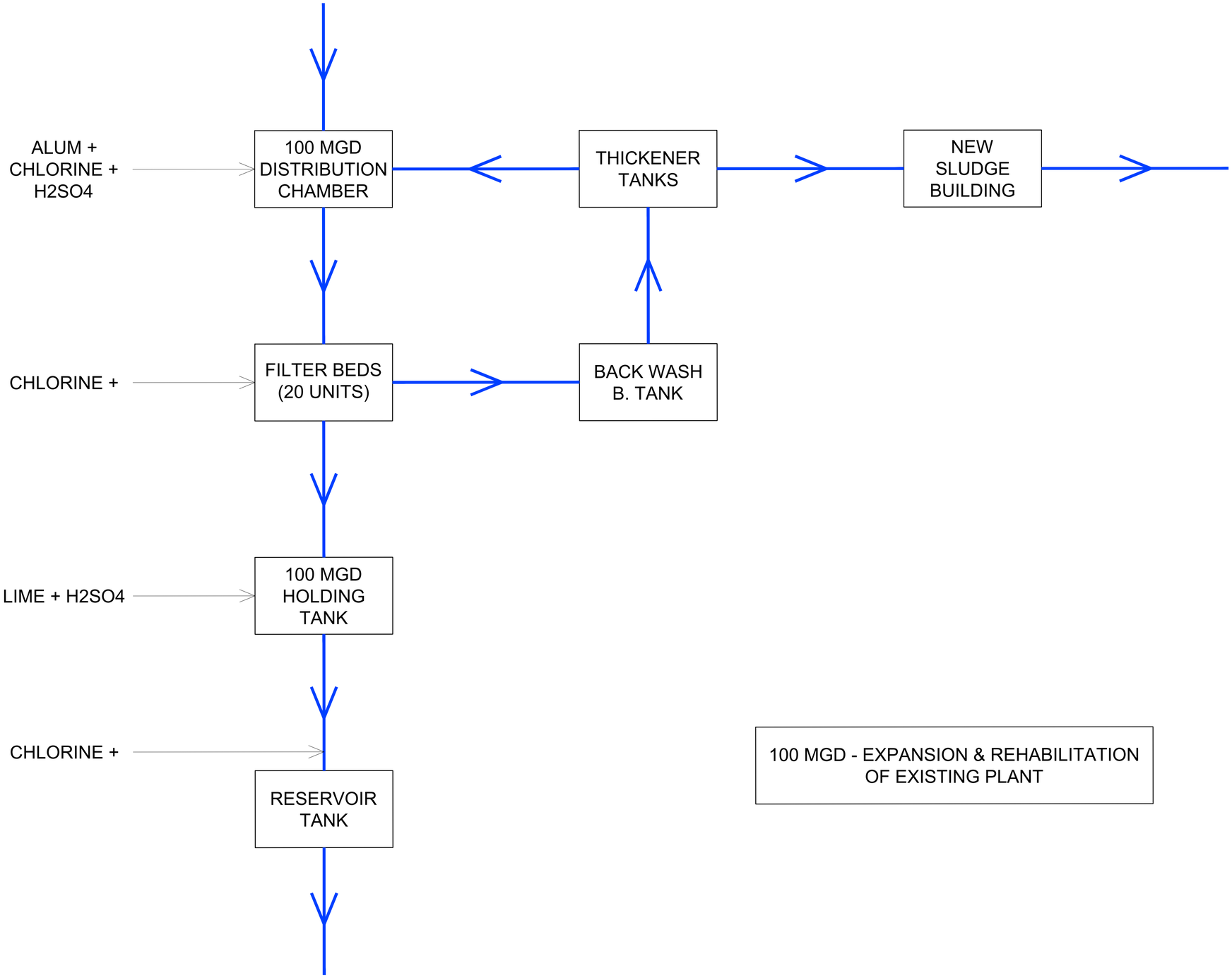
LEGEND

- NEW SLUDGE BUILDING (CENTRIFUGES)
- 4 NEW FILTERS
- CHANGE ALL EQUIPMENTS AND PIPELINES
- RESERVOIR REHABILITATION
- IP GATEWAY / RADIO NODE

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

HY6602--DR--05.01--FILTRATION_PLANT_UPGRADE_GENERAL_PLAN.DWG

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): 20 0 20 40 60 80 100 m SCALE 1:1.500	TITLE: FILTRATION PLANT UPGRADE: GENERAL PLAN	DRAWING NUMBER: 05.01 SHEET: 1 of 1

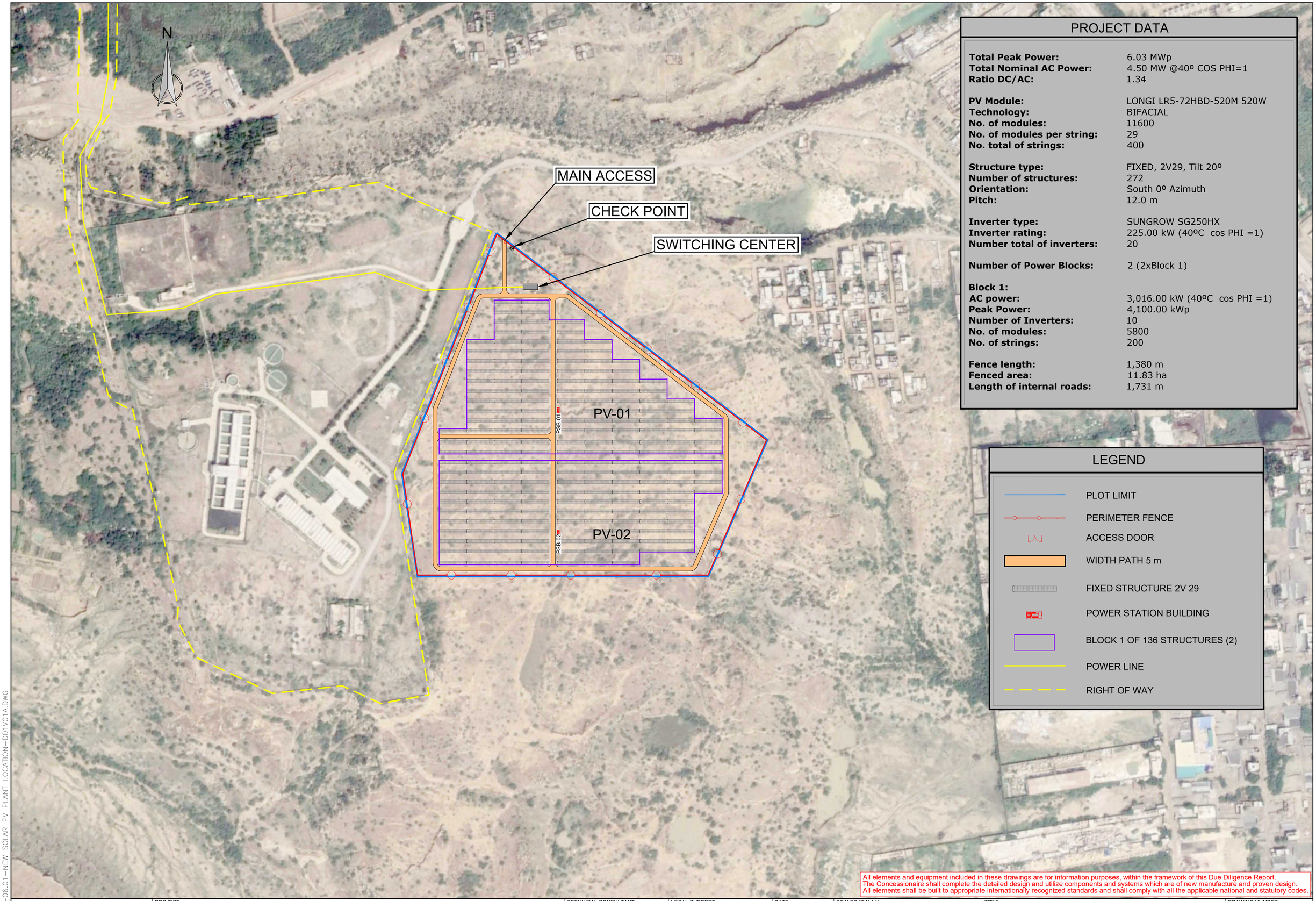


100 MGD - EXPANSION & REHABILITATION OF EXISTING PLANT

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1):	TITLE: FILTRATION PLANT UPGRADE 100 MGD FLOW DIAGRAM	DRAWING NUMBER: 05.02 SHEET: 1 of 1

HY6602-DR-05.02-FILTRATION PLANT UPGRADE FLOW DIAGRAM-D01V01A.DWG



PROJECT DATA

Total Peak Power:	6.03 MWp
Total Nominal AC Power:	4.50 MW @40º COS PHI=1
Ratio DC/AC:	1.34
PV Module:	LONGI LR5-72HBD-520M 520W
Technology:	BIFACIAL
No. of modules:	11600
No. of modules per string:	29
No. total of strings:	400
Structure type:	FIXED, 2V29, Tilt 20º
Number of structures:	272
Orientation:	South 0º Azimuth
Pitch:	12.0 m
Inverter type:	SUNGROW SG250HX
Inverter rating:	225.00 kW (40ºC cos PHI =1)
Number total of inverters:	20
Number of Power Blocks:	2 (2xBlock 1)
Block 1:	
AC power:	3,016.00 kW (40ºC cos PHI =1)
Peak Power:	4,100.00 kWp
Number of Inverters:	10
No. of modules:	5800
No. of strings:	200
Fence length:	1,380 m
Fenced area:	11.83 ha
Length of internal roads:	1,731 m

LEGEND

- PLOT LIMIT
- PERIMETER FENCE
- ACCESS DOOR
- WIDTH PATH 5 m
- FIXED STRUCTURE 2V 29
- POWER STATION BUILDING
- BLOCK 1 OF 136 STRUCTURES (2)
- POWER LINE
- RIGHT OF WAY

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP

PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)

TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS

LOCAL SUPPORT: HPK

DATE: APRIL 2021

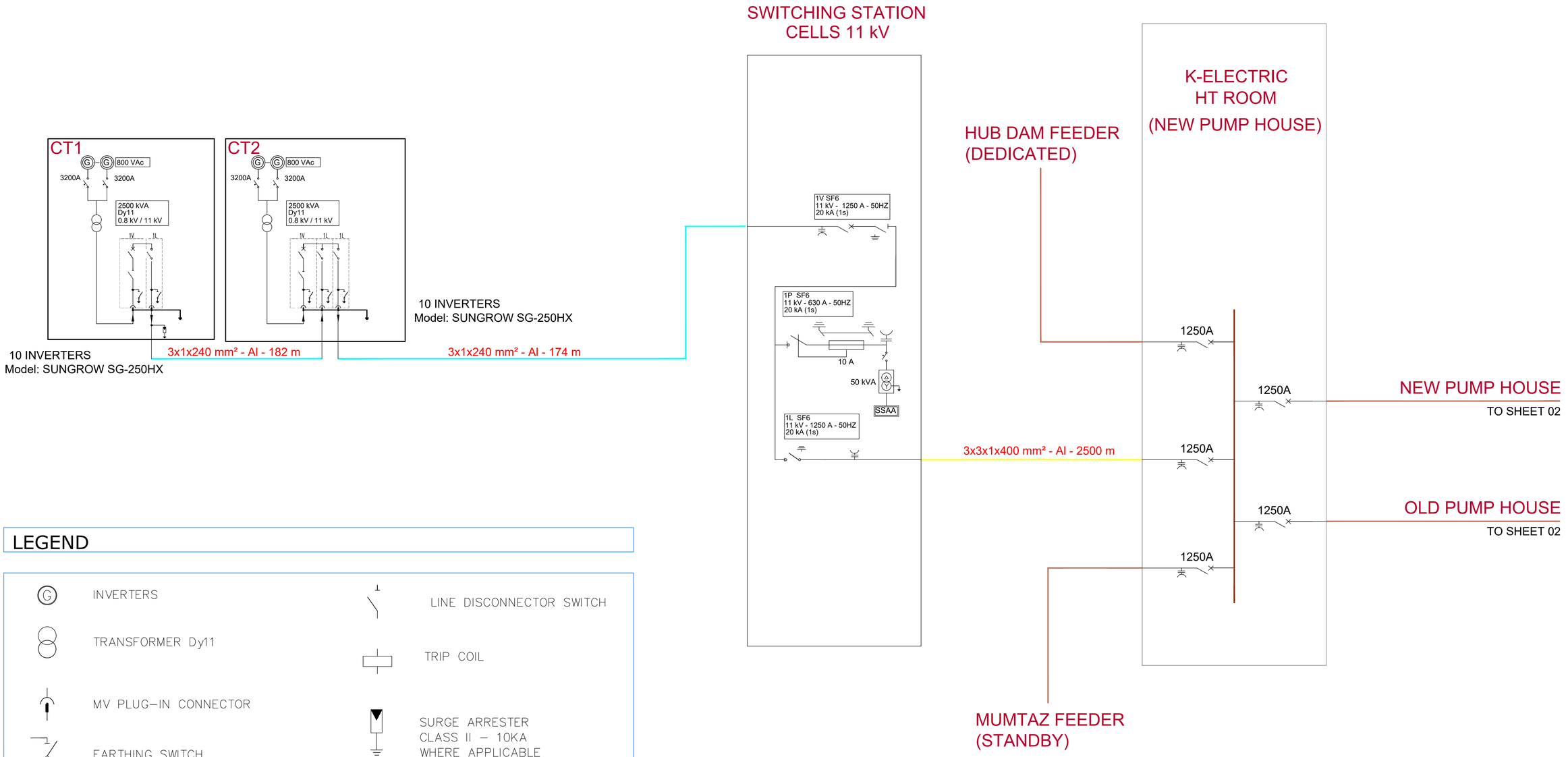
SCALES (DIN A1): 50 0 50 100 m — SCALE 1:2.000

TITLE: NEW SOLAR PV PLANT LOCATION

DRAWING NUMBER: 06.01

SHEET: 1 of 1

HY6602-DR-06.01-NEW SOLAR PV PLANT LOCATION-D01V01A.DWG



LEGEND

- INVERTERS
- TRANSFORMER Dy11
- MV PLUG–IN CONNECTOR
- EARTHING SWITCH
- VACUUM CIRCUIT BREAKER
- LINE DISCONNECTOR SWITCH (LBS)
- LINE DISCONNECTOR SWITCH
- TRIP COIL
- SURGE ARRESTER CLASS II – 10KA WHERE APPLICABLE
- TRANSFORMER AUX SERVICES
- LINE DISCONNECTOR SWITCH WITH FUSE

MV CIRCUITS

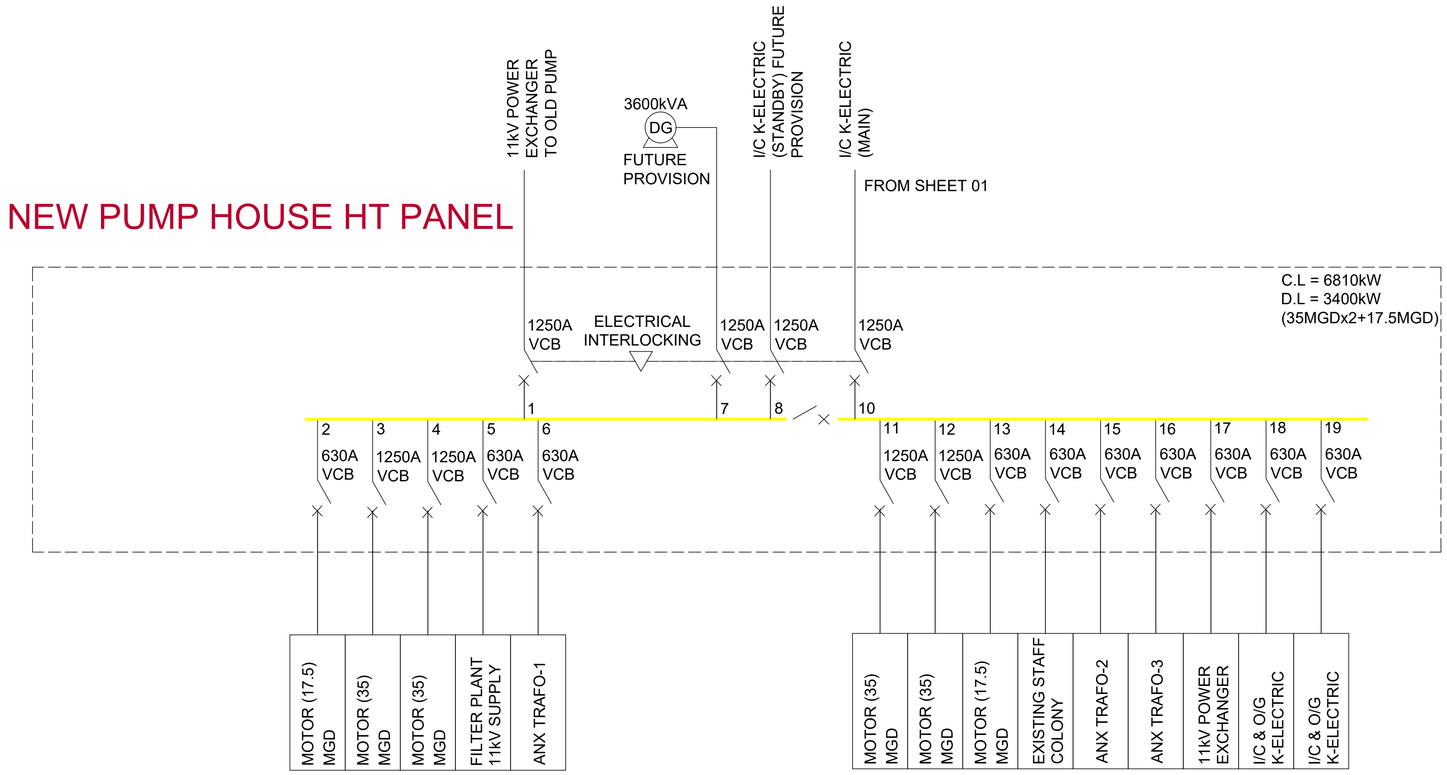
- CT.2 - CT.1 - CS
- CS - SET

All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

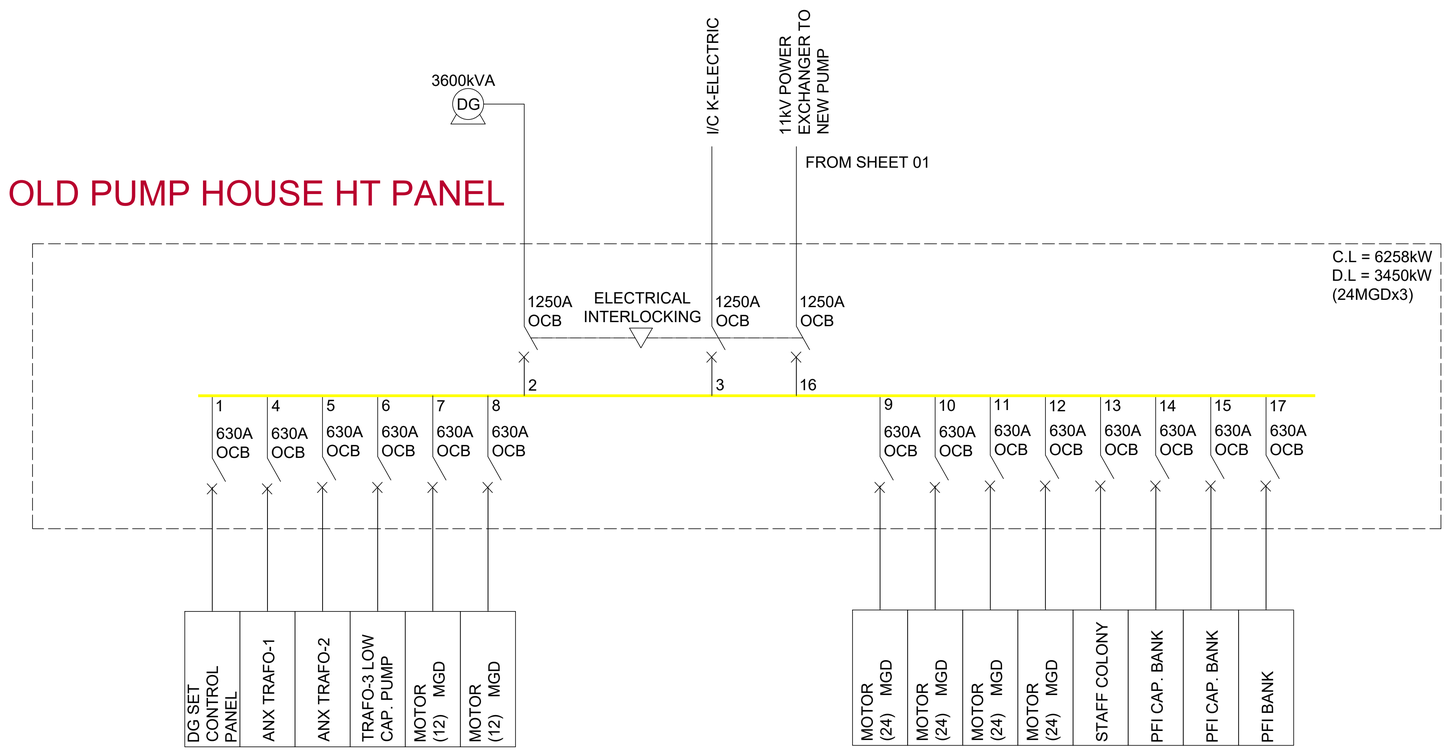
IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): N/S	TITLE: NEW SOLAR PV PLANTMV SLD MV SLD	DRAWING NUMBER: 06.02 SHEET: 1 of 2

HY6602–DR–06.02–NEW SOLAR PV PLANT MLD–D01V01A.DWG

NEW PUMP HOUSE HT PANEL



OLD PUMP HOUSE HT PANEL



All elements and equipment included in these drawings are for information purposes, within the framework of this Due Diligence Report.
The Concessionaire shall complete the detailed design and utilize components and systems which are of new manufacture and proven design.
All elements shall be built to appropriate internationally recognized standards and shall comply with all the applicable national and statutory codes.

IFC International Finance Corporation WORLD BANK GROUP	PROJECT: Karachi Water Canal PPP (IFC Contract 7196325)	TECHNICAL CONSULTANT: TYPSA CONSULTING ENGINEERS & ARCHITECTS	LOCAL SUPPORT: HPK	DATE: APRIL 2021	SCALES (DIN A1): N/S	TITLE: NEW SOLAR PV PLANT MV SLD	DRAWING NUMBER: 06.02
							SHEET: 2 of 2

HY6602-DR-06.02-NEW SOLAR PV PLANT MLD-D01V01A.DWG

Annex 4. UPDATED 100 MGD-ALTERNATIVE ANALYSIS FOR THE TSR

CONSULTING SERVICES KARACHI WATER CANAL PPP

Baseline 100 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)	Electricity Cost (USD/year)
Karachi Canal Rehabilitation (80 or 100 MGD) incl. 2.28 km Pipeline	USD 24 534 136	USD 294 410	50 years	USD 279 689	USD 20 000	USD 5 810 822
SCADA and metering system for the Canal, PS and RM incl. telecom.	USD 1 205 000	USD 14 460	15 years	USD 24 000	USD 10 000	
Pumping Station - PS (100 MGD) H=48m - 3,293 kW	USD 4 414 385	USD 52 973	25 years	USD 52 973	USD 75 000	
K-III Connection with Hub Pumping Station (80 MGD)	USD 3 170 000			USD 36 471	USD 75 000	
Rehabilitation of Rising Mains (2 GRP DN1900 mm pipes)	USD 5 261 462	USD 0	30 years	USD 60 533	USD 7 500	
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 14 840 000	USD 296 800	25 years	USD 163 659	USD 1 158 983	
Solar PV Plant (5.3 MW) + Distribution line (2.5 km)	USD 5 064 481	USD 151 360	25 years	USD 46 544	USD 35 000	
E&S Mitigation Measures (3%)	USD 1 754 684	-	-			
Contingencies (15%)	USD 8 773 420	-	-			
Overheads (12%)	USD 7 018 736	-	-			
Profit (6.5%)	USD 3 801 815	-	-			
TOTAL Construction Works	**USD 79 838 118**	**USD 810 003**	25 to 50 years	**USD 663 870**	**USD 1 381 483**	**USD 5 810 822**
Independent Engineer (1%)	USD 798 381					

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)	Electricity Cost (USD/year)
Independent Auditor (0.2%)	USD 159 676					
Design Consultancy (1%)	USD 798 381					
Project Management (1%)	USD 798 381					
Staff Cost (3.5%)	USD 2 794 334					
Insurance (1.5%)	USD 1 197 572					
Consultants (Legal & Financial) (0.6%)	USD 479 029					
Project Development Fee (1.5%)	USD 1 197 572					
TOTAL	**USD 88 061 444**					

NOTES.-

Assumptions are based on 100 MGD Design Flow and 100 MGD Water Flow from Hub Dam and KIII after accounting for 2% losses.

Pipeline 100 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)	Electricity Cost (USD/year)
Karachi Canal & Existing PS Decommissioning	USD 2 120 000	USD 0	-			USD 6 505 000
New GRP Pipeline DN1900 (100 MGD) within existing RoW	USD 29 293 618	USD 175 762	50 years	USD 149 397	USD 30 000	
SCADA and metering system for the system, including telecom.	USD 1 205 000	USD 14 460	15 years	USD 30 000	USD 10 000	
Pumping Station - PS (100 MGD) H=60.7m 4,043 kW	USD 5 370 986	USD 64 452	25 years	USD 102 492	USD 75 000	
K-III Connection with Hub Pumping Station (80 MGD)	USD 3 170 000			USD 36 471	USD 75 000	
New Dirt Road to access the new PS scheme (5 km)	USD 1 371 166	USD 41 135	10 years	USD 41 135	USD 0	
Rehabilitation of Rising Mains (2 GRP DN1900 mm pipes)	USD 5 261 462	USD 0	30 years	USD 60 533	USD 7 500	
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 14 840 000	USD 296 800	25 years	USD 252 280	USD 1 158 983	
Solar PV Plant (6.3 MW) + Distribution line (15 km)	USD 6 654 921	USD 181 265	25 years	USD 145 012	USD 35 000	
E&S Mitigation Measures (3%)	USD 2 078 615	-	-			
Contingencies (10%)	USD 6 928 715	-	-			
Overheads (12%)	USD 8 314 458	-	-			
Profit (6.5%)	USD 4 503 665	-	-			
TOTAL Construction Works	**USD 91 112 606**	**USD 773 874**	25 to 50 years	**USD 817 321**	**USD 1 391 483**	**USD 6 505 000**

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)	Electricity Cost (USD/year)
Independent Engineer (1%)	USD 911 126					
Independent Auditor (0.2%)	USD 182 225					
Design Consultancy (1%)	USD 911 126					
Project Management (1%)	USD 911 126					
Staff Cost (3.5%)	USD 3 188 941					
Insurance (1.5%)	USD 1 366 689					
Consultants (Legal & Financial) (0.6%)	USD 546 676					
Project Development Fee (1.5%)	USD 1 366 689					
TOTAL	**USD 100 497 205**					

NOTES.-

Assumptions are based on 100 MGD Design Flow and 100 MGD Water Flow from Hub Dam and KIII after accounting for 2% losses.

Hybrid 100 MGD

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)	Electricity Cost (USD/year)
Karachi Canal Rehabilitation (11km) & Partial Decommissioning	USD 9 849 474	USD 136 335	50 years	USD 116 335	USD 20 000	
New GRP Pipeline DN1900 (100 MGD) Length = 9.8 km	USD 11 524 354	USD 153 889		USD 138 889	USD 15 000	
Pumping Station - PS (100 MGD)+K-III Connection	USD 4 459 474	USD 128 941	15 years	USD 53 941	USD 75 000	
K-III Connection with Hub Pumping Station (18 MGD)	USD 2 999 810			USD 36 477	USD 75 000	
Rehabilitation of Rising Mains (2 GRP DN1900 mm pipes)	USD 5 389 709	USD 72 421	25 years	USD 64 921	USD 7 500	
Water Treatment Plant Upgrade - WTP (100 MGD)	USD 14 225 000	USD 1 329 733	30 years	USD 170 749	USD 1 158 983	
SCADA and metering system for the system, including telecom.	USD 1 205 000	USD 24 736	25 years	USD 14 736	USD 10 000	USD 5 080 063
Solar PV Plant (4.5 MW) + Distribution line (2.5 km)	USD 3 508 903	USD 77 286	25 years	USD 42 286	USD 35 000	
Government of Sindh Taxes over Civil Works (13%)	USD 0					
Government of Sindh Taxes over Imported Off-Shore Equipment (17%)	USD 4 238 600					
E&S Mitigation Measures (3%)	USD 1 594 852	-	-			
Contingencies (15%)	USD 5 316 172	-	-			
Overheads (12%)	USD 6 379 407	-	-			
Profit (6.5%)	USD 3 455 512	-	-			

	Total CAPEX Cost (USD)	Total OPEX Cost (USD/year)	Life Span years)	OPEX Fixed Cost (USD/year)	OPEX Variable Cost (USD/year)	Electricity Cost (USD/year)
TOTAL Construction Works	**USD 74 146 267**	**USD 1 923 341**	25 to 50 years	**USD 638 335**	**USD 1 396 483**	**USD 5 080 063**
Independent Engineer (1%)	USD 741 463					
Independent Auditor (0.2%)	USD 148 293					
Design Consultancy (1%)	USD 741 463					
Project Management (1%)	USD 741 463					
Staff Cost (3.5%)	USD 2 595 119					
Insurance (1.5%)	USD 1 112 194					
Consultants (Legal & Financial) (0.6%)	USD 444 878					
Project Development Fee (1.5%)	USD 1 112 194					
TOTAL	**USD 81 783 333**					

NOTES.-

Assumptions are based on 100 MGD Design Flow and 100 MGD Water Flow from Hub Dam and KIII after accounting for 3% losses.

Annex 5. CAPEX AND OPEX FIGURES

CONSULTING SERVICES KARACHI WATER CANAL PPP

CAPEX FIGURES

CHAPTER	ITEM	DESCRIPTION	UNIT	QUANTITY (Assumed)	UNIT COST (USD)	AMOUNT (USD)	Remarks
1		**CANAL REHABILITATION**					
	1.1	**Earth works (Canal embankment)**					
	1.1.1	Earth works (Import filling and Compaction)	m³	77,880.0	9.40	732,072	Assuming 30% of the total volume
		Subtotal				732,072	
	1.2	**Canal rehabilitation**					
	1.2.1	Geo Membrane	m²	236,622.5	4.98	1,178,380	Assuming 100% of the total area and 2 PVC linings + 1 m crowning overlap
	1.2.2	Geo Textile	m²	321,933.7	1.66	534,410	Assuming 100% of the total area and 3 geotextile layers
	1.2.3	Canal Curbs (side wall, parapet)	m	22,000.0	31.80	699,600	
	1.2.4	CC Lining 100mm thick, fc' 3000 PSI	m²	107,311.2	19.36	2,077,545	Assuming 100% of the total area
	1.2.5	Demolition of existing lining	m³	21,462.2	29.31	629,058	Assuming an average 0.20 m of thickness
	1.2.6	Transportation of debris to dump areas	m³	21,462.2	3.32	71,255	Assuming an average 10 km distance
	1.2.7	Temporary cofferdams and by-pass pipe to isolate 250m-long canal stretches during repair works	#	44.0	13,272.84	584,005	
	1.2.8	Major cross drainage repair works (culverts)	#	5.9	53,091.36	312,860	
	1.2.9	Canal perimeter fence	m	22,000.0	43.69	961,180	
	1.2.10	Canal gutters in cut sections	m	8,000.0	8.74	69,920	Gutters for longitudinal drainage in cut sections
	1.2.11	Canal roadway basic pavement treatment	m³	13,200.0	17.48	230,736	3 m wide roadway with a 0.20 m granular pavement & 2 side roads
		Subtotal				7,348,949	
	1.3	**Partial decommissioning of the final stretch of existing canal**					
	1.3.1	Earth works for decommissioning of existing canal (9,200 m)	m³	123,868.8	9.40	1,164,367	

CHAPTER	ITEM	DESCRIPTION	UNIT	QUANTITY (Assumed)	UNIT COST (USD)	AMOUNT (USD)	Remarks
	1.3.2	Demolition of Aqueduct XI	m³	1,783.7	29.31	52,281	
		Subtotal				1,216,648	
	1.4	**Retrofitting of existing Aqueducts**					
	1.4.1	Aqueduct I, 5m wide	m	50.0	1,476.60	73,830	Assuming 60% of new Const. cost
	1.4.2	Aqueduct II, 5m wide	m	30.0	2,461.01	73,830	Assuming 60% of new Const. cost
	1.4.3	Aqueduct III, 4m wide	m	38.0	1,941.15	73,764	Assuming 60% of new Const. cost
	1.4.4	Aqueduct IV, 4m wide	m	38.0	1,941.15	73,764	Assuming 60% of new Const. cost
	1.4.5	Aqueduct V, 4m wide	m	25.0	1,164.69	29,117	Assuming 60% of new Const. cost
	1.4.6	Aqueduct VI, 4m wide	m	32.0	1,164.69	37,270	Assuming 60% of new Const. cost
	1.4.7	Aqueduct VII, 4m wide	m	48.0	1,164.69	55,905	Assuming 60% of new Const. cost
	1.4.8	Aqueduct VIII, 3m wide	m	38.0	832.87	31,649	Assuming 60% of new Const. cost
	1.4.9	Aqueduct IX, 3m wide	m	75.0	832.87	62,465	Assuming 60% of new Const. cost
	1.4.10	Aqueduct X, 3m wide	m	35.0	832.87	29,150	Assuming 60% of new Const. cost
		Subtotal				540,744	
	1.5	**Repair of Pedestrian Bridge and Cross Drainage Structure**					
	1.5.1	Repair of Pedestrian Bridge and Cross Drainage Structure	L.S.	1.0	11,060.70	11,061	
		Subtotal				11,061	
	1.6	Government of Sindh Taxes over all civil works items	%	0.13	9,849,474.00	1,280,432	13% taxes
					Chapter 1 Total Amount (USD)	11,129,906	
2		**NEW PIPELINE SECTION**					
	2.1	**GRP pipe DN1900 mm**	m	9,800	676.32	6,627,936	Unit cost accounts for C&F, and transportation on site
	2.2	**Installation of pipeline in trench**	m	9,800	115.04	1,127,363	

CHAPTER	ITEM	DESCRIPTION	UNIT	QUANTITY (Assumed)	UNIT COST (USD)	AMOUNT (USD)	Remarks
	2.3	Excavation and earth works (for typical trench)	m	9,800	199.63	1,956,408	13.97 m² of excavation unit surface according to typical cross section
	2.4	Fittings, thrustblocks, inspection chambers and others	m	9,800	179.55	1,759,553	
	2.5	Intake chamber for the pipeline	m	1	53,094.00	53,094	This chamber ensures the transition from free surface to pressure flow.
	2.6	Government of Sindh Taxes over all civil works items	%	0.13	4,896,418.00	636,534	13%
	2.7	Government of Sindh Taxes over imported off-shore equipment	%	0.17	6,627,936.00	1,126,749	17%
					Chapter 2 Total Amount (USD)	13,287,637	
3		UPGRADE OF HUB PUMPING STATION					
	3.1	Civil works	L.S.	1	1,080,183.61	1,080,184	Demolition of existing "Old Pump House" and construction of a new one
	3.2	Hydromechanical equipment (Water pumps: 3,156 m³/h ; Total head 43 m; 500 kW)	L.S.	7	320,728.12	2,245,097	Unit cost accounts for taxes, C&F, and transportation on site
	3.3	Electrical equipment	L.S.	1	788,534.04	788,534	
	3.4	Rehabilitation of existing buildings and offices	L.S.	1	129,622.03	129,622	
	3.5	Urbanization and upgrade of appurtenant facilities	L.S.	1	216,036.72	216,037	
	3.6	Government of Sindh Taxes over all civil works items	%	0.13	1,425,843.00	185,360	13%
	3.7	Government of Sindh Taxes over imported off-shore equipment	%	0.17	3,033,631.00	515,717	17%
					Chapter 3 Total Amount (USD)	5,160,551	
4		K-III CONNECTION TO HUB PUMPING STATION					
	4.1	Civil works	L.S.	1	500,000.00	500,000	Upgrade of approach canal from K-III, screens and rakes, building
	4.2	Hydromechanical equipment (Water pumps: 3,030 m³/h ; Total head 43 m; 445 kW)	L.S.	6	295,000.00	1,770,000	Unit cost accounts for taxes, C&F, and transportation on site
	4.3	Electrical equipment	L.S.	1	729,810.00	729,810	

CHAPTER	ITEM	DESCRIPTION	UNIT	QUANTITY (Assumed)	UNIT COST (USD)	AMOUNT (USD)	Remarks
	4.4	Government of Sindh Taxes over all civil works items	%	0.13	500,000.00	65,000	13%
	4.5	Government of Sindh Taxes over imported off-shore equipment	%	0.17	2,499,810.00	424,968	17%
						Chapter 4 Total Amount (USD)	3,489,778
5		REHABILITATION OF RISING MAINS					
	5.1	2 GRP pipes DN1900 mm installed in trench	m	4,460	676.32	3,016,387	Unit cost accounts for taxes, C&F, and transportation on site
	5.2	Installation of pipeline in trench	m	9,800	115.04	1,127,363	
	5.3	Excavation and earth works (for typical trench in soil materials)	m	2,230	199.63	445,183	22.61 m² of excavation unit surface according to typical cross section
	5.4	Fittings, thrustblocks, inspection chambers and others	m	4,460	179.55	800,776	
	5.5	Government of Sindh Taxes over all civil works items	%	0.13	2,373,322.00	308,532	13%
	5.6	Government of Sindh Taxes over imported off-shore equipment	%	0.17	3,016,387.00	512,786	17%
						Chapter 5 Total Amount (USD)	6,211,027
6		WATER TREATMENT PLANT UPGRADE (100 MGD)					
	6.1	WTP Inlet and Water Distribution Chamber Rehabilitation	L.S.	1	1,000,000.00	1,000,000	
	6.2	New Sludge Building and Decommissioning of Existing One	L.S.	1	1,250,000.00	1,250,000	
	6.3	Sand Filter Upgrade including pumps, blowers and all components	L.S.	20	450,000.00	9,000,000	
	6.4	Upgrade of Pre and Post Chemical Dosing Pumps	L.S.	1	1,350,000.00	1,350,000	
	6.5	Upgrade of Pre and Post Chemical Screens and Rakes	L.S.	1	1,000,000.00	1,000,000	
	6.6	Reservoir Rehabilitation (no volume expansion)	L.S.	1	500,000.00	500,000	
	6.7	Sensoring and SCADA Set Up	L.S.	1	125,000.00	125,000	
	6.8	Government of Sindh Taxes over all civil works items	%	0.13	7,687,500	999,375	13% over: (75% of 6.2 and 6.5; 50% of 6.3; 100% of 6.1 and 6.6)

CHAPTER	ITEM	DESCRIPTION	UNIT	QUANTITY (Assumed)	UNIT COST (USD)	AMOUNT (USD)	Remarks
	6.9	Government of Sindh Taxes over imported off-shore equipment	%	0.17	6,537,500	1,111,375	17% over: (25% of 6.2 and 6.5; 50% of 6.3; 100% of 6.4 and 6.7)
						Chapter 6 Total Amount (USD)	16,335,750
7		SCADA, METERING AND COMMUNICATIONS					
	7.1	Flow Meters, Level Sensors and Control Gates in KWC Sections					
	7.1.1	Flow Measurement Sensors at Hub Reservoir and WAPDA Main Canal	L.S.	1	130,000.00	130,000	
	7.1.2	Regulation of KWSB Hub Canal at 3 Sections	L.S.	1	350,000.00	350,000	
	7.1.3	KWSB Hub Canal & New Pipeline Offtakes for Communities	L.S.	1	100,000.00	100,000	
	7.1.4	New Hub Pumping Station and K-III Metering System	L.S.	1	75,000.00	75,000	
	7.1.5	Spare Parts	L.S.	1	25,000.00	25,000	
		Subtotal				680,000	
	7.2	Flow Meters at GRP 1900mm Pipeline, Rising Mains, and Water Treatment Plant	L.S.	1	175,000.00	175,000	
	7.3	Radio Communication System	L.S.	1	200,000.00	200,000	
	7.4	SCADA Software, Server and Integration	L.S.	1	150,000.00	150,000	
	7.5	Government of Sindh Taxes over imported off-shore equipment	%	0.17	1,205,000	204,850	17%
						Chapter 7 Total Amount (USD)	1,409,850
8		NEW PHOTOVOLTAIC SOLAR PLANT (4.5 MW)					
	8.1	Civil Works	L.S.	1	144,981.07	144,981	
	8.2	PV Modules	L.S.	1	1,211,004.56	1,211,005	
	8.3	Fixed Structures	L.S.	1	1,159,832.94	1,159,833	
	8.4	Inverters & Power Stations	L.S.	1	375,239.51	375,240	

CHAPTER	ITEM	DESCRIPTION	UNIT	QUANTITY (Assumed)	UNIT COST (USD)	AMOUNT (USD)	Remarks
	8.5	Low Voltage Electrical Installations	L.S.	1	255,866.80	255,867	
	8.6	Medium Voltage Electrical Installations	L.S.	1	170,563.41	170,563	
	8.7	Control Center, Monitorización and PM	L.S.	1	25,612.70	25,613	
	8.8	Interconnection with K-Electric Room	L.S.	1	68,225.36	68,225	
	8.9	Medium Voltage Power Line (between Solar Plant and Pumping Station)	m	2.5	39,030.53	97,576	
	8.10	Government of Sindh Taxes over all civil works items	%	0.13	1,496,228	194,510	13% over 8.1; 8.3; 8.7; 8.8; 8.9
	8.11	Government of Sindh Taxes over imported off-shore equipment	%	0.17	2,012,675	342,155	17% over 8.2; 8.4; 8.5; 8.6
					Chapter 8 Total Amount (USD)		4,045,568
9		Environmental & Social Mitigation Measures					
	9.1	E&S mitigation measures	L.S.	1	1,594,851.72	1,594,852	3% of all the previous chapters excluding selected GoS taxes
					Chapter 9 Total Amount (USD)		1,594,852
					Total Construction & Rehabilitation Cost Including Taxes (USD)		62,664,919

OPEX FIGURES

A	FIXED COMMON OPEX COSTS						TOTALS
A1	Labour	Staff/shift		No. of staff	All-in rate	All-in rate	
		no.	no.	no.	USD/year	USD	
	Executive personnel	3	0	3	28 000.00	84 000.00	
	Plant manager	1	0	1	18 225.00	18 225.00	
	Chief operation engineer	1	0	1	12 453.75	12 453.75	
	Personnel manager	1	0	1	12 453.75	12 453.75	
	Accountant administrative	1	0	1	11 000.00	11 000.00	
	Administration assistant	1	0	1	7 087.50	7 087.50	
	Shift supervision	1	0	1	12 000.00	12 000.00	
	Chief maintenance engineer	1	0	1	12 453.75	12 453.75	
	Chief maintenance engineer electrical	1	0	1	12 453.75	12 453.75	
	Maintenance operator mechanical	1	1	2	11 000.00	22 000.00	
	Maintenance operator electrical	1	1	2	11 000.00	22 000.00	
	Lab chief	1	0	1	12 453.75	12 453.75	
	Lab operator	2	0	2	11 000.00	22 000.00	
	Technicians	2	2	4	7 087.50	28 350.00	
	Safety officer	1	0	1	4 151.25	4 151.25	
	Workshop manager	1	0	1	11 000.00	11 000.00	
	Workshop mechanic	2	0	2	7 087.50	14 175.00	
	Store manager	1	0	1	4 151.25	4 151.25	
	Secretary	3	0	3	5 265.00	15 795.00	
	Laborer	3	3	6	5 265.00	31 590.00	
	Cleaner	3	2	5	5 568.75	27 843.75	
	Driver	4	0	4	5 265.00	21 060.00	
	Security guard	5	5	10	5 568.75	55 687.50	
	Subtotal labour			**52**		**474 385.00**	**474 385.00**

A2	Administrative expenses	Units	Rate	Quantity	Annual cost	Subtotals	
			USD per unit		USD	USD	
	Utilities	per month	375.00	12	4 500.00		
	Telecommunications and post	per month	600.00	12	7 200.00		
	Printing and stationery	per month	300.00	12	3 600.00		
	Entertainment	per month	250.00	12	3 000.00		
	Office maintenance	per month	600.00	12	7 200.00		
	Amortization of office equipment	per annum	10 000.00	1	10 000.00		
	Amortization of furniture	per annum	10 000.00	1	10 000.00		
	Sundry expenses	per annum	5 000.00	1	5 000.00		
	Subtotal				**50 500.00**	**50 500.00**	50 500.00
A3	**Insurances**	**Units**	**Rate**	**Quantity**	**Annual cost**	**Subtotals**	
	Insurances	per annum	1.00%	81 783 333	817 833.33		
	Subtotal				**817 833.33**	**817 833.33**	817 833.33
A4	**Vehicles**	**Units**	**Rate**	**Quantity**	**Annual cost**	**Subtotals**	
	Amortization of 4 × 4	per annum	2 000.00	2	4 000.00		
	Amortization of bus/truck	per annum	1 500.00	1	1 500.00		
	Maintenance 4 × 4	per annum	500.00	2	1 000.00		
	Maintenance bus/truck	per annum	500.00	1	500.00		
	Road tax 4WD	per annum	200.00	1	200.00		
	Road tax bus/truck	per annum	150.00	1	150.00		
	Insurance 4WD	per annum	1 000.00	2	2 000.00		
	Insurance bus/truck	per annum	500.00	1	500.00		
	Subtotal				**9 850.00**	**9 850.00**	9 850.00

A5	Fuel and consumables	Units	Rate	Quantity	Annual cost	Subtotals	
	Fuel for vehicles	per month	500.00	12	6 000.00		
	Office consumables	per month	100.00	12	1 200.00		
	Lubricants	per month	200.00	12	2 400.00		
	Subtotal				**9 600.00**	**9 600.00**	9 600.00
A6	**External services**	**Units**	**Rate**	**Quantity**	**Annual cost**	**Subtotals**	
	Training	per annum	6 000.00	1	6 000.00		
	Software licenses	per annum	3 000.00	1	3 000.00		
	Subtotal				**9 000.00**	**9 000.00**	9 000.00
A7	**Spare Parts**	**Units**	**Rate**	**Quantity**	**Annual cost**	**Subtotals**	
	Strategic spares	per annum	15 000.00	1	15 000.00		
	Mechanical-Electrical equipment	per annum	15 000.00	1	15 000.00		
	Consumable spare parts	per annum	5 000.00	1	5 000.00		
	Subtotal				**30 000.00**	**30 000.00**	30 000.00
A8	**Maintenance**	**Units**	**Rate**	**Quantity**	**Annual cost**	**Subtotals**	
	Maintenance tools	per annum	3 000.00	1	3 000.00		
	Piping and utilities maintenance	per annum	6 000.00	1	6 000.00		
	Buildings maintenance	per annum	10 000.00	1	10 000.00		
	Others to O&M	per annum	36 000.00	1	36 000.00		
	Subtotal				**55 000.00**	**55 000.00**	55 000.00
	Total expenses					981 783.33	**981 783.33**
	Total OPEX Common expenses						**1 456 168.33**

B	VARIABLE OPEX. CANAL REHABILITATION						TOTALS
B1	**Other facility costs**		**Rate**	**Quantity**			
	Consumables (Concrete, PEAD membrane, etc.)	per annum	20 000.00	1	20 000.00		
	Subtotal				**20 000.00**	**20 000.00**	20 000.00
	Total variable OPEX for Canal Rehabilitation						**20 000.00**

C	VARIABLE OPEX. NEW GRP PIPELINE STRETCH						TOTALS
C1	**Other facility costs**		**Rate**	**Quantity**			
	Consumables (control devices, etc.)	per annum	15 000.00	1	15 000.00		
	Subtotal				**15 000.00**	**15 000.00**	15 000.00
	Total variable OPEX for New GRP Pipeline						**15 000.00**

D	VARIABLE OPEX. PUMP STATION UPGRADE						TOTALS
D1	**Energy costs**	**Units**	**Rate (USD/kWh)**	**Quantity (kWh/year)**	**Annual cost**	**Subtotals**	
	Power from the Existing Grid (82 MGD; 4.31 m^3/s)	per kWh	0.15625	19 892 349	3 108 179.51		
	Subtotal				**3 108 179.51**	**3 108 179.51**	3 108 179.51
D2	**Other facility costs**		**Rate**	**Quantity**			
	Consumables	per annum	75 000.00	1	75 000.00		
	Subtotal				**75 000.00**	**75 000.00**	75 000.00
	Total variable OPEX for the Pump Station Upgrade						**3 183 179.51**

E	VARIABLE OPEX. K-III CONNECTION TO HUB PUMPING STATION						TOTALS
E1	**Energy costs**	**Units**	**Rate (USD/kWh)**	**Quantity (kWh/year)**	**Annual cost**	**Subtotals**	
	Power from the Existing Grid (18 MGD; 0.947 m^3/s)	per kWh	0.15625	7 026 523	1 097 894.15		
	Subtotal				**1 097 894.15**	**1 097 894.15**	1 097 894.15
E2	**Other facility costs**		**Rate**	**Quantity**			
	Consumables	per annum	75 000.00	1	75 000.00		
	Subtotal				**75 000.00**	**75 000.00**	75 000.00
	Total variable OPEX for the Pump Station Upgrade						**1 172 894.15**

F	VARIABLE OPEX. NEW RISING MAINS						TOTALS
F1	**Other facility costs**		**Rate**	**Quantity**			
	Consumables (control devices, etc.)	per annum	7 500.00	1	7 500.00		
	Subtotal				**7 500.00**	**7 500.00**	7 500.00
	Total variable OPEX for New Rising Mains						**7 500.00**

G	VARIABLE OPEX. WATER TREATMENT PLANT UPGRADE						TOTALS
G1	**Energy costs**	**Units**	**Rate (USD/kWh)**	**Quantity (kWh/year)**	**Annual cost**	**Subtotals**	
	Power from the Existing Grid	per kWh	0.15625	5 593 529	873 988.84		
	Subtotal				**873 988.84**	**873 988.84**	873 988.84
G2	**Chemicals**		**Rate (USD/kg)**	**Quantity (kg/year)**			
	Chemicals: Chlorine	per annum	0.16	1 493 482	233 356.55		
	Chemicals: Aluminum	per annum	0.14	4 978 273	715 626.74		
	Subtotal				**948 983.28**	**948 983.28**	948 983.28
G3	**Other facility costs**		**Rate**	**Quantity**			
	Sludge treatment	per annum	200 000.00	1	200 000.00		
	Consumables	per annum	10 000.00	1	10 000.00		
	Subtotal				**210 000.00**	**210 000.00**	210 000.00
	Total variable OPEX for the Water Treatment Plant Upgrade						**2 032 972.12**

H	VARIABLE OPEX. SCADA, METERING AND COMMUNICATIONS						TOTALS
H1	**Other facility costs**		**Rate**	**Quantity**			
	Consumables	per annum	10 000.00	1	10 000.00		
	Subtotal				**10 000.00**	**10 000.00**	10 000.00
	Total variable OPEX for the SCADA, Metering, Monitoring and Communications System						**10 000.00**

I	VARIABLE OPEX. SOLAR PHOTOVOLTAIC PLANT						TOTALS
I1	**Other facility costs**		**Rate**	**Quantity**			
	Consumables. PV modules	per annum	35 000.00	1	35 000.00		
	Subtotal				**35 000.00**	**35 000.00**	35 000.00
	Total variable OPEX for the Solar PV Plant						**35 000.00**

#	DISTRIBUTION PER CHAPTER	OPEX COMMON EXPENSES	OPEX VARIABLE EXPENSES	TOTALS
1	CANAL REHABILITATION	265 383.97	20 000.00	285 383.97
2	NEW PIPELINE SECTION	316 833.39	15 000.00	331 833.39
3	UPGRADE OF HUB PUMPING STATION	123 049.33	3 183 179.51	3 306 228.84
4	K-III CONNECTION WITH HUB PUMPING STATION	83 211.05	1 172 894.15	1 256 105.20
5	REHABILITATION OF RISING MAINS	148 097.12	7 500.00	155 597.12
6	WATER TREATMENT PLANT UPGRADE (100 MGD)	389 513.27	2 032 972.12	2 422 485.39
7	SCADA, METERING AND COMMUNICATIONS	33 616.78	10 000.00	43 616.78
8	NEW PHOTOVOLTAIC SOLAR PLANT (4.5 MW)	96 463.43	35 000.00	131 463.43
9	ENVIRONMENTAL & SOCIAL MITIGATION MEASURES	-		-
	Total OPEX Common expenses	1 456 168.33	6 476 545.78	7 932 714.11

TECHNICAL CONSULTANT FOR KARACHI WATER SUPPLY CANAL PPP

Quality control sheet

Document	Environmental and Social Scoping Report – Karachi Water Supply Canal PPP							
Project	HY6602 Karachi Water Supply Canal PPP							
Code	HY6602-TD-TYP-E&S_Scoping_Report_Final-20210602-0101							
Authors:	Signed:	Margaret TRÍAS ; Luis SÁNCHEZ ; Jaime RUIZ	Margaret TRÍAS ; Luis SÁNCHEZ ; Jaime RUIZ	Margaret TRÍAS ; Luis SÁNCHEZ ; Jaime RUIZ	Margaret TRÍAS ; Luis SÁNCHEZ ; Jaime RUIZ	Margaret TRÍAS ; Luis SÁNCHEZ ; Jaime RUIZ	Margaret TRÍAS ; Luis SÁNCHEZ ; Jaime RUIZ	Margaret TRÍAS ; Luis SÁNCHEZ ; Jaime RUIZ
	Date:	28/01/2021	14/02/2021	21/02/2021	28/03/2021	10/04/2021	14/04/2021	28/04/2021
Verified	Signed:	Manuel G. MEMBRILLERA						
	Date:	29/01/2021	15/02/2021	22/02/2021	29/03/2021	11/04/2021	15/04/2021	29/04/2021
Recipient	International Finance Corporation (IFC/WB)							
Notes								

Contents

Glossary of abbreviations and acronyms 6

Executive Summary 8

1. Introduction and Background 13

2. Scoping Report Objectives 15

3. Project Description 16

3.1. Geographic Location 16

3.2. Project Components 16

3.2.1. Canal Rehabilitation & Pipeline Component 18

3.2.2. Water Filtration Plant 24

3.2.3. Solar PV Plant 26

3.2.4. Infrastructure and Civil Works 27

3.3. Workforce and Worker Housing 27

3.4. Project Water Consumption 28

3.5. Project Phases 28

3.5.1. Pre-Construction Activities 28

3.5.2. Construction & Site Preparation 28

3.5.3. Testing & Commissioning 29

3.5.4. Construction Demobilization 29

3.5.5. Operations and Maintenance 29

3.5.6. Decommissioning 32

4. Project Alternatives 35

5. Regulatory Framework 44

5.1. Overview of Environmental Legislation 44

5.1.1. Sindh Environmental Protection Act 2014 44

5.1.2. Sindh Environmental Quality Standards 44

5.1.3. Sindh Environmental Protection Act Key Clauses 45

5.1.4. Sindh Environmental Protection Agency (Review of IEE and EIA) Regulations, 2014 47

5.1.5. Sindh Wildlife Protection Act, 2020 51

5.1.6. Hub Dam Wildlife Sanctuary, designated July 1974 52

5.2. National and Provincial Social and Other Legislation 53

5.3. International Conventions and Agreements 54
5.4. IFC Performance Standards and EHS Guidelines 54
6. Scoping Approach and Methodology 56
6.1. General Approach 56
6.2. Natural Environment (physical and biological) 56
6.2.1. Biodiversity 57
6.3. Socio-economic Environment 59
6.3.1. Definition of Project Affected Area from a social perspective. 59
6.3.2. General methodological considerations 59
6.3.3. Field visit and data gathering through consultation with local leaders and PAPs representatives. 60
7. General Description of Study Area (Baseline) 61
7.1. **Physical Environment** 61
7.1.1. Topography 61
7.1.2. Geology and Soils 61
7.1.3. Seismicity 63
7.1.4. Climate 64
7.1.5. Air Quality 66
7.1.6. Surface Water 67
7.1.7. Groundwater 73
7.1.8. Water Quality 73
7.1.9. Waste Management 77
7.2. Biological Environment 77
7.2.1. Brief Background of the Hub Dam Canal and its Environment 77
7.2.2. Trends in Land Use and Habitats 80
7.2.3. Integrated Biodiversity Assessment Tool (IBAT) 80
7.2.4. Protected Areas 84
7.2.5. Key Biodiversity Areas 87
7.2.6. Consultation with Sindh Wildlife Department 89
7.2.7. Segmentation of Karachi Water Canal Project area 90
7.2.8. Findings - Field Survey 92
7.2.9. Threats to Biodiversity 117
7.2.10. Natural, Modified and Critical Habitat 117

7.2.11. Ecosystem Services 135
7.3. Socio-economic Environment 136
7.3.1. Administrative organization and social institutions 136
7.3.2. Human Environment 140
7.3.3. Housing 141
7.3.4. Economic activity and livelihoods 143
7.3.5. Access to water 150
7.3.6. Education 152
7.3.7. Health 154
7.3.8. Social infrastructure and cultural heritage 155
7.3.9. Summary and Key Findings 157
8. Stakeholder Mapping and Consultations 161
8.1. Stakeholder mapping 161
8.2. Initial community consultation held during site visit 163
8.3. Institutional consultations 164
8.4. Additional consultations and site visits 165
8.4.1. Additional institutional consultations on agricultural issues 165
8.4.2. Additional site visit on agricultural issues 166
8.4.3. Second community consultation (December 2020) 166
9. Potential Impacts & Recommended Mitigation Measures 169
9.1. Approach and Impact Assessment Methodology 169
9.2. Preliminary Impacts and Mitigation Measures – Natural Environment 173
9.2.1. Air Quality 173
9.2.2. Noise 174
9.2.3. Surface Water / Water Bodies 175
9.2.4. Groundwater (Quantity) 177
9.2.5. Surface and Ground Water Quality 178
9.2.6. Soil Moisture 180
9.2.7. Erosion and Sediment Transport 180
9.2.8. Soil Contamination & Pollution 183
9.2.9. Vegetation/flora 184
9.2.10. Fauna 186

9.2.11. Ecosystem Services 187
9.2.12. Waste Management 188
9.3. Key Risks and Mitigation Measures – Social Environment 189
9.3.1. Access to water by affected communities. 189
9.3.2. Dependence of agricultural land on seepage water 196
9.3.3. Impacts over land and assets along the Canal's corridor 200
9.3.4. Community/Public Safety and risk of drowning 202
9.3.5. Impact over community mobility and crossing paths during construction. 203
9.3.6. Substitution of KWSB workers 205
9.3.7. Land related impacts of proposed PV Plant 207
9.3.8. Job opportunities 209
9.3.9. Presence of workers, interaction with PAP and COVID-19 210
9.3.10. Water Supply to City of Karachi 212
9.4. Potential Decommissioning Impacts 213
9.5. Potential Cumulative Impacts 214
10. Summary of Proposed Mitigation Measures 216
11. Summary and Conclusions 216
11.1. Main Environmental Findings 216
11.2. Main Social Findings 217
11.3. Recommendations for Future Studies 218
11.4. Recommendations to enhance Project Outcomes 218
12. References 220
Appendices 221
Appendix A – Gap Analysis Regulatory Framework and IFC Performance Standards 222
Appendix B – Guideline questions for discussion with local leaders 240
Appendix C – Summary of Preliminary Mitigation Measures for Identified Risk/Impacts 243
Appendix D – ERT Report 252
Appendix E – Habitat Mapping 253
Appendix F – Social Mapping 254
Appendix G – Roles and Responsibilities 255

Glossary of abbreviations and acronyms

AC/DC	Alternative/Direct Current
AOI	Area of Influence
CMS	Convention on the Conservation of Migratory Species of Wild Animals
DAPA	Directly Affected Project Area
EAAA	Ecologically Appropriate Area of Analysis
E&S	Environmental and Social
ESIA	Environmental and Social Impact Assessment
GoP	Government of Pakistan
GoS	Government of Sindh
HV	High Voltage
HVDC	High Voltage Direct Current
IBA	Important Bird Area
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
KE	K-Electric, formerly known as Karachi Electric Supply Company
KWSB	Karachi Water and Sewerage Board
MGD	Million Gallons per Day
NOC	No Objection Certificate
OHL	Overhead Line
PAP	Project Affected People
PAA	Project Affected Area

POI	Point of Interconnection
PPP	Public Private Partnership
RFP	Request for Proposals
SWPA	Sindh Wildlife Protection Act
ToR	Terms of Reference
TYPSA	Técnica y Proyectos S.A.
USP	Unsolicited Proposal
WAPDA	Pakistan Water & Power Development Authority
WB	World Bank
WTP	Water Treatment Plant

Table 1. Abbreviations and acronyms

Executive Summary

Introduction

TYPSA has been retained by the IFC to provide consulting and advisory services to support the Government of Sindh (GoS), Pakistan, and the Karachi Water and Sewerage Board (KWSB) in the private sector rehabilitation of the Hub Canal that supplies part of the Karachi water supply system. The GoS has appointed the IFC as its Lead Transaction Advisor to prepare and undertake the structuring and tendering of the Project on a Public Private Partnership (PPP) basis.

The Hub Canal is a 22 km infrastructure that conveys water from the Hub Dam to the KWSB water treatment plant (WTP) located in Manghopir-Karachi, providing drinking water to Karachi, a city of over 16 million people. The system was originally designed to treat 100 MGD (5.26 m^3/s) of water coming from the Hub Dam. Presently, the canal's capacity is limited to around 75 MGD (3.95 m^3/s).

The successful implementation of the project will enhance its capacity by around 25 MGD (1.32 m^3/s), to reach the total expected capacity of 100 MGD (5.26 m^3/s). The project entails the following:

- Rehabilitation of 11 km of the existing canal.
- Construction of a 9.8 km new pipeline in the last stretch.
- Upgrade of Hub pumping station (to achieve 100 MGD; 5.26 m^3/s).
- Connection with the K-III canal at the Hub Pumping Station during drought periods.
- Upgrade of the 2.2 km rising mains that connect the Pumping Station with the water treatment plant.
- Upgrade of the water treatment plant, moving from 80 (4.21 m^3/s) to 100 MGD (5.26 m^3/s).
- SCADA and Metering system, including telecommunications.
- A new solar PV plant to optimize energy requirements with a 2.5 km distribution line.
- E&S mitigation measures.

The current condition of the canal causes leakage and seepage of water from the conveyance infrastructure (aqueducts and canal) into the surrounding environment. Studies carried out during the Scoping stage indicate that seepage may be contributing to soil moisture, and to the development of vegetated areas, particularly on the west side of the canal in the direction of the Hub River Valley.

Natural Environment

Most of the canal, from the Hub Dam all the way to the Northern By-pass road (i.e. the 8.3 km WAPDA canal reach plus approx. 15 km of the KWSB Hub Canal) is located within a protected area, the Hub Dam Wildlife Sanctuary which is part of the larger Kirthar Protected Areas Complex (KPAC). At the time the wildlife sanctuary was established in 1974, it probably included habitat for biodiversity including raptors, but due to its proximity to the Karachi Metropolitan area and its industrial zone, the area has lost its ecological significance. The Northern Bye-pass road with heavy traffic linking Sindh with Balochistan Province has further deteriorated its importance. The Hub Dam (and its reservoir) were built in 1984 on the Hub River on the arid plains north of Karachi and have since been designated as a Ramsar site.

The following habitats are found within the project's area of influence and can be classified as modified habitat according to PS6: seasonal agricultural fields, settlements, and other built environments. The following habitats could also be classified as modified habitat since its current extension and conditions are subject to human activity and largely dependent on man-made infrastructure such as the water canal and seepage water: Riverbed (riparian) vegetation including areas influenced by seepage, and Bushland/Rangeland. Natural habitats existing in the project's area of influence are limited to "Dry / desert with scarce vegetation including hills/cliffs". In some areas, under natural regional climatic conditions, less human intervention, and no seepage from the canal, it would still be possible to have some of the "Riverbed (riparian) vegetation" and "Bushland/Rangeland" which could be classified as natural habitat. One critically endangered tree was found within the PAA, a *Commiphora wightii* (Gugal/Mukul tree) and observations or known presence of the Indian pangolin (EN), the Steppe eagle (EN) and the Saker Falcon (EN) were also recorded in the PAA. The extent of occurrence (EOO) of the Gugal; *Commiphora wightii* is 20,000 to 22,000 km^2, which falls under the definition of restricted-range species, defined as those species that have an EOO of less than 50,000 km^2, triggering critical habitat, as defined by PS6.

Potential environmental impacts

It is expected that the project will have short term impacts during the construction phase (nuisance impacts such as noise and dust generation, traffic impacts etc.) but also long-term impacts due to the cessation of seepage and leakage of water from the canal. The seepage contributes to maintaining surface water bodies, wetlands, ponds, surface moisture and potentially groundwater that support wildlife habitats and ecosystem services. Project impacts include a decrease in surface water and soil moisture which supports existing vegetation and habitat patterns that support wildlife habitat and ecosystem services. Ecosystem services include the provision of water to communities and livestock, support cropland and subsistence agriculture, grazing areas and fodder for livestock and provide a source of water for communities and crops during periods of prolonged drought. The canal also provides communities with recreational areas along the canal for camping and picnics and for recreational and leisure activities.

Recommended Environmental Mitigation Measures

During the rehabilitation works, Good International Industry Practice in line with the IFC Performance Standards and the General Environmental Health and safety (EHS) Guidelines to mitigate impacts of the construction and rehabilitation activities. Critical Habitat criteria (as defined in PS6) was triggered by the plant species *Commiphora wightii* identified in the Project Area of Influence (AOI) during the Scoping Phase. The ESIA/ESMP that will be prepared for the project are expected to include specific mitigation measures to avoid any impacts on other species, as well as non-protected raptor species. A Biodiversity Action Plan will need to be developed for *Commiphora wightii* and the Indian Pangolin, also known to occur in the AOI.

Socioeconomic Environment

- There are seven human settlements located in the Project Affected Area (PAA), all of them within a range of 600m distance from the canal, hosting a total population of 38.300 inhabitants (approx.). All of these communities show a predominantly migrant profile, with people arriving from other parts of

the country, having settled in the Karachi area in the last 20-30 years, with the exception of Allah Dino Goth.

- Six out of the seven settlements show a high vulnerability profile in terms of income generation opportunities and access to basic services, with Haji Gul Mohd Goth (the largest in population with around 30.000 inhabitants) being the only one connected to public electricity and water networks. The remaining affected population show significant rates of extreme poverty, informal livelihood sources, illiteracy and temporary (kachcha) housing.

- Two of the settlements, namely Maharaj and Haji Ibrahim Goth, remain in informal legal status, and are not recognised by the authorities as population settlements. This condition is accompanied by the highest levels of vulnerability in the form of housing and livelihood conditions. In the case of Haji Ibrahim, livelihoods are tightly linked to the presence of a nearby waste management facility, as most of their members are engaged in scavenging activities.

- Rainfed agricultural activities are performed in some extensive areas near Maharaj, Patai Brohi and Allah Dino. Rainwater and mountain spring water is accumulated in dug ponds during the rainy season and later used for the winter cropping cycle. Agricultural land belongs to influential landlords who do not reside in the PAA. Local villagers work the land under informal agreements with the landlords. Only in very few cases have villagers acquired smaller agricultural plots.

- Main livelihood sources in the PAA settlements include hired labour in nearby towns and agricultural areas, subsistence agriculture on leased land, livestock, rubbish picking (Haji Ibrahim Goth) and, to a lesser extent, small handcrafts. Formal employment opportunities are only found in Haji Gul Mohd Goth in the form of government and private sector (mostly in the marble industry) jobs.

- All but two settlements (Haji Noor Mohd Goth and Haji Gul Mohd Goth) are highly dependent on canal water for human and animal consumption as well as domestic uses. Different means of collection are used along the PAA, including distribution through tankers, direct collection with jerrycans, and summer pumps. One illegal piped connection has been identified in Maharaj Community.

  All but one settlement are dependent on off-grid solar power, whereas basic social infrastructure (health and education) is totally missing in two of them (Allah Dino Goth and Maharaj Goth). Five settlements have at least one primary school within 1km of their boundaries and three of them have a clinic or hospital within a 2km range.

Potential Social Impacts

- The substitution of the existing infrastructure by a water pipeline and/or the subsequent access restriction will imply a severe impact for six of the identified settlements, potentially leaving a total population of 8,000 villagers without a feasible source of water for all basic needs. While non-consumption uses can be partially covered through existing borewells in some communities, the absence of any mitigation measures provided by the project could force communities to abandon their villages and migrate to other areas where water for human and animal consumption is accessible. The total demand of water by the affected communities is estimated at 0.1 MGD.

- Spatial correlation between seepage water (and the generated wild vegetation) and the presence of agricultural land indicates that the rehabilitation of the canal infrastructure may negatively affect soil moisture and agricultural yield in the vicinity of the canal. Although mostly rainfed, the actual extent of the seepage influence over agricultural activities might be non-negligible and will need to be further investigated during the ESIA stage.
- The project is not expected to trigger IFC's PS5 and no land acquisition or resettlement impacts are expected along the corridor of the project. Nevertheless, some identified narrower areas, in which the existing right of way seems to have been compromised will need to be taken into consideration before the commencement of the works.
- Enforcement of access restrictions and the installation of a water pipeline will prevent the population from drowning hazards, potentially saving up to 10-15 fatalities every year.
- Construction works are expected to affect the mobility of the local population, particularly in some specific settlements where villagers are highly dependent on the auxiliary service road along the canal for connectivity with the main Karachi City and some other relevant destinations. Some crossing areas used by villagers to access the opposite side of the canal will be also temporarily affected.
- The involvement of a private contractor in the operation of the water conveyance system and the WTP after the rehabilitation works will cause the substitution of a significant part of the current KWSB staff. In the absence of a proper transitional plan for the recycling of positions and the transfer to other projects, a number of employees could be subject to retrenchment and the subsequent social impacts, including potential opposition to the project.
- Land related impacts of the proposed PV Plant for the provision of power to the rehabilitated WTP are not expected, as no land acquisition will be required, and the land is free of any informal uses or assets to be compensated.
- Job opportunities for local community members, particularly during construction works, might be accessible in the presence of proper stakeholder management and planning.
- Community health and safety may be at risk from worker migration and the presence of workers in the PAA, resulting in a potential change in the disease profile of the local population. Particular attention should be paid to the COVID-19 risks, as, in the context of Pakistan, communicable respiratory diseases will likely be the most significant concern for potential interactions between the workforce and community members.
- Presence of indigenous peoples has not been observed. IFC Performance Standard 7 is not triggered in the context of the project.

<u>Recommended Social Mitigation Measures</u>

- Access to water by affected communities should be granted through a Community Water Access System. The exact elements and functioning of the system will need to be determined during the ESIA stage, although it is recommended that a mix of different alternatives are offered to the

community, particularly in the form of distribution through tankers and direct collection at watering points. The system might be governed by a participatory approach and it would be directly managed by KWSB, with all necessary physical investments by the Private Contractor (watering points, auxiliary transport infrastructure, etc.).

- The exact water demands in order to address the dependence of agricultural land on seepage water, as well as the conservation of natural habitats, will need to be determined during the ESIA stage. Nevertheless, it is recommended that the private Project Developer provides feasible solutions in the designs of the infrastructure that allow for controlled discharges of water in strategic points, once the demand is determined during the ESIA process. These design elements might be jointly addressed through the watering points installed for the community needs or separately. The project proponent will need to implement a monitoring system to determine water needs and the impact of controlled discharges with the participation of affected stakeholders.
- In order to avoid possible damages of private property elements in narrower sections of the canal corridor, the Project Developer is expected to provide feasible solutions in the sequencing of the works and the location of construction laydown areas. No RAP process is expected in the framework of this project.
- As part of a Community Health and Safety Plan, the project developer shall provide alternative routing and crossing paths in particularly sensitive areas where the mobility of local communities might be compromised. The solutions can be provided in the form of safe corridors and may include the provision of collective transportation means during the construction works. Permanent blockage of the existing road infrastructure along the canal should be avoided.
- In order to avoid retrenchment of workers and the subsequent negative social implications, in agreement between IFC and KWSB, it has been determined that large share of the labour force currently involved in the management of the Hub Canal infrastructure will be transferred to other available projects in the area, whereas some selected positions will be proposed to be transferred to the private Project Developer after an adequate training plan.
- Job opportunities for local communities must be offered through a specific local employment plan, including the provision of training programs for the development of skills beyond the construction stage.
- Hazards related to the exposure of the community to the construction works and the labour force, and in particular COVID related risks shall be addressed in the corresponding Community Health and Safety Plan. Additionally, the Project Developer shall prepare an Occupational Health, Industrial Safety and Accidents Prevention Program with appropriate accident prevention program, reporting and periodic review (summary of relevant measures).

1. Introduction and Background

TYPSA has been retained by the IFC to provide consulting and advisory services to support the Government of Sindh (GoS), Pakistan, and the Karachi Water and Sewerage Board (KWSB) in the private sector rehabilitation of the Hub Canal that supplies part of the Karachi water supply system. The Project had been conceived by a private sector entity, USP Developer, which had approached GoS and KWSB via an unsolicited proposal (USP). While unsolicited bids are permitted under the Sindh Public Procurement Act 2009, the act also prescribes the unsolicited proposal to undergo a competitive bidding process to achieve the lowest price for the government. The GoS has appointed the IFC as its Lead Transaction Advisor to prepare and undertake the structuring and tendering of the Project on a Public Private Partnership (PPP) basis.

The Hub Canal is a 22 km canal that conveys water from the Hub Dam to the KWSB water treatment plant (WTP) located in Manghopir-Karachi. The system was originally designed to treat 100 MGD (5.26 m^3/s) of water coming from the Hub Dam. Presently, the canal's capacity is limited to around 75 MGD (3.95 m^3/s). The successful implementation of the project will enhance its capacity by around 25 MGD (1.32 m^3/s), to reach the total expected capacity of 100 MGD (5.26 m^3/s). The project entails the following:

- Rehabilitation of 11 km of the existing canal.
- Construction of a 9.8 km new pipeline in the last stretch.
- Upgrade of Hub pumping station (to achieve 100 MGD; 5.26 m^3/s).
- Connection with the K-III canal at the Hub Pumping Station during drought periods.
- Upgrade of the 2.2 km rising mains that connect the Pumping Station with the water treatment plant.
- Upgrade of the water treatment plant, moving from 80 (4.21 m^3/s) to 100 MGD (5.26 m^3/s).
- SCADA and Metering system, including telecommunications.
- A new solar PV plant to optimize energy requirements with a 2.5 km distribution line.
- E&S mitigation measures.

The water supply scheme for the City of Karachi from the Hub Dam was planned and executed in the late 70s and commissioned in 1981. The scheme relies on the availability of water received from the upstream catchment after rains. There have been instances when due to drought conditions in the Hub Dam catchment area the water levels in the reservoir were so low that water could not be supplied to the city. The main Hub Canal offtakes from the Hub Dam and travels approximately 8.3 kms in a South-Westerly direction. This 8 km section of the canal and the Hub Dam itself is owned, operated and maintained by the Water and Power Development Authority of Pakistan (WAPDA), a federal agency. The Hub Dam consists of an embankment dam and a large water storage reservoir, constructed on the Hub River for the purpose of supplying municipal, industrial and irrigation water to Sindh and Balochistan. The Main Canal from the dam bifurcates into two branches at about 8km downstream from the dam at a Head Regulator: the Lasbela Canal which flows west towards Balochistan and the Hub Canal which continues for 22 km in a South-Westerly direction towards the KWSB pumping station and water treatment plant, as shown in Figure 1. The 22 km section of the canal is owned operated and maintained by KWSB.

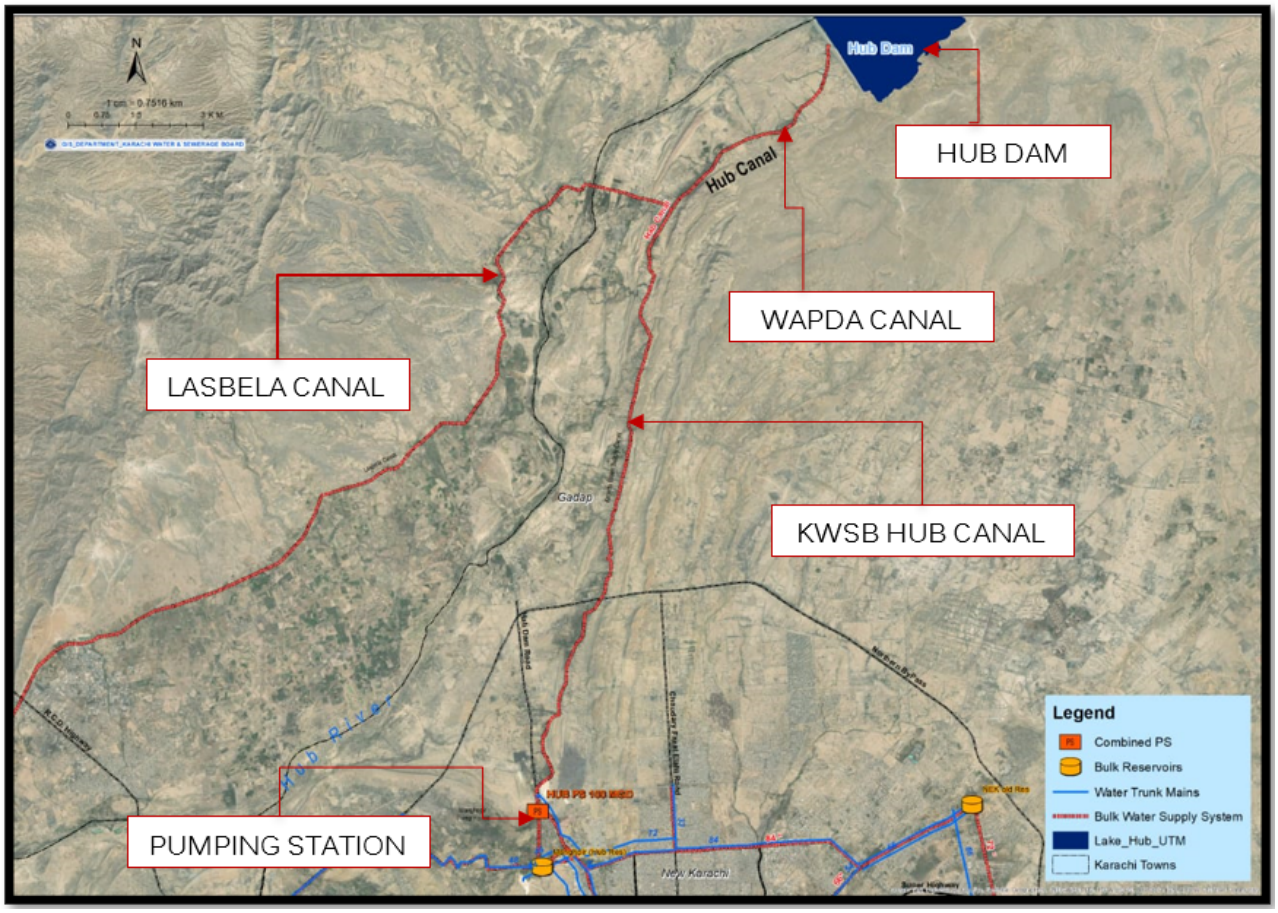


Figure 1. Project location north of the City of Karachi.

2. Scoping Report Objectives

Scoping is a critical step in the preparation of an environmental and social impact assessment. It identifies the issues that are likely to be of most importance during the ESIA process and eliminates those that are of little concern. Scoping is a systematic exercise that establishes the boundaries of an ESIA and sets the basis of the analyses to be conducted at each stage. A good scoping study reduces the risk of including inappropriate components or excluding components that should be addressed and involves:

- Identifying all relevant issues and factors, including preliminary environmental and social impacts, cumulative effects, and health risks.
- The preliminary identification of the Project area of influence (PAI)
- A description of the E&S Regulatory Framework applicable to the Project
- Identifying the important issues to be considered in the ESIA, such as setting the baseline and identifying alternatives.
- The identification, preliminary assessment, and definition of the magnitude of key E&S risks and impacts associated with the Project, including ancillary and associated facilities.
- Facilitating meaningful public engagement and review.

The E&S Scoping Report is based on, but not limited to, the following framework documents: the IFC Performance Standards and other World Bank Group guidance documents such as the IFC's General EHS (Environmental, Health and Safety) Guidelines, sector specific guidance documents such as the IFC's EHS Guidelines for Electric Power and Transmission and Distribution, local environmental regulatory framework, IFC's Stakeholder Engagement Handbook, Good Practice Handbook on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets and Good International Industry Practices.

3. Project Description

3.1. Geographic Location

The Hub Canal conveys water from the Hub Dam over a distance of 8.3 km to a head regulator which bifurcates part of the flow to the Lasbela canal, flowing to the west. The remaining 22 km of the Hub Canal (owned, operated and maintained by KWSB) conveys water to the KWSB pumping station and water treatment plant (WTP) located in Manghopir-Karachi (Figure 1).

The canal is located to the east of the Hub River as shown in Figures 1 and 2. In addition, Figure 2 presents the location of aqueduct structures downstream from the head regulator within the KWSB-owned portion of the canal.

3.2. Project Components

The project includes the rehabilitation of the 22 km KWSB Hub Canal from the head regulator (bifurcation point) up to and including the rehabilitation of the pumping station, rising mains and the KWSB WTP. In addition, the project includes the development of a Solar PV plant to be located on KWSB land adjacent to the WTP. The canal requires rehabilitation due to damage, cracking and significant seepage losses. The 11 aqueducts within the KWSB-owned portion of the canal (Figure 2) show visible cracks and leaks which contribute flow to seasonal watercourses flowing west towards the Hub River.

The rehabilitation of the canal would require the complete disruption of flow in the KWSB canal and to the KWSB WTP, representing a significant portion of Karachi's water supply or the provision of costly diversion works. To avoid disrupting Karachi's water supply, alternatives involving pipelines which can be built within the canal right-of-way (RoW) while the canal continues to convey water to the WTP have been studied. Descriptions of the feasible alternatives for rehabilitating the canal/conveyance system are provided in Section 4. The preferred alternative carried forward in this report, is a hybrid configuration and is described in the following section. Alternative means of supplying water to the City of Karachi have not been studied as part of this scoping exercise but are suggested in Section 4 and should be considered during the project ESIA.

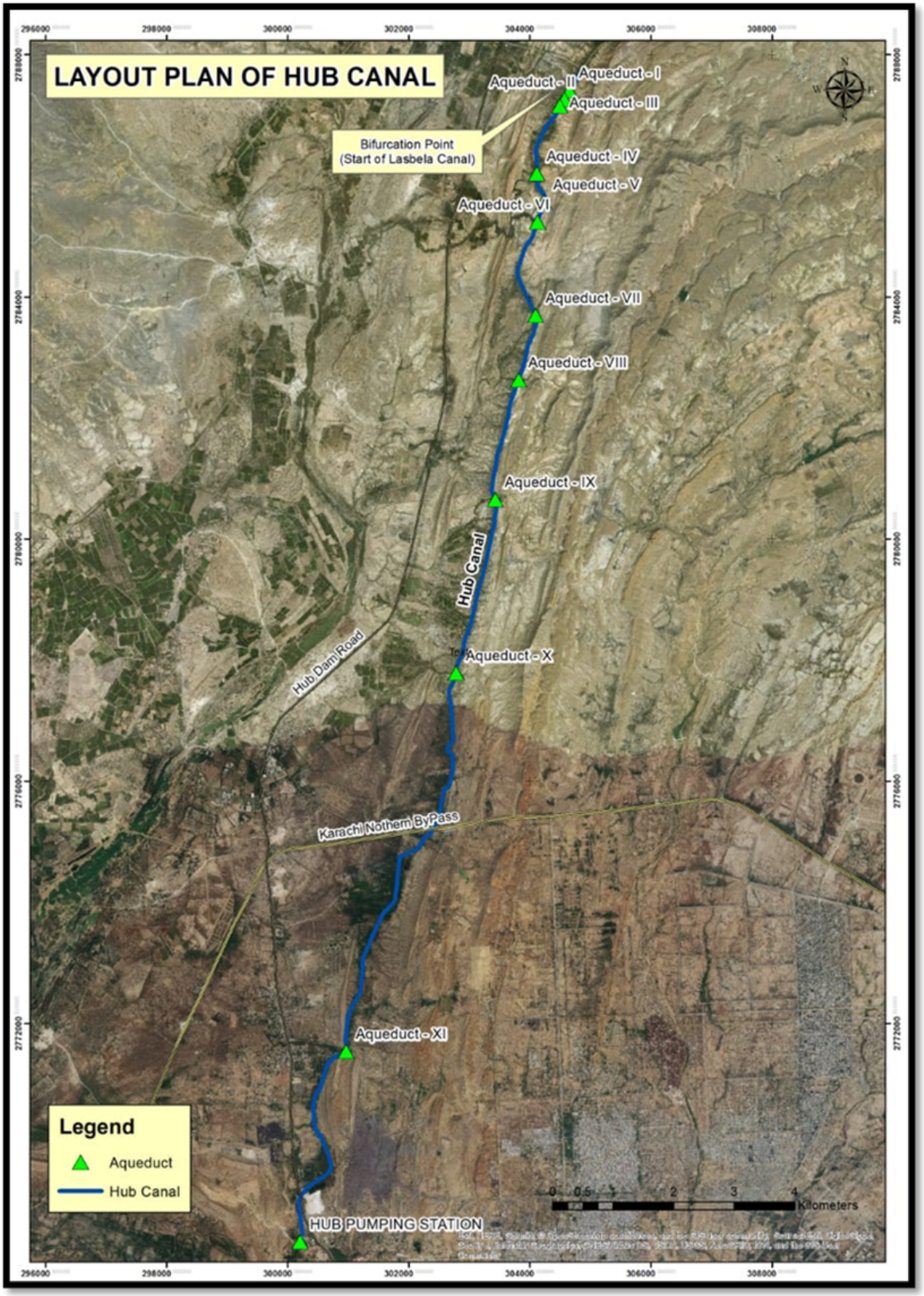


Figure 2. KWSB Hub Canal layout with location of aqueducts

The following photographs depict aspects of the current condition of the infrastructure in need of repair, rehabilitation, or reconstruction.

Figure 3. From left to right starting from the top: 1. Deteriorated canal lining; 2. Reeds and grasses within canal section; 3. Visible seepage, deterioration, and vegetation growth Aqueduct #7; 4. Visible seepage, deterioration, and vegetation growth Aqueduct #1.

3.2.1. Canal Rehabilitation & Pipeline Component

A hybrid canal rehabilitation and new pipeline configuration has been selected as the preferred alternative for the project The first section of the canal, which is relatively flat, will be rehabilitated from the head regulator over a distance of 11.94 km. . The second section of the canal (the most downstream portion) will be replaced by a pipeline that will be buried in a trench, excavated within the canal and service road right-of-way. A pressure chamber with a debris screen and mechanical rakes will be located at the end of the canal section and inlet to the pipeline section. It is proposed that the water pre-treatment system be located in the pressure chamber. The pipeline section will be approximately 9.8 km long and will ensure pressurized flow at the pumping station inlet, minimizing head losses through the system.

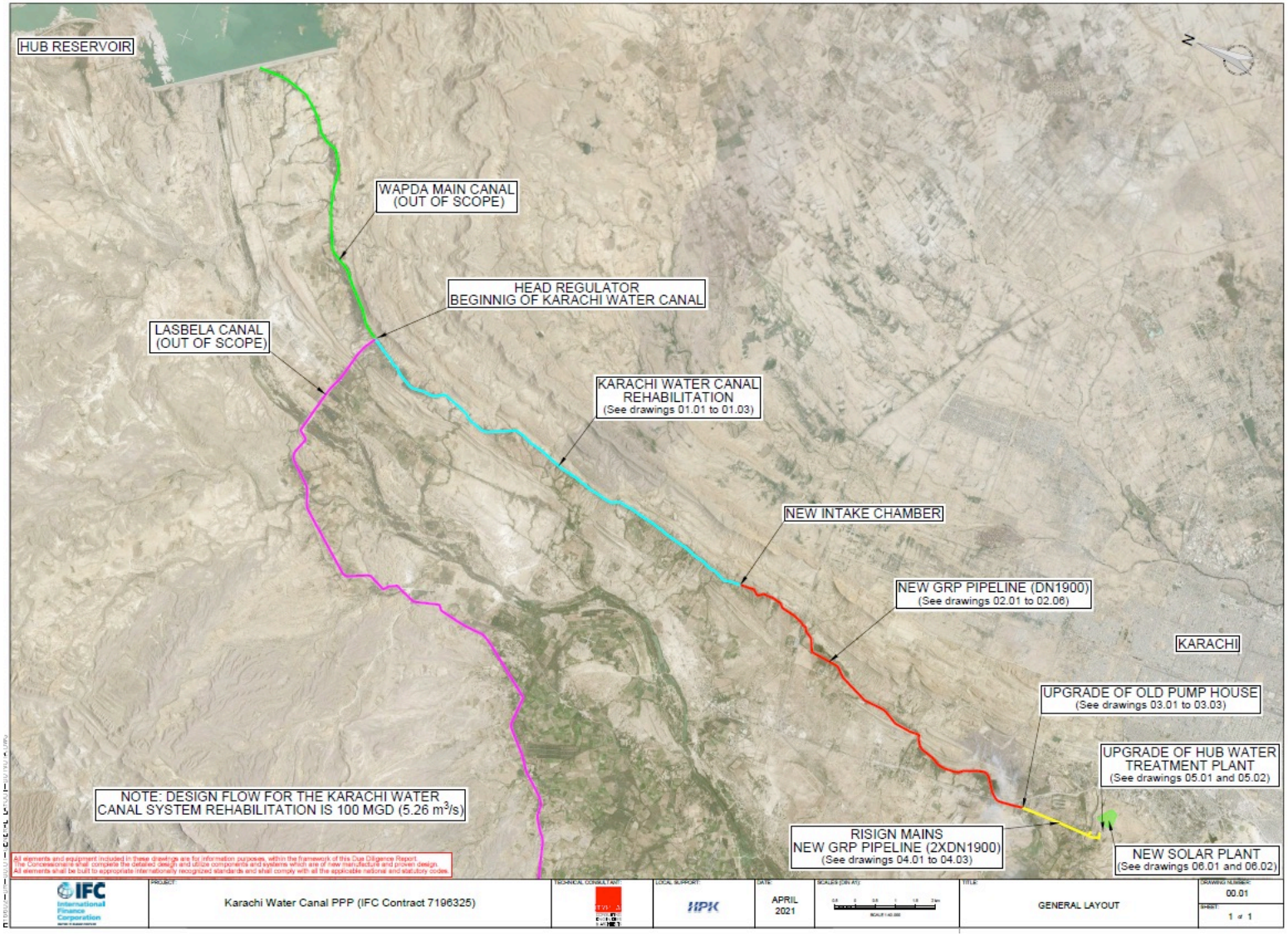


Figure 4. Preferred configuration: Canal rehabilitation + new pipeline.

The proposed rehabilitated canal channel cross section is shown in the following figure. Construction activities will include:

- Conditioning of the embankment by clearing and shaping the slopes.
- Conditioning of the canal lining by means of a 0.10 m layer of concrete (fc 3000 psi/ 20 MPa)
- Waterproofing of the sections by means of 3 layers of geotextile sheets of 300 S/cm² and two layers of PVC waterproofing sheets of 1.5 mm thickness.
- Upgrade of the service roads, 3.0 m wide, on a 20 cm thick granular base, with a 2% slope, a curb on the sides of the canal, and longitudinal drainage.
- Transversal drainage works (culverts) according to needs.

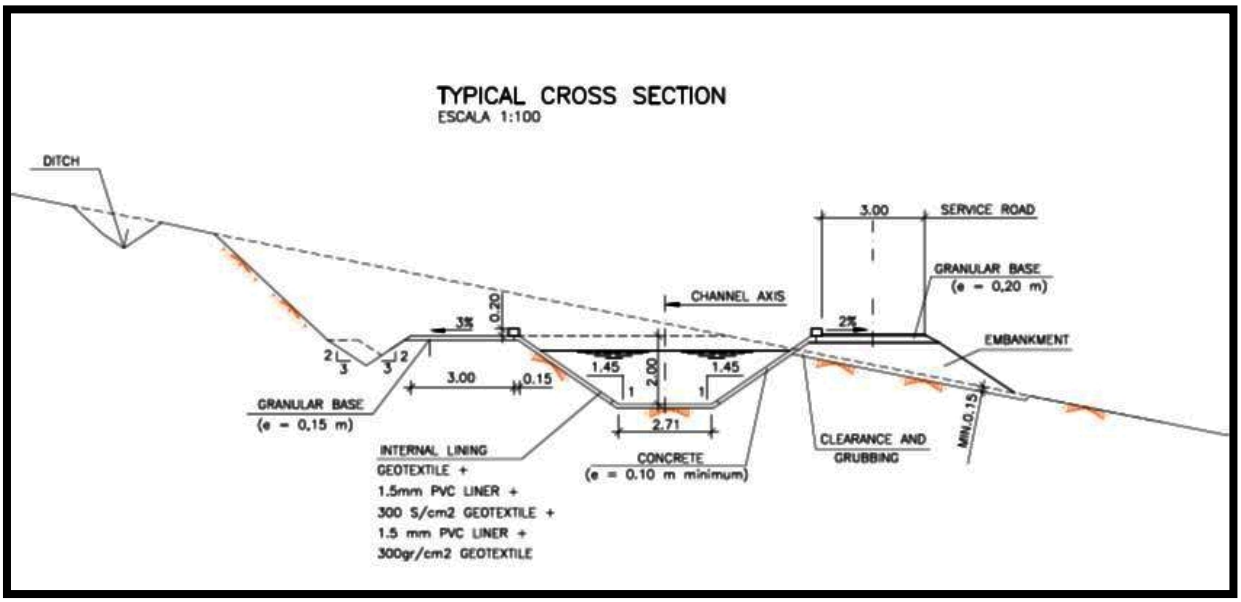


Figure 5. Typical Hub Canal rehabilitation section.

The canal rehabilitation and aqueduct demolition and reconstruction will generate significant amounts of inert construction waste that can be disposed of at nearby waste disposal facilities (refer to section 7.1.9).

A surge chamber equipped with a trash rack and raking system to prevent debris carried by the canal from entering the pipeline section will link the rehabilitated canal section and the pipeline.

The proposed pipeline would consist of a 1900 mm diameter GRP (glass reinforced plastic) pipe placed in trapezoidal trenches. Proposed typical trench cross sections and dimensions are shown in the following figure. All trench configurations have in common a 2.8 m width at the base, include a bedding of compacted sand and backfill of granular material (20 mm diameter) overlaid by thoroughly compacted selected fill material. The minimum depth from the surface to the top of the pipeline will be 1 m. . The pipeline will be constructed within the canal and service road right-of-way.

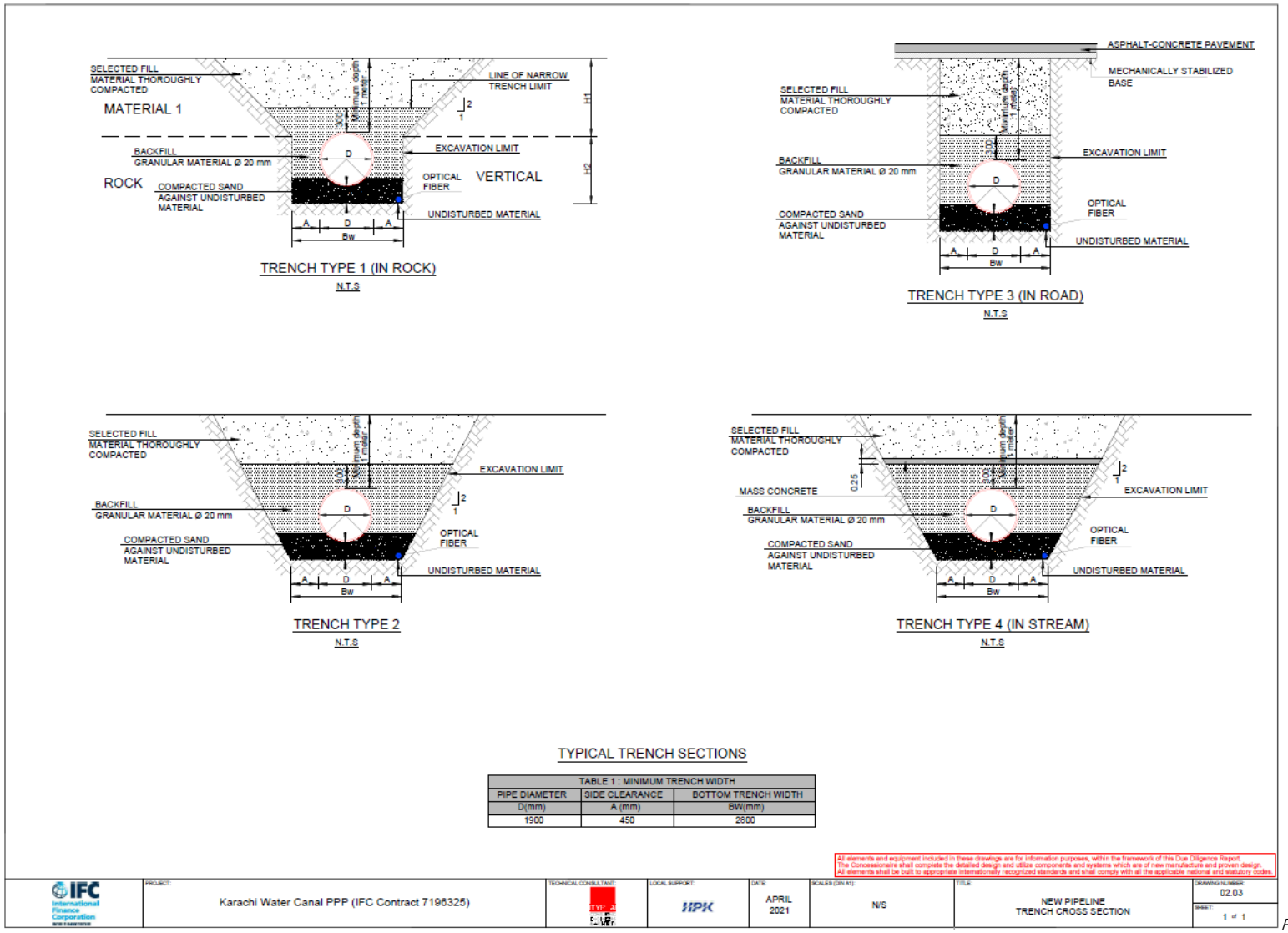
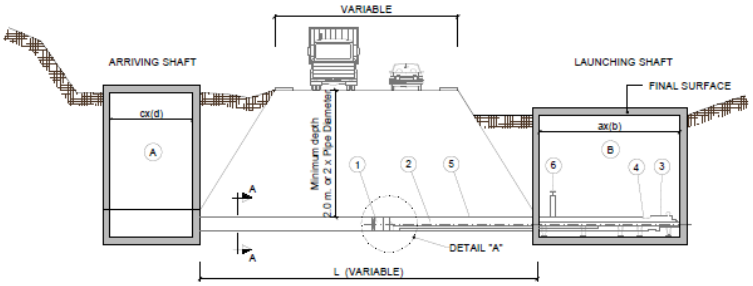


Figure 6. Typical Pipeline Trench Sections.

Buried pipelines provide some protection from vandalism and water theft.

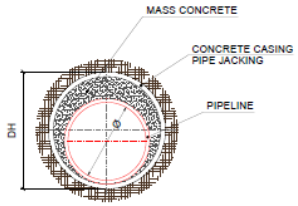
The pipeline can be constructed at the same time as the rehabilitation of the upper section of the canal. . During the rehabilitation of the upstream canal section, coffer dams, pumps and temporary piping will be used to isolate canal stretches during the rehabilitation works and to ensure water conveyance downstream. Detailed construction planning to minimise the overall interruption of water supply to the Water Filtration Plant and City of Karachi has not been developed at this time. A construction plan that minimises water supply interruption to the city will be developed during the detailed feasibility studies and should be described in the project's ESIA. The City of Karachi will continue to have access to water being supplied from other sources and may experience water shortages during the rehabilitation works. KWSB will need to coordinate the water supply to the City being supplied from other sources to minimise shortages during the rehabilitation of the Hub Canal and the Water Filtration Plant.

Pipeline alignment from the upstream end will be on the west side of the canal up to a 90-degree elbow in the canal located approximately 6.2 km (chainage 6+175) from the start of the pipeline, opposite the community of Gul Mohammad where it will be transferred to the east side of the canal, avoiding settlements and populated areas closer to WFP. The horizontal drilling/pipe jacking construction method that will be used to lay the pipe under the canal is shown in the figures below.

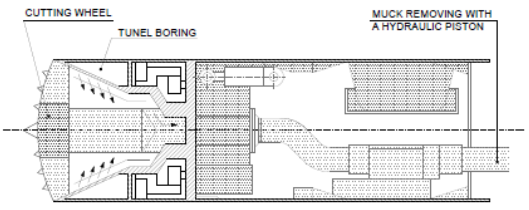


PIPE JACKING WITH SHIELD AND ENCASING REINFORCED CONCRETE PIPE

WITHOUT SCALE



SECTION A-A



DETAIL "A"

LEGEND	
A	ARRIVING SHAFT
B	LAUNCHING SHAFT
1	CUTTING WHEEL
2	MUCK REMOVING WITH HYDRAULIC PISTON
3	HYDRAULIC UNIT
4	PULLING HEAD
5	CASING PIPE
6	SPINDE TO FIX THE LEVEL

INITIAL CHAINAGE	FINAL CHAINAGE	LENGTH (m)	a (m)	b (m)	c (m)	d (m)	DIAMETER (mm)	PIPE-JACKING (mm)	CLASS
6+173	6+188	15	10.5	4.0	2.5	3.0	1,900	2,500	CONCRETE
9+052	9+072	20	10.5	4.0	2.5	3.0	1,900	2,500	CONCRETE

The same method will be used to lay the pipe under Hub Dam Road which crosses the canal near the WTF (at chainage 9+052).

Although a final solution for the future disused downstream section of the canal has not been included in the design at this stage, the disused structure shall be decommissioned (and a provision for decommissioning of the canal is included in the project CAPEX). It is recommended that demolition waste from the upper canal rehabilitation works (old canal lining for example), aqueduct demolition waste, as well as excess excavated soils from the pipeline trenching activities be used to infill the disused section of the canal. The structure may be rehabilitated as a service road, revegetated or other use. The full width of the canal right-of-way will be fenced on both sides preventing public access. Only demolition waste and excess soils categorised as clean fill should be used for in-filling. It is possible that decommissioning may require partial demolition of the canal structure.

Once all components of the water conveyance system are completed (i.e. the new rising mains are constructed, the pump house is upgraded, the new pipeline is installed and the upstream reach of the canal is rehabilitated, a minimum water closure will be necessary to connect the canal section with the pipeline, fill the pipeline and rising mains with water and commission the system. The commissioning to shift flow from the existing system to the upgraded system should take several days up to about one week.

3.2.2. Pumping Station Rehabilitation

The upgrades to the pump house will include the following basic activities and will be restricted to KWSB property:

- Demolition of the “Old Pump House” and construction of a new pumping station that will connect with the new GRP pipeline and work as a booster to convey water to the WTP. The design flow is 100 MGD (5.26 m^3/s) and a 6+1 pump scheme is proposed. All appurtenant equipment, connections, SCADA and metering are also included.
- Rehabilitation of the existing “New Pump House” to accommodate 80 MGD (4.21 m^3/s) from the K-III connection, which is a water transfer used in the North-West area of the city during drought periods, when Hub Reservoir cannot convey water to the Hub Canal. This activity encompasses the installation of 5+1 pumps, the associated electrical equipment, upgrade of the approach canal from K-III, screen rehabilitation and minor building repairs.
- New valve chamber downstream of both pump houses, to connect with the rising mains.

In relation to the three main pipelines that connect the pumping station (PS) with the water treatment plant (WTP) it was no possible to undertake any survey in the area because KWSB did not give the authorization. In any case, at the request of KWSB, the total replacement of these pipelines is envisaged, including 2 GRP pipelines with a diameter of 1900 mm.

3.2.3. Water Filtration Plant

An aerial view of the existing Water Filtration Plant is presented in Figure 7.

Figure 7. Aerial view of the KWSB Water Treatment Plant.

The upgrade to the Water Filtration Plant will be restricted to the KWSB property and will include the following:

- Increase the plant capacity from 80 MGD (4.21 m^3/s) to 100 MGD (5.26 m^3/s) and ensure water quality according to WHO guidelines[1]. The upgraded disinfection component of the plant will ensure appropriate residual chlorine levels throughout the distribution system.
- Replacement of existing filter media with new sand.
- Construction of 4 new filter beds, each having capacity of 5 MGD.
- Construction of inflow & backwash channel with penstock gates and installation of pipes & valves for backwashing and air blower operation for two new beds.
- Install new filter bed control panels with SCADA system.
- Repairs to acid and lime dosing systems.
- Replacement of all pumping machinery including backwash pumps, chlorine motive pumps, thickener feed pump etc.
- Replacement of leaky valves and penstock gates with new ones.
- Coating of exposed piping, existing valves, and penstock gates.
- Repair of leakages and cracks in civil structures.
- Landscaping.
- Repair or replacement of outdoor lighting.

[1] https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/water-safety-and-quality/drinking-water-quality-guidelines

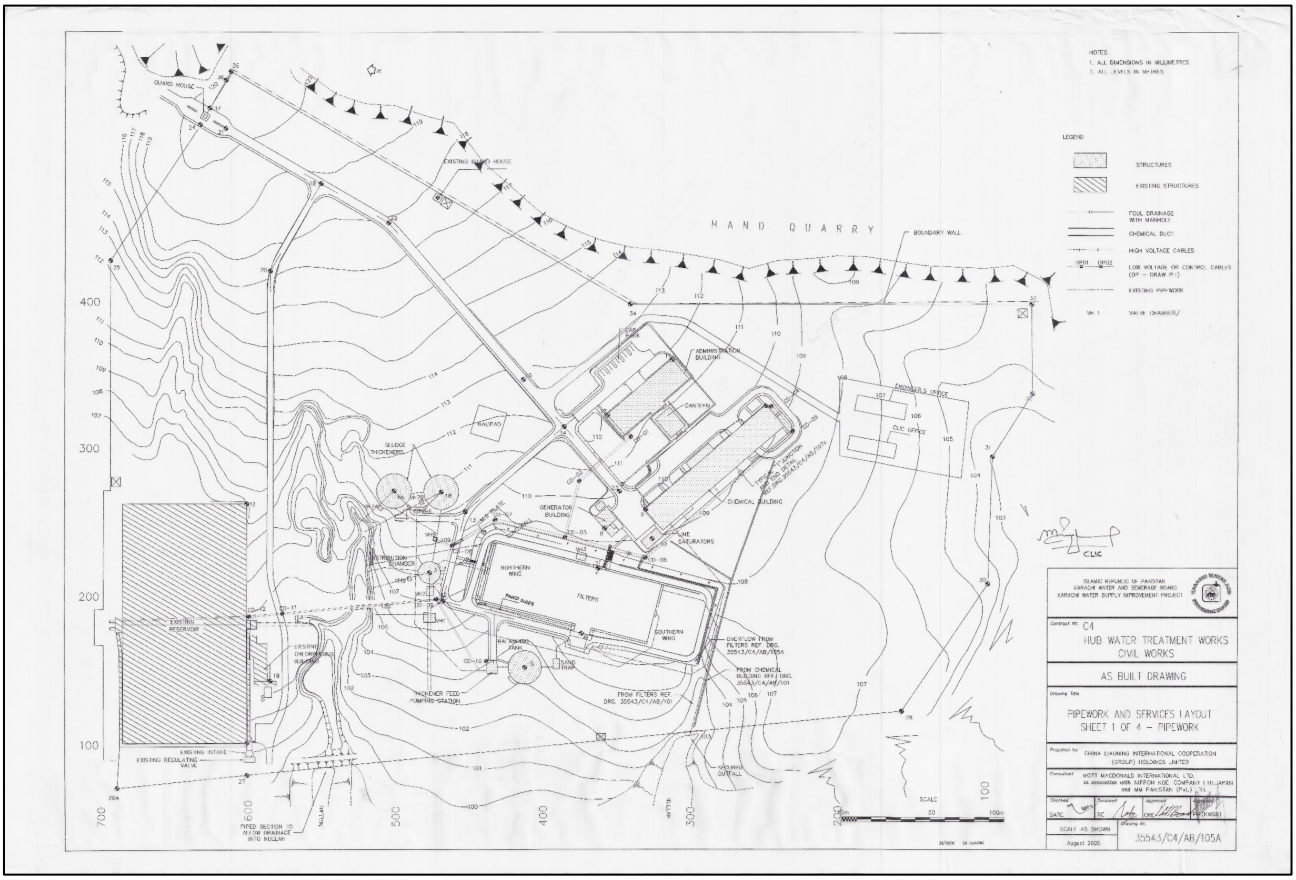


Figure 8. Original layout of the KWSB Water Filtration Plant.

It is worth mentioning that the existing sludge line starts at the **washwater balance tank,** which must be sized to hold the washwater coming from the filters being washed. During the detailed design and the concession period, it has to be determined whether more than one filter is to be washed at the same time and taking this into consideration, whether the capacity of the existing wash water balance tank is sufficient.

Feed thickener pumps must be sized to send the washwater to the sludge thickeners with a flowrate that allows hydraulic and mass loading rates within adequate limits for a good thickening of sludge.

Then, the sludge arrives at the **thickener gravity tanks**, which must have enough capacity to separate and thicken the sludge carried by the filters washwater. The thickened sludge shall have the necessary concentration (minimum 3% dry mass) to be sent to the new centrifuges for dewatering.

To improve the current performance, the due diligence report recommends the replacement of the scrapers, sludge thickener pumps, pipelines, and valves. In addition, it would be necessary to introduce flow meters and instrumentation to automatize the unit process.

Finally, a new **sludge building** must be constructed:

- The **centrifuges** and all auxiliary equipment shall be sized according to the estimated sludge production. A **dewatered sludge storage system** will be provided, so the dewatered sludge can easily be loaded into trucks for its evacuation to designated areas outside the plant.

- Centrifuge feed pumps must be selected according to the capacity of the centrifuges installed. Progressive cavity pumps are advised.
- For the sludge dewatering, a polymer system preparation and dosing shall be designed.
- The dewatered sludge must be sent to a storage area or silos from where it can be evacuated from the plant. Adequate transport and storage systems must be proposed.

3.2.4. Solar PV Plant

A solar PV plant will be installed adjacent to the WTP on land owned by KWSB, as shown in the figure below. The figure shows a solar PV plant with a nominal AC capacity of approximately 4.5 MW (total peak power of 6.03 MWp) which will be the maximum load of the WTP, however a smaller PV plant may be constructed (see descriptions of alternatives in section 4). The layout shown in the figure below comprises a total of 11,600 bifacial modules with a maximum power of 520 Wp each and the expected yield of the facility is presented in the following table:

Results 1st year of operation (P50)	
Energy produced (MWh)	10,324
Specific production (kWh/kWp)	1,712
Performance Ratio (%)	80.68

Table 2: Estimated energy production at the Hub Solar PV Plant

A 2.5 km 11.1 kV distribution line will connect the solar PV plant to the existing substation located at the WTP pumping station. The existing substation will require electrical equipment upgrades. The solar PV facility will be fenced and gated (not accessible to the public).

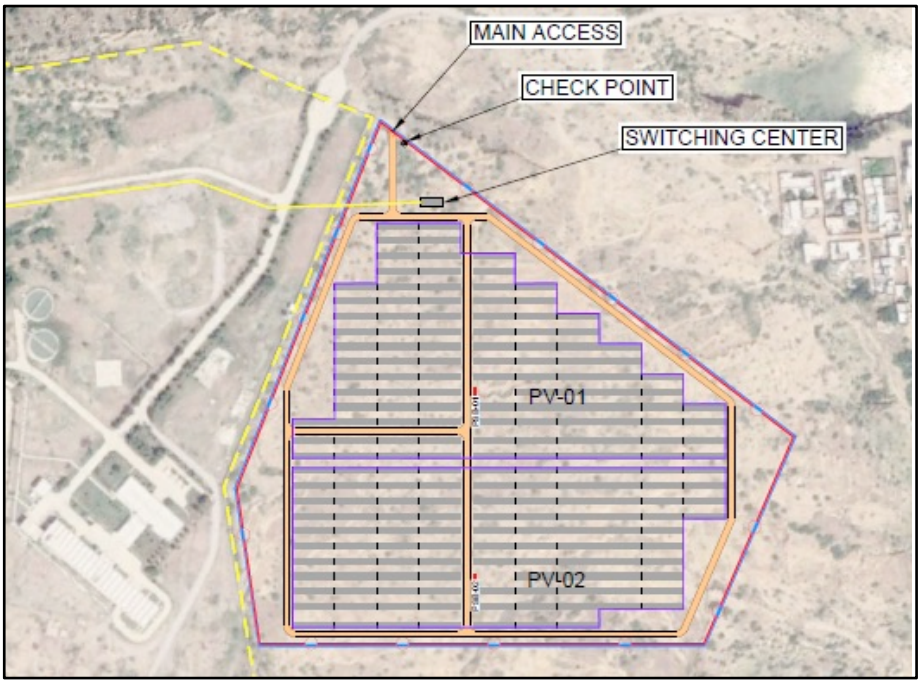


Figure 9 Figure 10. Solar PV plant layout

The frequency of panel cleaning is dependent on how soiling decreases generation or performance of the PV plant. Panel washing is typically carried out when the cost of washing compensates for the losses due to

soiling. Precipitation data indicates that there are three months of abundant rainfall when panel cleaning would not be required. The latest layout includes 11,600 modules which would conservatively require 3 litres each for cleaning. Considering cleaning would be carried out during 9 months per year and twice a month would require a total of 70 m^3/month for nine months if dry-cleaning methods are not used, e.g., approximately 630 m^3/year. Cleaning schedule optimization can minimize the annual volume of water used for panel cleaning. Water used for panel cleaning must meet quality standards of the panel manufacturer.

Dry cleaning methods should also be considered to minimize any pressure on freshwater sources and avoid the use of water does not meet the PV panel manufacturer's quality standards. Dry cleaning methods include semi-automated options consisting of truck/tractor configurations with customized cleaning equipment or fully automated rigs which run along the panels as a track and clean the panels with spinning brushes, micro-fiber cloth wipers, a combination of brush and vacuum cleaner etc. and are widely used in arid countries.

The solar PV plant will be fenced and have a dedicated gated access. The fenced area is 11.83 ha and the fence length is 1,380m.

3.2.5. Infrastructure and Civil Works

Access Roads:

The existing service road that follows the canal will be used by heavy equipment and vehicles to access the construction areas along the canal. Access to the construction areas will be restricted during construction (fencing, gated access and signage). During operations, the full ROW area to each side of the canal will be fenced to prevent public access to the canal and pipeline areas. .

A new access road will be required for the solar PV plant adjacent to the WTP. This access will need to be gated.

Stormwater management works:

Stormwater management and design will be needed to control run-off from the construction catchment areas to avoid erosion and sediment transport for the solar PV plant area. Internal PV plant stormwater management would consist of a series of standard trapezoidal ditches associated with the PV Plant sectors appropriately sized to carry storm run-off.

The rehabilitated canal cross section and service road include stormwater ditches. Stormwater design will include water crossings with culverts where necessary.

3.3. Workforce and Worker Housing

The total workforce during the peak construction period is estimated at approximately 400 workers (skilled and non-skilled workers).

Use of child labour and forced labour during rehabilitation work or project operations is strictly forbidden and the project proponent shall ensure that all provisions of Performance Standard 2 (PS2) shall be met, including monitoring of wages, working hours and occupational health and safety (OHS) practices, to ensure

enforcement of legislated and PS2 requirements. An OHS Plan in line with PS2 will be developed and clauses relating to working conditions for the main contractor will also be required for sub-contractors. The monitoring program will also apply to sub-contractor activities.

There is no information regarding workers' accommodation or whether a worker's camp will be required at this time. If the project requires construction camps which include workers accommodation, the "Worker's Accommodation Processes and Standards": guidance note by IFC and EBRD[2] should be followed.

3.4. Project Water Consumption

During construction, water will be needed in the construction camps for domestic purposes by workers, for construction activities (wash down of equipment and heavy vehicles), for dust suppression on roads, for preparation of concrete etc. The amount and source of water required for construction has not yet been determined and will require further investigation during the ESIA.

As described previously, water required for PV panel cleaning during the operations phase of the solar PV plant is estimated to be a maximum of 630 m^3/year if dry-cleaning methods are not used. Cleaning schedule optimization can minimize the annual volume of water used for panel cleaning.

3.5. Project Phases

This section lists the main activities for each of the project phases.

3.5.1. Pre-Construction Activities

Preconstruction activities include those carried out to date as well as the following, but is not limited to:

- Full ESIA studies for the Project & associated Stakeholder Engagement
- Additional surveying and geotechnical investigations, if required.
- Acquisition of permits and approvals.
- Location and identification of all utility services, in consultation with relevant utility service provider(s), whether above ground or below the ground prior to construction, obtain relevant crossing permits as required. If any utilities need to be moved permanently or temporarily, engage and coordinate with individual utilities.

3.5.2. Construction & Site Preparation

[2] EBRD, 2009

It is assumed that construction will be carried out by an EPC (Engineering, Procurement and Construction) contractor and that the main site preparation and construction activities will be the following (but not limited to):

- Required road upgrades and widening of turning radii, if needed.
- Construction of temporary construction camp (if required) and/or construction lay-down areas in carefully selected locations to minimize community and environmental impacts.
- Demolition and reconstruction of existing aqueduct structures that are in a sever state of disrepair.
- Repairs to other aqueducts will include cleaning and removing any damaged concrete, grouting of seepage holes and cracks with crystalline cement mortar or epoxy grout and coating with water proofing material.
- Canal rehabilitation, service road rehabilitation.
- Excavation of trenches and placement of pipeline sections, construction of pressure chamber and intake works.
- Rehabilitation and upgrades to pumping station and WTP.
- Construction of PV solar plant, substation and electrical control room and erection of permanent PV plant fencing.

3.5.3. Testing & Commissioning

All systems (conveyance system and water treatment/filtration system) will undergo a full functional and safety testing to ensure that they are fit for purpose. The contractor will be responsible for functional testing, commissioning, performance testing and reliability testing of all project components.

3.5.4. Construction Demobilization

Upon completion of the construction phase all temporary infrastructure, waste, and debris, will be removed and the affected areas will be levelled and rehabilitated (e.g.: lay-down areas for construction staging, working areas, temporary construction offices, new access roads that will no longer used etc.). Topsoil stored in piles during construction will be reused as topsoil for areas that will be revegetated. The Contractor shall carefully remove all temporary infrastructure in a manner to prevent damage, with all equipment and materials specified or indicated to be salvaged and reused. Roads used for the access to site will be rehabilitated if any damage occurred during the construction phase. Any material damages to private properties will be repaired.

3.5.5. Operations and Maintenance

Operation and maintenance of the canal and pipeline sections will follow a preventative maintenance program including regular inspections carried out by qualified personnel with appropriate training. Access to the conveyance system for maintenance and inspections will be through the access road that runs parallel

to the canal/pipeline hybrid system and that is within the project right-of-way. The road will need to be maintained on a regular basis.

The following basic maintenance tasks are required for the canal/pipeline sections:

- The need for annual maintenance of the canal shall be determined during annual closure through detailed inspections. The function of inspections shall be to record, using both absolute and relative measures, the canal's condition, lining and joint reliability and structural integrity.
- On an annual basis, condition surveys shall be undertaken of the whole canal within the concession area. These surveys shall be divided into half-kilometre sections and shall record the location, type, and magnitude of all cracking in the lining, settlement if any, damage to joints, signs of seepage etc.
- Based on the findings of these inspections, immediate maintenance shall be carried out as required and to the extents possible during the annual closure period. For less immediate concerns, a planned maintenance program shall be developed for the following year, the objective of such a program being to take remedial action at the earliest possible time to both reduce the overall need for maintenance and the consequent disruption to water supply.
- All earthworks shall be inspected for signs of deterioration, at three- monthly intervals, and more frequently during the monsoon season, as part of a 'rolling planned maintenance program' and appropriate remedial action shall be taken to repair any identified defects.
- In addition, daily inspections of any susceptible areas of earthworks shall be made during periods when unusually high-water levels are identified adjacent to the Concession Area or the rainy season takes place, and appropriate action shall be taken to both safeguard the structural integrity of the facility and to remedy any defects that occur.
- The drainage system shall be inspected and routinely maintained at six-monthly intervals. The timing of these inspections shall be such as to ensure that the system is fully functional at times of heaviest rainfall and there is no water ponding which may cause damage to the road pavement.
- The six-monthly inspection and routine maintenance shall be designed to ensure that the system is free of silt and other debris, all covers, and manholes are in place and secured, and are fully functional. Catch basins and culvert inlets and outlets should also be cleaned regularly to remove accumulated debris.
- In addition, at two-yearly intervals, the drainage system shall be fully inspected to ascertain its structural integrity, and appropriate remedial action shall be taken, as necessary.

The following basic maintenance requirements pertain to the aqueducts:

- All structures shall be fully inspected at two yearly intervals as part of a planned monitoring procedure, and any identified defects shall be remedied within a period of six months from the date of inspection.
- If such an inspection shows that the structure's structural integrity has been compromised, appropriate action shall be taken immediately to ensure the safety of project and its personnel. Remedial repairs should then be undertaken, as soon as is practical, to restore the structure to a safe operational condition.
- Minor damage that does not in any way compromise the structural integrity of the structure shall be carried out within three months as part of a rolling maintenance program.

The operation and maintenance of the Solar PV facility includes replacement of modules, repair of inverters, and other ancillary equipment, which should be limited over the estimated 25-year life cycle of the solar PV

plant. Modules will need to be cleaned periodically depending on soiling and sand/silt accumulation. A preventive maintenance program will be established for maintenance of the inverters; mounting structures; surge arresters, cables, and PV junction boxes; meteorological station; security, fencing and gates; ditches and drainage culverts; and all sub-station components, including services and septic tank. A monitoring program will also be developed.

Staffing during the operation stage of the rehabilitated project may differ from current KWSB staffing levels. At the moment, KWSB has 105 employees working at the Karachi Water Canal Facilities, including the canal, pumping station, rising mains and water filtration plant. They are responsible for the daily operations and maintenance tasks. The list comprises 97 people plus 8 security personnel, filling the following positions:

- Superintending Engineer (Civil)
- Accounting and administration personnel
- Electrical and mechanical engineers
- Foremen and supervisors
- Electrician, mechanics and machine operators
- Laboratory personnel
- Coolies, helpers and valve men
- Security guards.

It is estimated that the private sector will employ less personnel to carry out the O&M tasks, and the following estimation of the future operation stage workforce is presented in TYPSA's due diligence report and reproduced below:

Workforce	No. of staff
	no.
Plant manager	1
Chief operation engineer	1
Personnel manager	1
Accountant administrative	1
Administration assistant	1
Shift supervision	1
Chief maintenance engineer	1
Chief maintenance engineer electrical	1
Maintenance operator mechanical	2
Maintenance operator electrical	2
Lab chief	1
Lab operator	2
Technicians	4

Safety officer	1
Workshop manager	1
Workshop mechanic	2
Store manager	1
Secretary	1
Laborer	6
Cleaner	5
Driver	4
Security guard	10
Subtotal labor	**50**

Out of these 50 positions, it is estimated that only 10 could be filled by current KSWB staff. The incorporation of this staff into the private sector will require an adequate transition and knowledge transfer programme. The remaining staff will need to be redistributed amongst other KSWB facilities and activities within reasonable distance from their homes and will require proper training and support for transition needs (transportation, moving, skills etc.). In the absence of a proper transitional plan for the recycling of positions and the transfer to other projects, a number of employees could be subject to retrenchment and subsequent social impacts, which could potentially generate some opposition to the project. The transitional plan will need to be fully compliant with PS2, specifically the following paragraphs:

- Paragraph 18. Prior to implementing any collective dismissals,10 the client will carry out an analysis of alternatives to retrenchment.11 If the analysis does not identify viable alternatives to retrenchment, a retrenchment plan will be developed and implemented to reduce the adverse impacts of retrenchment on workers. The retrenchment plan will be based on the principle of non-discrimination and will reflect the client's consultation with workers, their organizations, and, where appropriate, the government, and comply with collective bargaining agreements if they exist. The client will comply with all legal and contractual requirements related to notification of public authorities, and provision of information to, and consultation with workers and their organizations.

- Paragraph 19. The client should ensure that all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner. All outstanding back pay and social security benefits and pension contributions and benefits will be paid (i) on or before termination of the working relationship to the workers, (ii) where appropriate, for the benefit of the workers, or (iii) payment will be made in accordance with a timeline agreed through a collective agreement. Where payments are made for the benefit of workers, workers will be provided with evidence of such payments.

3.5.6. Decommissioning

Towards the end of the system's useful life a decision to rehabilitate or decommission the project components will need to be made. The typical design life of the components of the project are estimated to be:

- Civil works and structures: 30 to 50 years

- Pipeline: 60 years
- Mechanical and Electrical Equipment: 15 to 30 years
- Instrumentation and SCADA: 5 to 10 years

A decommissioning plan should be prepared 3 years prior to decommissioning of any of the main components of the water conveyance system, water treatment plant or solar PV plant outlining all demolition activities as well as land rehabilitation. Decommissioning plans are the responsibility of the infrastructure owners; however, owners can include clauses in agreements with operators that require the operators to prepare a Decommissioning Plan and Budget by a given date/year.

The life expectancy of a solar PV power facility is around 20 to 30 years. It is expected that the facility will be continuously maintained and repaired and will be operated for several decades. The facilities may be upgraded and/or renewed based on cost/benefit analysis and new technologies at the end of their life cycle. The decommissioning processes would be undertaken in accordance with environmental laws and standards in place at the time of decommissioning.

PV panels end-of-life management is an important issue facing many older PV facilities and increased deployment around the world is generating the need for end-of-life solutions for PN panels. IRENA and IEA's joint publication on end-of-life management for solar photovoltaic panels (June 2016) indicates that global installed PV capacity reached 222 GW at the end of 2015 and is expected to rise further to 4,500 GW by 2050. The report states that by the end of 2016, cumulative global PV waste streams were expected to have reached 43,500-250,000 tonnes and this amount will continue to increase.

In addition to increased waste volumes, PV panels pose unique waste management challenges. Today's typical c-Si PV panels contain about 76% glass (panel surface), 10% polymer (encapsulant and back-sheet foil), 8% aluminium (mostly the frame), 5% silicon (solar cells), 1% copper (interconnectors) and less than 0.1% silver (contact lines) and other metals (mostly tin and lead). More than 90% of their mass is composed of glass, polymer, and aluminium, which can be classified as non-hazardous waste. However, smaller constituents of c-Si panels can present recycling difficulties since they contain silicon, silver, and traces of elements such as tin and lead, accounting for around 4% of the mass. At this time, very few jurisdictions include specific PV waste regulation (European Union) or include PV wastes in their general waste regulations (USA, Japan). The EU Waste Electrical and Electronic Equipment (WEEE) Directive requires all producers supplying PV panels to the EU market to finance the costs of collecting and recycling end-of-life PV panels put on the market in Europe. Lessons can be learned from the experience of the EU in creating its regulatory framework to help other countries develop locally appropriate approaches. To date there are no such initiatives in any country in Southeast Asia. This is expected to change over the life of the project, as it is changing in other jurisdictions. The WEEE also highlights that End-of-life management could become a significant component of the PV value chain and recycling PV panels at their end-of-life can unlock large amounts of raw materials and other valuable components. The recovered material injected back into the economy can serve for the production of new PV panels or be sold into global commodity markets, thus increasing the security of future raw material supply.

4. Project Alternatives

Project alternatives were developed based on water availability and water resources analysis carried out by TYPSA and in accordance with the water needs of the City of Karachi (refer to TYPSA Hydrology study included in the Due Diligence Report, 2021 – see more information from the hydrology study in section 7.1.6 of this report) . The project alternatives are summarized in the following table (Table 3) and include a "base case" alternative which consists of the rehabilitation of the existing KWSB Canal (22 km in length), pumping station, rising-mains, and water treatment plant (WTP) and the construction of a 4.5 MW solar PV plant.

Alternatives were developed to avoid or minimise the interruption of the water supply to the water treatment plant and the City of Karachi. The rehabilitation of the canal in its entirety without interruption of water supply service is extremely difficult, costly and involves high risks.. Because such an impact on the water supply of Karachi is untenable, alternatives which combine the construction of a pipeline within the right of way of the canal and service road would minimise the interruption of the water supply to the population of Karachi. The alternatives and selected alternative carried forward have evolved depending on technical feasibility, the need to minimise interruption of Karachi's water supply and cost, while remaining within the canal ROW.

The selected alternative carried forward is the hybrid alternative which includes canal rehabilitation over the first 11 km and constructing a pipeline for the remaining 11 km. As described in section 3.2, during the rehabilitation of the upstream canal section, coffer dams, pumps and temporary piping will be used to isolate canal stretches during the rehabilitation works and to ensure water supply to downstream sections of the canal and WTP. The construction of the pipeline can be undertaken in parallel to canal rehabilitation activities such that the pipeline is ready to be connected to the rehabilitated canal section and the full water conveyance system can be commissioned. Once all components of the water conveyance system are completed (i.e. the new rising mains are constructed, the pump house is upgraded, the new pipeline is installed and the upstream reach of the canal is rehabilitated, a minimum water closure will be necessary to connect the canal section with the pipeline, fill the pipeline and rising mains with water and commission the system. The commissioning to shift flow from the existing system to the upgraded system should take several days up to about one week.

Refer to Section 7.1.6. (Surface Water Flows) for further discussion on the selection of a preferred alternative based on water resource availability and water needs of Karachi.

Alternatives for decommissioning and re-use of the downstream canal that will be in disuse are nor including in this report. These alternatives should be explored further during the detailed feasibility studies carried out by the developer/concessionaire and included in the ESIA.

Table 3: Project configuration alternatives

Alternative 1.1 (Baseline with 80 MGD) ▪ Existing Canal rehabilitation, including the 2.28 km pipeline in the high slope stretch (80 or 100 MGD) ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 80 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (3.3 MW)	**Alternative 1.2 (Baseline with 100 MGD)** ▪ Existing Canal rehabilitation, including the 2.28 km pipeline in the high slope stretch (80 or 100 MGD) ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 100 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (being defined)
Alternative 2.1 (Hybrid with 80 MGD) ▪ Existing Canal rehabilitation in the first 11 km ▪ New GRP pipeline DN1900 for 9.2 km (80 MGD) with a pressure chamber at its beginning ▪ Decommissioning of the existing canal in the last 9.2 km ▪ Mitigation measures for the pipeline stretch ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 80 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (3.3 MW)	**Alternative 2.2 (Hybrid with 100 MGD)** ▪ Existing Canal rehabilitation in the first 11 km ▪ New GRP pipeline DN1900 for 9.2 km (100 MGD) with a pressure chamber at its beginning ▪ Decommissioning of the existing canal in the last 9.2 km ▪ Mitigation measures for the pipeline stretch ▪ Pumping Station (PS) and Water Treatment Plant (WTP) with 100 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (being defined)
Alternative 3.1 (Pipeline with 80 MGD) ▪ Decommissioning of the existing canal and PS ▪ New GRP pipeline DN1900 within existing RoW ▪ Mitigation measures for the new pipeline ▪ New Pumping Station at the Head Regulator, H=51.75m 2760 kW ▪ Water Treatment Plant (WTP) with 80 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (4.5 MW) ▪ New power distribution line (15 km)	**Alternative 3.2 (Pipeline with 100 MGD)** ▪ Decommissioning of the existing canal and PS ▪ New GRP pipeline DN1900 within existing RoW ▪ Mitigation measures for the new pipeline ▪ New Pumping Station at the Head Regulator, Head and Power being defined ▪ Water Treatment Plant (WTP) with 100 MGD ▪ Connection with existing RM ▪ Downscaling the Solar PV Plant (being defined) ▪ New power distribution line (15 km)

4.1. Analysis and Selection of Alternatives[3]

The purpose of this analysis is to make a comparison of the different alternatives and to propose the one which, according to the structure of criteria and weightings, is considered the most appropriate.

The solution chosen, following the meeting between IFC, KWSB, GoS PPP Unit is developed in more detail in the subsequent chapters of this document.

4.1.1. Methodology

To select the most suitable alternative a multicriteria analysis process has been conducted considering technical, economic, environmental, and social criteria.

At the same time, the four set of criteria and each one of the single criteria have been weighted considering its relative importance or value within the set of criteria. Thus, a multicriteria matrix has been obtained, getting a final weight for each of the studied alternatives.

The criteria set presents some quantitative criteria (indicated as "q") and others are related to qualitative aspects of the alternative (indicated as "Q"), more difficult to evaluate as they have a subjective connotation. The selection and how to weight each of both types of criteria has been discussed considering the opinion of several technicians and water experts.

To weight the first level of criteria, it has been given a high weight to the economic criteria and the technical and management ones, considering their relationship with the sustainability of the water supply scheme. Considering that the cost of the infrastructure's works should be recovered in a high proportion, the initial cost of the works will affect directly to the future durability of the project.

The technical impact of alternatives is considered also but with a lower weight; the water supply scheme should be simple but robust and easy to manage and maintain, so no special difficulties should be expected when designing it. Finally, some weight has been given to the social issues taking in consideration the local opinions and concerns. Therefore, the First Level Weights considered are the following ones:

Criteria. Level 1.	TYPE	Relative Weight (W1)
Technical	Q	0.3
Economical	q	0.4
Environmental	Q	0.2
Social	Q	0.1

At the same time, and within each 1st level, some 2nd level criteria have been considered and given a relative weight (W2). The criteria finally considered are the following ones:

C1-Technical Criteria:

- Ease of construction works

[3] excerpt from TYPSA's Final Due Diligence Report (HY6602-RP-TYP-Final Due Diligence-D01V04)

- Duration of works
- Risks of unexpected events on schedule
- New energy supply requirements
- Ease of maintenance
- Management complexity (Technical staff required)
- Losses of water and efficiency

C2- Economical Criteria:

- Investment costs
- Operation and Maintenance costs
- Energy costs

C3- Environmental Criteria:

- Adequacy of water resources availability
- Impacts to natural Vegetation and Wildlife
- Landscape and current status / modification
- Water quality protection (water delivered) / contamination risks

C4- Social Criteria:

- Impact on human life's losses
- LARAP requirements & Involuntary Resettlement
- Uncontrolled water use

4.1.1.1. Technical Criteria

Ease of construction.

The construction of the water system scheme will consider the works to build the following elements (depending on each alternative):

- Rehabilitation of the Hub Canal (8 km long)
- Refurbishment of the Head Regulator
- Rehabilitation of existing canal and associated infrastructures (aqueducts, bridges, etc).
- Construction of a pipe section (steep section CH 6+940 to CH 9+200)
- Construction of new pipe network
- A main conduction from the Head Regulator to the WTP
- A track (road) network

The gravity solutions where water is conducted through open canals are easier of construction than the solutions based on pressurized solutions; the conveyance canal already exist while a pipe network- based solution would require complete construction works along all the alignment.

Related with the above, based on the work requirements for each identified solution, it can be considered that the water stress situation in Karachi highlighted by KWSB (November 4th, 2020 meeting) makes it necessary for the canal to remain operational all days, and any canal closure during the rehabilitation works will have a great impact. Rehabilitation based solutions will require the construction and decommissioning of numerous by-passes and cofferdams during the implementation of the solution, while the pipe-based solutions will allow the water supply through the canal while the pipe network is under construction.

Duration of works

Considering that the objective is to contribute to solve the water supply to Karachi's problem, the faster the implementation of a solution is done, the better.

Risks of unexpected events on schedule

Related to the duration of works and considering the difficulties that the KWSB restriction to maintain the water supply at any given moment, the construction procedures will have a different level of risk on the accomplishment of the foreseen schedule.

New energy supply requirements

As it has been mentioned when describing the different alternatives, in some of them, the construction of new pumps (or booster stations) would require a new energy supply and connection lines, with an additional cost and difficulties (permits, construction schedule, environmental requirements, etc).

Ease of maintenance (replacement costs of materials)

The operational and maintenance cost and ease to conduct are some important criteria to be considered, mainly for the PPP private companies interested in the water supply management.

Management complexity (technical staff required)

Related with the above, the training required by each alternative during the O&M period has been considered.

Losses of water and efficiency

As it has been mentioned and identified during the hydrologic studies, water is a scare resource, and any future solution should try to minimize the water losses through infiltration and/or evaporation.

4.1.1.2. Economic Criteria

Investment costs

The construction of a new water supply scheme will require a high investment by the National and/or Federal Government. An important allocation of available (limited) fonds on this project could impact on the execution of other possible projects.

Operation and Maintenance costs

As it has been already mentioned at 0, to make attractive a PPP project, the annual O&M cost should be of low magnitude, as the management contract would have a 20-30 year duration.

On the other hand, if not all the water costs are passed to the final users (cost's recovery) the difference should have to be supply by other means, to be identified, in order to make feasible a proper functioning of the water supply system.

Energy costs

Likewise, as it has been mentioned at the Alternatives' description, some of them will not require additional energy supplies, and therefore, no additional costs during the O&M period.

4.1.1.3. Environmental Criteria

Adequacy of water resources availability

During the execution of the Hydrologic Study, and the analysis of the total water conducted through the KWSB canal, it seems that the area is suffering from dry periods, limiting the availability of water at the Hub Dam, and thus, the volume of water conducted should not reach 100 MGD but in some few occasions. Therefore, the final solution should be adapted and designed to the expected future available water resources.

Impacts to natural Vegetation and Wildlife

Regarding the environmental impact of the identified alternatives, it has been considered that all of them should be implemented in the same (wide) area, and therefore, there should not be great differences in the environment among them. The inventory conducted does not show any critical area that could be affected by any of the proposed solutions. All area is closed to the inhabited zones, and therefore already being affected by the population.

The displacement of the water conduction infrastructures in a new strip separated by a few hundred metres, and its impact, a priori, could not be of great magnitude.

Landscape and current status / modification

Each alternative would have a limited impact on the landscape, considered basically during the construction works. The KWSB canal to rehabilitate has already an impact, and its rehabilitation, once works finished should maintain the initial landscape impact. On the other hand, pipe-based solution would show a lower impact on landscape as the main infrastructures are grounded.

Water quality protection (water delivered) / contamination risks.

Finally, risk of possible contamination of water through an open canal are logically greater than if water is confined in a pipe network. The water treatment requirements to make water drinkable will be strongly related to the raw water quality delivered from the Hub Dam.

4.1.1.4. Social Criteria

Impact on human life losses

During the assessment visits and study of documentation it has been detected that unfortunately, each year some human life's losses are occurred (15-20 people dead from drowning). This could be limited or avoided if the length of open canal is reduced.

LARAP requirements & Involuntary Resettlement.

As it has been commented, several alternatives should need an additional land occupation for the implementation of the proposed solution, and the construction works. At this regard, it is considered that in all cases, there would be a need for the required accesses and the stoking of machinery and material, but even if they should be of grater magnitude for the alternatives based on a piped solution (Alternatives nº 6 and 7), the differences shouldn't be of great magnitude.

As commented above, alternatives based on the implementation of a new pipe along the total length of the Karachi canal will required the occupation of new areas, for the construction of the new piped infrastructure. This occupation. Those areas should be agrarian land under cultivation and should be duly compensated.

Based on the information gathered during the field visits, no involuntary resettlement should be to be considered, as, in general, there are no living areas close to the expected occupation' strip.

Uncontrolled water uses.

Finally, the open canal-based solutions make easier to get access to the water, being more difficult to control the water use at all the canals length and the allocation of consumption by the final users. Thus, the risk for a non-revenue water use should be higher.

The multicriteria analysis matrix is shown in the next table, along with the basic power consumption for each alternative (mainly at the PS and the WTP), the overall timeline for construction works and the yearly outflows and losses envisaged.

		1 st LEVEL CRITERIA	2nd LEVEL CRITERIA	Weight (W1)	Weight (W2)	Weight (W)	ALTERNATIVES PONDERATION						EVALUATION					
							ALT-1.1	ALT-1.2	ALT-2.1	ALT-2.2	ALT-3.1	ALT-3.2	ALT-1.1	ALT-1.2	ALT-2.1	ALT-2.2	ALT-3.1	ALT-3.2
1.-		**Technical**		22.0%	100.0%													
	1.1.-		Ease of construction works		15.0%	0.03	1	1	3	3	3	3	0.033	0.033	0.099	0.099	0.099	0.099
	1.2.-		Duration of works		15.0%	0.03	1	1	3	3	4	4	0.033	0.033	0.099	0.099	0.132	0.132
	1.3.-		Risks of unexpected events on schedule		25.0%	0.06	1	1	4	4	4	4	0.055	0.055	0.220	0.220	0.220	0.220
	1.4.-		New energy supply requirements		10.0%	0.02	3	3	5	3	3	1	0.066	0.066	0.110	0.066	0.066	0.022
	1.5.-		Ease of maintenance		15.0%	0.03	2	2	3	3	4	4	0.066	0.066	0.099	0.099	0.132	0.132
	1.6.-		Management complexity (Technical staff required)		5.0%	0.01	5	5	3	3	2	2	0.055	0.055	0.033	0.033	0.022	0.022
	1.7.-		Losses of water and efficiency		15.0%	0.03	2	2	4	4	5	5	0.066	0.066	0.132	0.132	0.165	0.165
2.-		**Economical**		34.0%	100.0%													
	2.1.-		Investment costs		50.0%	0.17	0.91	0.75	1.00	0.81	0.77	0.64	0.155	0.128	0.170	0.139	0.132	0.109
	2.2.-		Operation and Maintenance costs		30.0%	0.10	0.78	0.61	1.00	0.73	0.77	0.54	0.079	0.063	0.102	0.075	0.079	0.056
	2.3.-		Energy costs		20.0%	0.07	0.77	0.63	1.00	0.76	0.73	0.53	0.052	0.043	0.068	0.052	0.050	0.036
3.-		**Social**		22.0%	100.0%													
	3.1.-		Impact on human life's losses		50.0%	0.11	2.00	2.00	4.00	4.00	5.00	5.00	0.220	0.220	0.440	0.440	0.550	0.550
	3.2.-		LARAP requirements & Involuntary Resettlement		40.0%	0.09	5.00	5.00	4.00	4.00	1.00	1.00	0.440	0.440	0.352	0.352	0.088	0.088
	3.3.-		Uncontrolled water use (non-revenue water)		10.0%	0.02	1.00	1.00	4.00	4.00	5.00	5.00	0.022	0.022	0.088	0.088	0.110	0.110
4.-		**Environmental**		22.0%	100.0%													
	4.1.-		Adequacy to water resources availability		50.0%	0.11	5.00	3.00	5.00	3.00	5.00	3.00	0.550	0.330	0.550	0.330	0.550	0.330
	4.2.-		Impact on natural Vegetation and Wildlife		20.0%	0.04	5.00	5.00	4.00	4.00	2.00	2.00	0.220	0.220	0.176	0.176	0.088	0.088
	4.3.-		Landscape and current status / modification		10.0%	0.02	2.00	2.00	4.00	4.00	4.00	4.00	0.044	0.044	0.088	0.088	0.088	0.088
	4.4.-		Water quality protection (water delivered) / contamination risks		20.0%	0.04	2.00	2.00	4.00	4.00	4.00	4.00	0.088	0.088	0.176	0.176	0.176	0.176
			WEIGHTED SUM METHOD										**1.96**	**1.74**	**2.66**	**2.40**	**2.49**	**2.22**

CONCLUSIONS

From a technical point of view, the hybrid solution that combines the partial rehabilitation of the existing canal in the first leg of the alignment, with a new pipeline in the last leg, plus an upgrade of the existing PS and WTP would be optimal.

As summarised in the following Table, the results of the multicriteria analysis also show that the Alternative 2.1 is the most suitable solution to be implemented. However, the GoS and KWSB consider of paramount importance to maximise the quantity of water for Karachi, so it has been decided to prioritise 100 MGD alternatives solutions and, therefore, the selected alternative is 2.2.

ALTERNATIVES	RANKING
Alternative 2.1 (80 MGD)	2,66
Alternative 3.1 (80 MGD)	2,49
Alternative 2.2 (100 MGD)	2,40
Alternative 3.2 (100 MGD)	2,22
Alternative 1.1 (80 MGD)	1,96
Alternative 1.2 (100 MGD)	1,74

Desalination plants should also be considered by authorities/utilities in Pakistan and Sindh to complement freshwater sources and meet the growing population needs as freshwater scarcity may be aggravated by climate change over the lifetime of the project.

5. Regulatory Framework

There are a number of national and regional requirements that the project will have to comply with in addition to appropriate international standards. This section provides a brief overview of the applicable legislation, associated regulations and relevant standards that will be applied to the Project.

5.1. Overview of Environmental Legislation

After the 18th amendment was passed by the National Assembly of Pakistan on April 8, 2010 the Pakistan Environmental Protection Agency (PEPA) transferred its power to four provincial environmental agencies in Pakistan.

The project has been assessed in compliance of the existing legal framework in Sindh Province as well as relevant international policies and guidelines. All provinces have now enacted their own environmental protection laws. These provincial laws are largely based on Pak-EPA 1997 and provide the same level of environmental protection as the parent law. The provincial assembly of Sindh passed the Sindh Environmental Protection Act 2014 (the 'Sindh Act 2014') in March 2014.

5.1.1. Sindh Environmental Protection Act 2014

The Sindh Environmental Protection Act 2014 (SEP Act 2014) is the main legislative tool empowering SEPA to frame and govern regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, marine and noise pollution, as well as to the handling of hazardous wastes.

Under the Sindh Act 2014, SEPA is an autonomous agency. For administrative purposes, it is part of the Forest, Environment and Wildlife Department of the Government of Sindh. SEPA is a regulatory agency with the following main functions:

- Enforcement of Sindh Act 2014
- Implement environmental policies
- Ensure implementation of Sindh Environmental Quality Standards (SEQS)
- Establish systems and procedures for environmental management
- Issue licence for handling of hazardous substance
- Specify safeguards for the prevention of accidents which may cause pollution
- Review and approve mitigation plans and give guidance for clean-up operations
- Carry out any other task related to the environment assigned by the government.

5.1.2. Sindh Environmental Quality Standards

Section 6 of the SEP Act 2014 prohibits any emissions or discharges in excess of the SEQS, which determine limit values or maximum allowable concentrations for parameters including wastewater, ambient air, motor vehicles' exhaust gases and noise emissions, drinking water quality and ambient noise. The SEQS are applicable to pollutant discharges irrespective of the type of source and location.

5.1.3. Sindh Environmental Protection Act Key Clauses

1. The following articles of the SEPA 2014 have a direct bearing on the proposed Project:

- **Article 11(1):** 'Subject to the provisions of this Act and the rules and regulations therein, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, pollutant, noise or any other matter that may cause or likely cause pollution or adverse environmental effects, as defined in Section 2 of this Act, in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards.
- **Article 11(2):** 'All persons, in industrial or commercial or other operations, shall ensure compliance with the Environmental Quality Standards for ambient air, drinking water, noise or any other Standards established under section 6(1)(g)(i); shall maintain monitoring records for such compliances; shall make available these records to the authorized person for inspection; and shall report or communicate the record to the Agency as required under any directions issued, notified or required under any rules and regulations.
- **Section 11(3):** Monitoring and analysis under sub-section (1) and (2), shall be acceptable only when carried out by the Environmental Laboratory certified by the Agency as prescribed in the rules. All stipulated tests will be regularly performed from designated laboratories approved by Sindh EPA.
- **Article 14 (1):** 'Subject to the provisions of this Act and the rules and regulations, no person shall cause any act, deed or any activity', including (b) disposal of solid and hazardous wastes at unauthorized places as prescribed; (c) dumping of wastes or hazardous substances into coastal waters and inland water bodies; and(d) release of emissions or discharges from industrial or commercial operations as prescribed.
- **Article 15 (1):** 'Subject to the provisions of this Act, no person shall operate or manufacture a motor vehicle or class of vehicles from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the Sindh Environmental Quality Standards or, where applicable, the standards established under sub-clause (i) of clause (g) of sub-section (1) of section 6'.
- **Article 17(1):** 'No proponent of a project shall commence construction or operation unless he has filed with the Agency **an initial environmental examination or environmental impact assessment and** has obtained from the Agency approval in respect thereof.

- **Article 17(2):** The agency shall; o a) review the initial environmental examination and accord its approval, subject to such terms and conditions as it may prescribe, or require submission of an environmental impact assessment by the proponent; or o (b) review the environmental impact assessment and accord its approval subject to such terms and conditions as it may deem fit to impose or require that the environmental impact assessment be re-submitted after such modifications as may be stipulated or decline approval of the environmental impact assessment as being contrary to environmental objectives.
- **Article 17(3):** 'Every review of an environment impact assessment shall be carried out with public participation and subject to the provisions of this Act, after full disclosure of the particulars of the project'.
- **Article 17(4):** 'The Agency shall communicate its approval or otherwise within a period of two months from the date that the initial environmental examination is filed, and within a period of four months from the date that the environmental impact assessment is filed complete in all respects in accordance with the regulations, failing which the initial environmental examination or, as the case may be, the environmental impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations'.
- **Article 20(1):** 'The Agency shall from time to time require the person in charge of a project to furnish, within such period as may be specified, an environmental audit or environmental review report or environmental management plan containing a comprehensive appraisal of the environmental aspects of the project'.
- **Article 20(2):** The report of a project prepared under sub-section (1) shall include: (a) analysis of the predicted qualitative and quantitative impact of the project as compared to the actual impact; (b) evaluation of the efficacy of the preventive, mitigation and compensatory measures taken with respect to the project; and (c) Recommendations for further minimizing or mitigating the adverse environmental impact of the project.
- **Article 20(3):** 'Based on its review of the environmental audit report, the Agency may, after giving the person in charge of the project an opportunity of being heard, direct that specified mitigation and compensatory measures be adopted within a specified time period and may also, where necessary, modify the approval granted by it under section 17'.
- **Section 31(1):** The Agency shall cause relevant details of any proposed project regarding which an Environmental Impact Assessment has been received to be published, along with an invitation to the public to furnish their comments thereon within a specified period. (2) In accordance with such procedure as may be prescribed, the Agency shall hold public hearings to receive additional comments and hear oral submissions. (3) All comments received under sub-sections (1) and (2) shall be duly considered by the Agency while reviewing the environmental impact assessment or strategic

impact assessment, and decision or action taken thereon shall be communicated to the persons who have furnished the said comments.

5.1.4. Sindh Environmental Protection Agency (Review of IEE and EIA) Regulations, 2014

The Sindh Environmental Protection Agency (Sindh EPA) (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations, 2014 describe the Initial Environmental Examination (IEE) and EIA process. Schedules I, II and II of the Regulations consist of lists of types of projects that require an IEE, EIA or neither (i.e., only requiring the completion of a checklist).

Schedule I projects requiring an IEE include:

- Water Supply schemes and filtration plants with total cost less than 100 million
- Solar projects (regardless of size)

Schedule II projects which require an EIA include:

- Large Water supply schemes and filtration plants.

It is assumed that because of the magnitude of the project and its potential impacts, the project will require an EIA. The EIA will need to fulfil both the national requirements and comply with the IFC performance standards. The EIA / EMP process is described in figure 10 below.

As defined in section 37 of SEP Act, 2014, Sindh Environmental Protection Agency formulated the Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulation 2014, under this act, the project proponent must prepare an IEE or EIA. Schedule I lists the types of projects requiring an IEE and Schedule II those requiring an EIA. The following sections define the steps to follow in order to get final approval from SEPA in the form of a no-objection certificate (NOC). The review and approval procedure are illustrated in Figure 10.

Review fee: At the time of filling the EIA/IEE the project proponent shall pay the Non- refundable fee as defined in schedule-IV of act.

Filling: It is required to submit 10 hard and 2 electronic copies of EIA/IEE report along with format prescribed in Schedule-V.

Preliminary scrutiny: After submission of report, SEPA is bound to reply in 15 days to conform EIA/IEE is complete to initiate a process or may demand for additional information, if needed.

Review: The agency shall review the IEE in 2 months and EIA in 4 months of issue of conformation of completeness under regulation 9. In reviewing the report, the agency shall conduct an Expert committee meeting by Director General SEPA and may solicit views of concerned Advisory committee.

Decision: On completion of the review process, the decision of SEPA will be communicated to the proponent in the form prescribed in Schedule V.

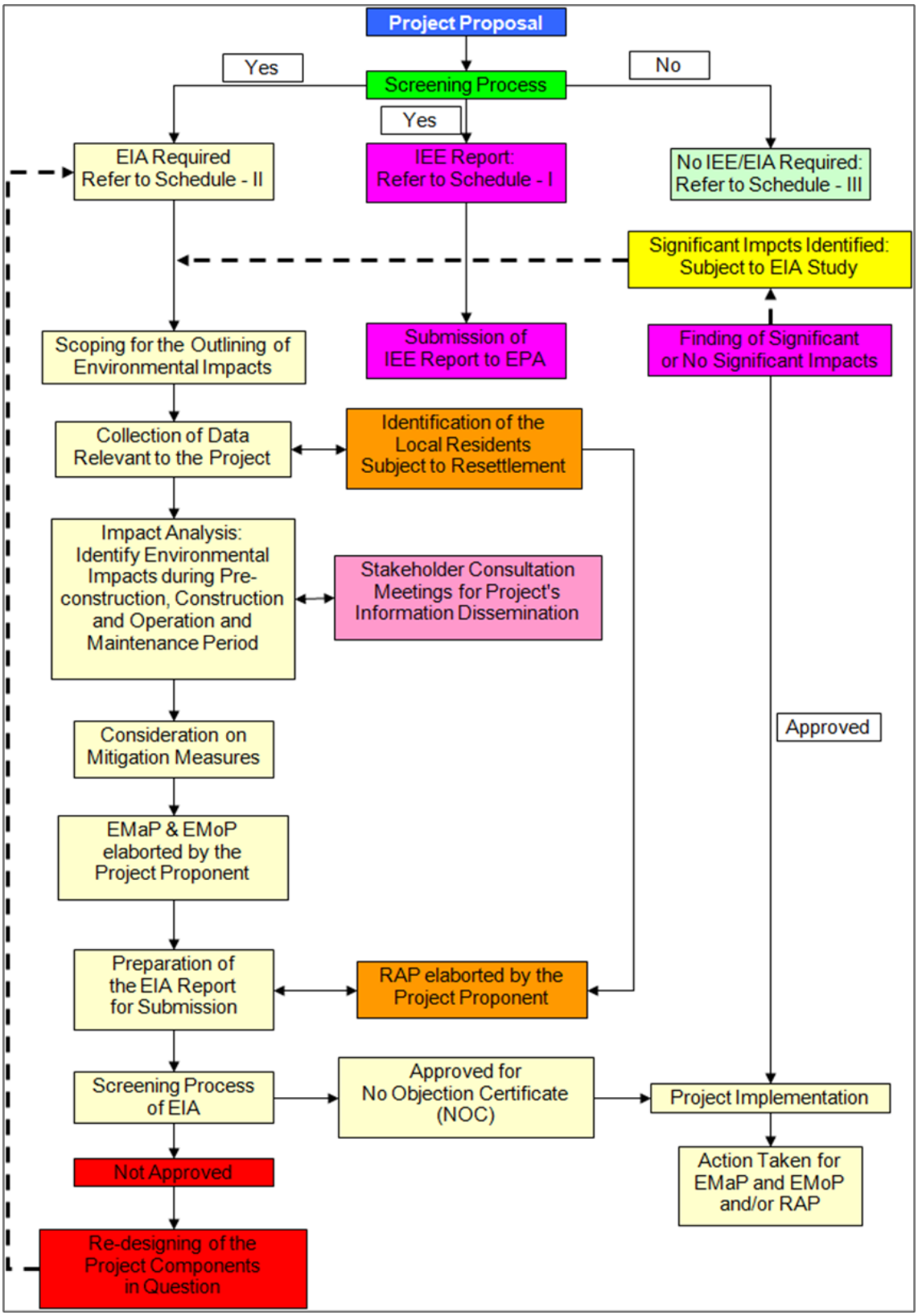


Figure 11. EIA/EMP process

5.1.4.1. Typical conditions of approval

Condition of approval: Regulation 18 defines the validity period of approval of an IEE or EIA to be 3 years from the date of issue. If construction is commenced during the initial 3 years' validity period, the validity of the approval shall stand extended for a further period of three years from the date of issue with or without a fresh EIA.

5.1.4.2. Reporting and Monitoring (and their frequency)

Monitoring: After issue of conformation of compliance, the project proponent shall submit an annual report summarizing operational performance of the project, with reference to the condition of approval and maintenance and mitigation measures adopted by the project.

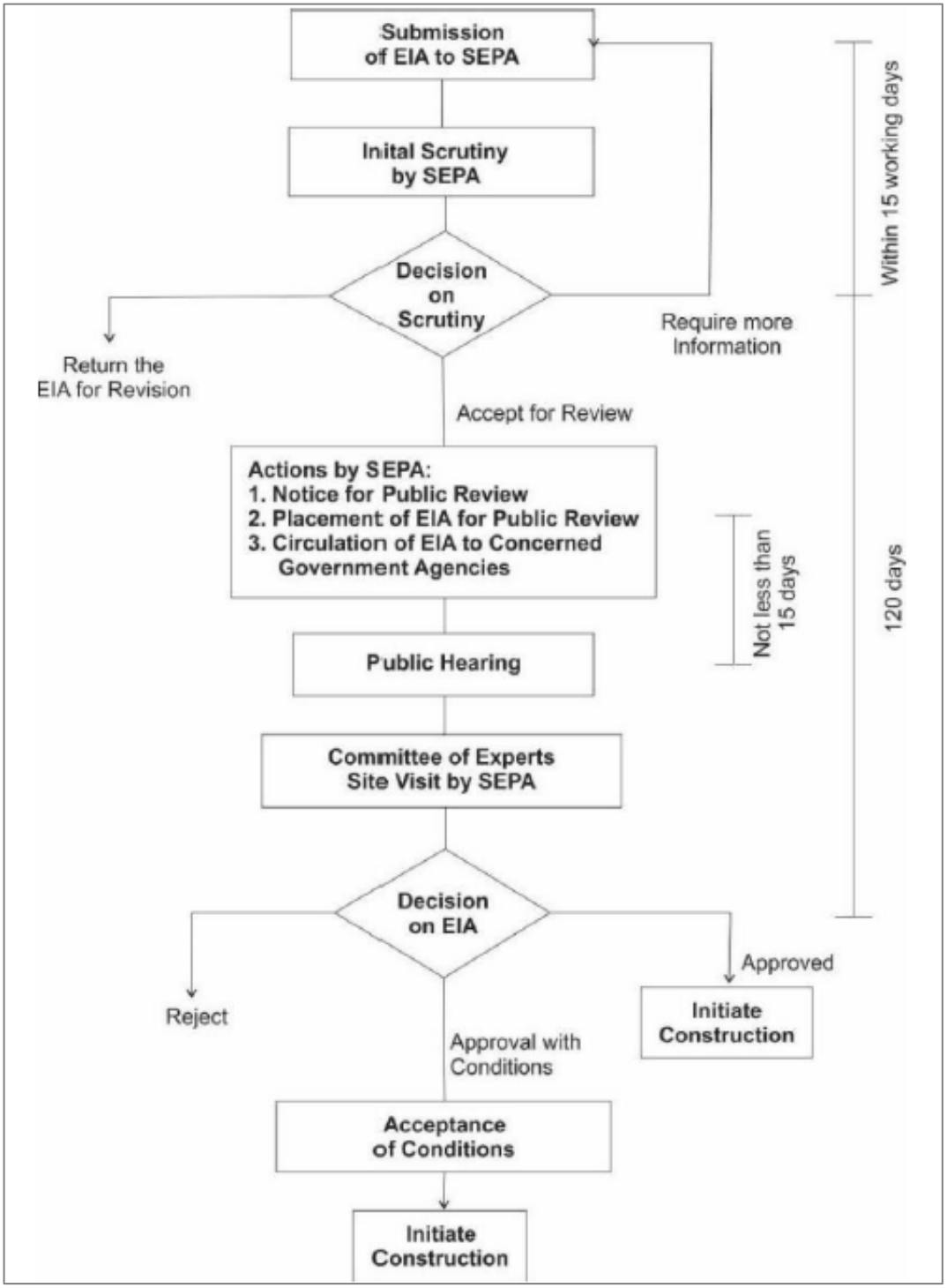


Figure 12. IEE Review and Approval Procedure

5.1.5. Sindh Wildlife Protection Act, 2020

The Sindh Wildlife Protection Ordinance 1972 was updated in 2020 and is now The Sindh Wildlife Protection Act, 2020. The 2020 Act distinguishes three types of protected area:

- National Parks
- Wildlife Sanctuaries
- Game Reserves.

In the Act, wildlife sanctuaries are defined under section 13 (2) as follows: "The wildlife sanctuary shall be set-aside as undisturbed breeding ground for the protection of wildlife and access thereto for public shall, except in accordance with the rules, be prohibited and no exploitation of forest therein shall be allowed except for reducing fire hazards, epidemic or insect attacks or other natural; calamities."

Section 9 of the Act describes prohibited actions in protected areas and any wildlife habitat as follows:

a) hunting, shooting, killing, injuring, trapping, snaring, and poisoning of wildlife found therein.
b) polluting, poisoning, draining, or diverting the water resource for the purpose other than the purpose which is essential for health of wildlife.
c) cutting, girdling, damaging, injuring, or destroying floral resource or burning and collecting the plants or part thereof.
d) damaging the infrastructure and culturally significant natural structures, defacing, counterfeiting the boundary marks, encroachment, cultivation of changing the land use; or
e) breaking the land for oil and gas exploration, seismic survey, or any kind of other survey.
f) drilling, kindling fire or abating in setting fire.
g) grazing, fishing, trespassing.
h) blowing pressure horn and playing electronic instruments such as television, radio or tape recorder, loudspeaker, causing noise and car racing or other noise related sports.
i) quarrying, causing, or fashioning of natural stones, exploration and exploitation of mines and minerals.

There is provision in the Act under subsection (3) of Section 9 for the following:

> "The Department with the previous sanction of competent authority may, for scientific purpose, improvement of aesthetic, scenic beauty, and in the larger public interest, relax to undertake any of the acts prohibited. under sub-section (1) particularly in wildlife protected areas, subject to fulfilment of the requirements provided in Section 86."

Section 86 (Value of loss or degradation of habitat) indicates that:

> "The Department shall determine through a committee of experts, the value of loss to habitat caused as a result of any development activity of important nature, oil spill in coastal waters, flood disaster,

un-authorized land use in a protected area or wildlife habitat owned by Government, to be recovered; and same amount shall be utilized for improvement thereupon".

Consultation[4] with Mr. Javed Mahar, Conservator with the Wildlife Department, Government of Sindh indicated that the proponent of the project (or KWSB) must submit a formal request for a no objection certificate (NOC), in writing, stating the purpose of the subject activity seeking NOC from the of the Government of Sindh. The formal request should be addressed to the Secretary of the Government of Sindh Forests & Wildlife Department. This process can take time and should be initiated as soon as possible.

5.1.6. Hub Dam Wildlife Sanctuary, designated July 1974

The Hub Dam Wildlife Sanctuary was designated as such in July 1974 (before the construction of the Hub Dam on the Hub River) for being an important bird site and providing important habitat for migratory birds. A document[5] obtained from the Conservator with the Wildlife Department, Government of Sindh states that the reservoir/ wetland upstream from the dam is also important for fish resources, water supply and recreation, and, was at the time, among the few pockets left where Mahseer[6] could be found.

The List of Important Fauna and Flora when designated as a Wildlife Sanctuary is presented in the following table.

Table 4: Original List of Important Flora and Fauna, Hub Dam Wildlife Sanctuary

Birds	Fishes	Reptiles	Flora
1. Ferruginous Duck	1. Mahsheer	1. Marsh Crocodile	1. *Acacia Senegal*
2. Tufted Duck	2. Roha	2. Monitor Lizard	2. Acacia Jacuemontii
3. Shoveller	3. Mori	3. Indian Cobra	3. *Zizyphus nummularia*
4. Red Crested Pochard	4. Gulfam	4. Saw Scale Viper	4. *Capparis decidua*
5. Black-necked Grabe	5. Thaila	5. Micro Geko	5. Prosopis cineraria
6. Red-necked Grabe	6. Silver Carp		6. *Tamarix aphylla*
7. White Pelican	7. Grass Carp		7. *Euphorbia caducifolia*
8. Black-headed Gull			8. *Tecoma undulata*

[4] Communications via e-mail in March/April 2021.

[5] "Hub Dam Wildlife Sanctuary" from the Wildlife Reference Library, Karachi (no date, assumed post-dam construction because it mentions the dam)

[6] The species of Mahseer is not specified in the Hub Dam Wildlife Sanctuary document. The IUCN Red List does not include this region within the current geographic extant of the endangered (EN) *Tor Putitora*.

9. Common Crane			9. *Acacia nilotica*
10. Common Teal			

5.2. National and Provincial Social and Other Legislation

This section provides a list of social and other legislation that may be relevant to various stages of the project.

- The West Pakistan Shops and Establishments Ordinance 1969
- The Employment of Children Act 1991
- Sindh Occupational Health and Safety Act 2019
- The Bonded Labour System Abolition Act 1992.
- The Sindh Terms of Employment (Standing Orders) Act, 2015
- Industrial and Commercial Employment (Standing Orders) Ordinance, 1968
- The Factories Act 1934
- Workers' Welfare Fund Ordinance, 1971Hazardous Occupations Rules, 1963 (Chapter 3)
- Factories Act, 1934
- Land Acquisition Act of 1894
- Ancient Monuments Act 1904
- Export Control Act 1947
- Antiquities Act 1968, 1975
- Sindh Building Control Ordinance 1979
- Sindh WAQF Properties Ordinance 1979
- Sindh Cultural Heritage (Preservation) Act 1997
- Nation Fund for Cultural Heritage Act 1994, 1996, 1997, 2002
- Karachi Building & Town Planning Regulations 2002, 2005
- Land Revenue Department and Colonization Act 1967 (see Box on Land Formalization in Section 7.4.1.3 Land Tenure)
- The Sindh Gothabad (Housing Scheme) Rules, 2008 (see Box on Land Formalization in Section 7.4.1.3 Land Tenure)
- The National Canal and Drainage Act, 1873

- The Sindh Forest Act, 2012.

The ESIA will determine whether stakeholder engagement with the Balochistan Wildlife Department or other government entities is required besides engagement with the Lasbela Canal authorities in Balochistan, as mentioned previously. The E&S Scoping has concluded that none of the project components or AOI are located in Balochistan.

5.3. International Conventions and Agreements

Pakistan is a signatory of the following international conventions and agreements and therefore the project will need to abode by the commitments of these agreements.

- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
- The Vienna Convention for the Protection of the Ozone Layer and The Montreal Protocol on Substances that Deplete the Ozone Layer
- The Stockholm Convention on Persistent Organic Pollutants
- CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora
- The Convention on Biological Diversity
- The United Nations Framework Convention on Climate Change
- ILO Conventions: Pakistan has ratified 36 of the ILO conventions, including the 8 Fundamental Conventions:
    - C029 - Forced Labour Convention, 1930 (No. 29)
    - C087 - Freedom of Association and Protection of the Right to Organise Convention (No. 87)
    - C098 - Right to Organise and Collective Bargaining Convention, 1949 (No. 98)
    - C100 - Equal Remuneration Convention, 1951 (No. 100)
    - C105 - Abolition of Forced Labour Convention, 1957 (No. 105)
    - C111 - Discrimination (Employment and Occupation) Convention, 1958 (No. 111)
    - C138 - Minimum Age Convention, 1973 (No. 138)
    - C182 - Worst Forms of Child Labour Convention, 1999 (No. 182)

5.4. IFC Performance Standards and EHS Guidelines

In order to facilitate financing of the project by international and/or multilateral financial institutions the Environmental and Social Scoping of the project is based on the requirements of the local regulatory framework and those of the IFC's Sustainability Framework (2012) embodied in the IFC Performance Standards and IFC's Environmental, Health and Safety (EHS) Guidelines, which are considered a benchmark

of Good International Industry Practice (GIIP). The applicable EHS Guidelines would include the General EHS Guidelines (IFC, 2007) and the EHS Guidelines for Electric Power Transmission and Distribution (2007).

The IFC Performance Standards are as follows:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

All Performance Standards are applicable to the project with the exception of Performance Standard 7: Indigenous Peoples, refer to Section 9.3.10 for a discussion on why it is not triggered. The applicability of the Performance Standards is described in more detail throughout the report. A data gap analysis between the local regulatory framework and the IFC Performance Standards has been carried out and is included in Table form in Appendix A.

6. Scoping Approach and Methodology

6.1. General Approach

The main objective of the E&S Scoping Study is to inform project stakeholders (the client, IFC and potential private sector bidders) about the key E&S risks and potential impacts affecting the Project, related gaps in information, and ways to close such gaps and support the Project development in line with national legislation and IFC Performance Standards.

The general methodology and approach used for the identification of the E&S constraints and preliminary magnitude of E&S risks of the project included: the collection of qualitative and quantitative data, gathering of existing data from secondary sources, field observations and interviews, stakeholder engagement and consultation[7].

All scoping field work activities carried out by the local consultants (HPK) were conducted between August and December 2020, with a screening site visit undertaken by the local consultant (HPK) environmental, social and the biodiversity expert was carried out on August 21st, 2020. Subsequent site visits were carried out by environmental and social consultants between September and October, and by the biodiversity expert later in the year, to be able to observe avifauna during the appropriate season.

Due to the Covid-19 pandemic, the international consultants could not travel to the field to perform the surveys and research activities for the scoping study. The design of research and data collection tools and guidelines were therefore prepared by the international social and environmental consultants and implemented by the local national social and environmental consultants. Training on how to use the guidelines was conducted through an online platform to present the content to the local team that would be carrying out the activities. During the training sessions the local team was instructed on the intent of the surveys and consultations, and the purpose of the information to be gathered, and on the importance of managing the community´s expectations with regards to the proposed project.

The international experts were available for consultation and any clarifications daily, throughout the scoping activities and organised regular progress meetings with the field teams to ensure adequate and sufficient data was being recorded and to be appraised of any issues or concerns that arise during field work.

6.2. Natural Environment (physical and biological)

The physical environment baseline information was gathered from secondary sources of information (climate data, hydrology, river streamflow, geology etc.), stakeholder consultation, and site-specific data collection and observations from the geotechnical investigations and topographical surveys.

For the biological environment, an initial desk-top screening of the site and surrounding areas was carried out using the Integrated Biodiversity Assessment Tool (IBAT) to identify nearby Protected Areas, Key

[7] Data gathering was conducted during a period when Covid-19 restrictions were in place, limiting movement within Pakistan.

Biodiversity Areas and to obtain a list of IUCN Red List species that could potentially occur in the project area. The IBAT "World Bank Group Biodiversity Risk Screen" (or PS6 Report) was generated. IBAT provides initial screening for critical habitat values. Performance Standard 6 (PS6) defines these values for critical habitat and legally protected and internationally recognized areas. PS6 will be triggered when IFC client activities are located in modified habitats containing "significant biodiversity value," natural habitats, critical habitats, legally protected areas, or areas that are internationally recognized for biodiversity.

Secondary information on biodiversity was collected from other sources such as BirdLife International website, the IUCN Red List, the Ramsar website, government sources and other scientific research papers.

6.2.1. Biodiversity

The applicability of Performance Standard 6 (PS6) is established during the environmental and social risks and impacts identification process (International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources).

6.2.1.1. Definition of the Area of influence and Ecologically Appropriate Area of Analysis (EAAA)

The identification of the project's Area of Influence (AOI), in terms of biodiversity, covers the area likely to be affected by the project and includes:

i) the footprint of the Project,
ii) the nearby surrounding areas likely to be affected by the project and
iii) the likely receiving area of indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.

For habitat identification and mapping, a 1,000 m buffer to each side of the existing Hub Dam Canal has been considered. This area of influence ensures that all Project risks are taken into consideration.

As is discussed in the Biodiversity section of this report, for wide ranging species, e.g. Vultures, Steppe Eagle and Saker Falcon, an Ecologically Appropriate Area of Analysis (EAAA) has been defined taking into account the distribution of each species within, and extending beyond, the project's AOI. As such, some critical habitat may be informed by areas of aggregation, recruitment, or other specific habitat features of importance to the species.

Areas of nesting and foraging for the vulture, eagle and falcon species considered, are linked to hilly and rocky cliffs or tall trees for nesting, and arid to semiarid and steppe ecosystems for foraging. These landscape and geomorphological features extend widely over the Sindh Province, South and South-West Pakistan, including the large Kirthar Protected Area Complex. For the Hog Deer (*Axis porcinus*), the EAAA could be defined as the riverbed ecosystems along the Indo River and, as applicable to the Karachi Water Canal Project, the possibility of its occurrence along the Hub River.

6.2.1.2. Methodology for biodiversity data collection

Secondary data

Secondary data sources were used including:

- Available bibliography on biodiversity, vegetation, flora and fauna. These include studies conducted during the EIA process for oil/gas exploration in Kirthar Protected Areas Complex. Other studies include works of Roberts (1977, 1991, 1992 and 1997) and Schaller (1977). Information on other secondary data sources consulted during field survey is provided in the references section of this report.
- Integrated Biodiversity Assessment Tool (IBAT), including the available data on Red List species, Key Biodiversity Areas (KBA), Endemic Bird Areas (EBA), Important Bird areas (IBA), wetland areas (IUCN).
- Satellite imagery (Google earth available images from different years).
- Proposed Project infrastructure descriptions and conceptual designs.

Primary data and field work methodology

Primary field data for the current study was collected by a team of local consultants from Halcrow Pakistan:

- Mr. Umeed Khalid (Local Biodiversity Specialist)
- Mr. Abdur Razaq Khan (Wildlife Expert).
- Mr. Ameen Ahmad (Professional photographer).

Primary data for flora and fauna was collected in different habitats within the project area. The sampling locations were selected on the basis of a preliminary desk assessment including google imagery of the area and polygons representing all possible habitats around the canal and its 1,000 m buffer on both sides / banks of the canal.

The field survey for the biodiversity assessment of the Project was conducted in two parts. The first reconnaissance survey was conducted during August 2020. The second proper survey was undertaken during November 2020. The methodology of field survey is provided below.

1) **Vegetation and flora:** The vegetation surveys were carried out following scientifically accepted survey techniques. However, prominent trees were individually recorded due to their ecological importance in the project area. The field data collection included line transects, incidental sightings and plot searches for flora including bushes and trees. All the plant species (trees, shrubs, and grasses) were also identified in the field. The important plants/trees species were photographed for record and report.
2) **Fauna:** The field data collection included line transects, incidental sightings and plot searches for fauna including ungulates, carnivores, birds, reptiles, and small mammals. For birds, the field survey methodologies followed scientifically established and accepted biodiversity survey techniques. These included direct sightings (with photography) using binoculars (10X40), of avifauna while roosting or in flight, or through distinguishable calls (such as francolins, parakeets, doves, tree pie, bulbuls, black drongo etc.)

6.3. Socio-economic Environment

6.3.1. Definition of Project Affected Area from a social perspective.

From a social perspective the project affected area will be defined at two different levels, depending on the nature and magnitude of the impacts. Therefore, two different categories will be used along this report to refer to this concept:

- Directly Affected Project Area (DAPA): is defined as the project area directly affected by land restrictions and/or (temporary or permanent) changes to the land/resources used by occupants, regardless of the status of the land. In this sense, the DAPA is defined in terms of a distance criteria of 30m to each side of the canal, where sensitive receptors may be affected by changes to usage, along with impacts from the project's construction activities including noise, dust, property damage claims, rehabilitation required post-construction etc.

- Project Affected Area (PAA). This category includes the DAPA and the area that can be potentially the subject of other impacts not directly related with land use/resource restrictions or disturbance due to construction. These other impacts on sensitive receptors[8] have been considered under a non-fixed distance criterion and are directly related with aspects such as the dependence on seepage water for agriculture (crops and grazing land/fodder), or households directly benefitting from the canal water.

6.3.2. General methodological considerations

The design of research and data collection tools was performed by the international social consultant and implemented by the national social and environmental consultants.

To collect the primary information from the field visits, the following methodology was adopted,

- Stakeholder Consultation with local people from the PAA
- Focus group discussions with men and women of the communities living within the PAA.
- Walkthrough along the water canal to identify spatial activities.
- In-house meetings with the KWSB staff

[8] Sensitive receptors include land use in which there is a reasonable degree of sensitivity to a decrease in seepage (i.e. crops, grazing land) and households that currently use canal water.

- Consultation with institutional stakeholders

Coordinates of the important areas of interest has been obtained using GPS along with photographs for authentication.

6.3.3. Field visit and data gathering through consultation with local leaders and PAPs representatives.

Guidelines were developed for the local consultation team to identify other possible stakeholders from the civil society (cooperatives, women´s associations, etc.) as well as individual receptors (schools, healthcare clinics, cultural heritage and religious worship centres, community centres etc.), and Project Affected People (PAPs) to be consulted. The consultation exercise was performed for a double purpose:

1. To understand the main socioeconomic characteristics of the communities (baseline information)
2. To collect perceptions on possible effects of the project on affected people (impacts).

Refer to Appendix B for Guideline questions used by local consultants for discussion with local leaders.

The main purpose of the site visit is to identify human activity taking place in the project area, document the conditions of the natural environment at that specific time and to consult with the relevant stakeholders. It is important to understand the current legal status of those activities, their frequency, magnitude, and the existence of alternative uses in nearby areas. The preliminary list of main issues presented below was used during the site visits subject to the discovery of additional issues arising during the consultations with authorities.

- Identifying and characterizing “sensitive receptors” within the project affected area that may potentially be affected by the project.
- Understanding the administrative structure within the project affected area, identifying communities, administrative boundaries, and community leaders.
- Identifying current canal water uses by community members (drinking, cooking, recreation, bathing, washing etc.)
- Identifying areas of obvious visible seepage from the canal or the aqueducts.
- Identifying any environmental, cultural, sacred features which may pose a constraint to the project.

7. General Description of Study Area (Baseline)

The activities associated with the project could result in beneficial and adverse environmental and social impacts on the immediate and surrounding environments. It is therefore necessary to understand the nature of the existing environment, natural and human (social), before undertaking the proposed project.

Baseline conditions were approached from two different perspectives; the natural environment (physical and biological) and the social environment, as such the methodologies used to arrive at a baseline description of each of them are different. Although more comprehensive studies will be conducted for the project as part of the ESIA process, it is possible to give a brief description of the existing baseline based on preliminary site visit observations and rapid surveys of the project site and surrounding areas. This section presents the natural and social conditions in the project area.

7.1. Physical Environment

7.1.1. Topography

The project lies in the area with topography of slight undulating with a range of low cliffs in the vicinity. The topsoil mainly consists of windblown deposit in the form of silty, fine to coarse sand/clayey silt.

The topography over the first 11.94 kilometres downstream from the head regulator is relatively flat as shown in the following figure.

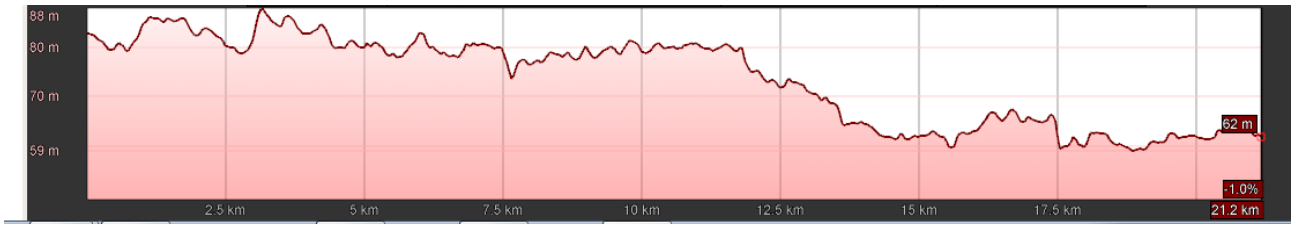


Figure 13. Topography between the head regulator and the WTP

7.1.2. Geology and Soils

The main geological unit around the site is Miocene to Pliocene age Gaj/Manchhar/Nari Formation comprising mainly marine shale and friable to hard limestone with sandstone, shale, clay beds & conglomerates in the topmost part. The rocks dominantly comprising interbedded sandstone, siltstone, mudstone, and shale.

Thin beds of limestone are also present in a small stretch. In addition, thin veins of secondary gypsum are also present within the rocks. The overburden comprises silty sand with thin layer of slightly consolidated gravel.

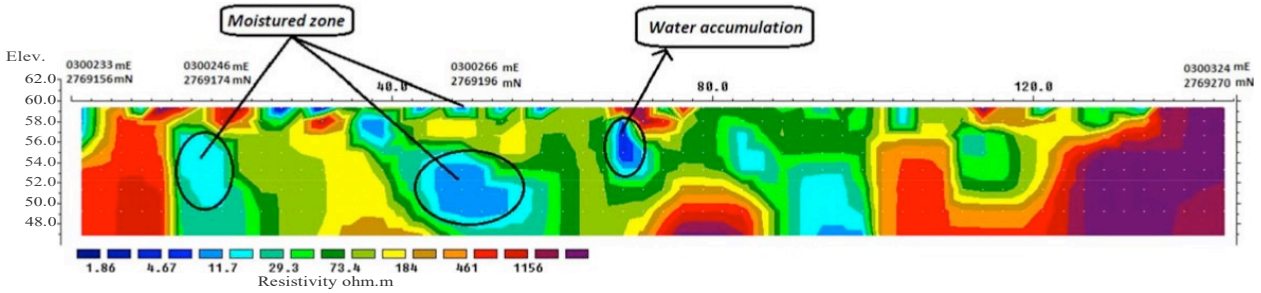
Laboratory analyses of soil samples obtained from boreholes and test pits carried out during the geotechnical investigations included sulphate, chloride, pH, and organic matter content (according to British Standard BS 1377 Part 3). Analysis results indicate that soluble sulphates are present in lower quantities, therefore,

Ordinary Portland Cement (OPC) is recommended for use in this project (or other suitable type in concrete construction work according to requirement)[9].

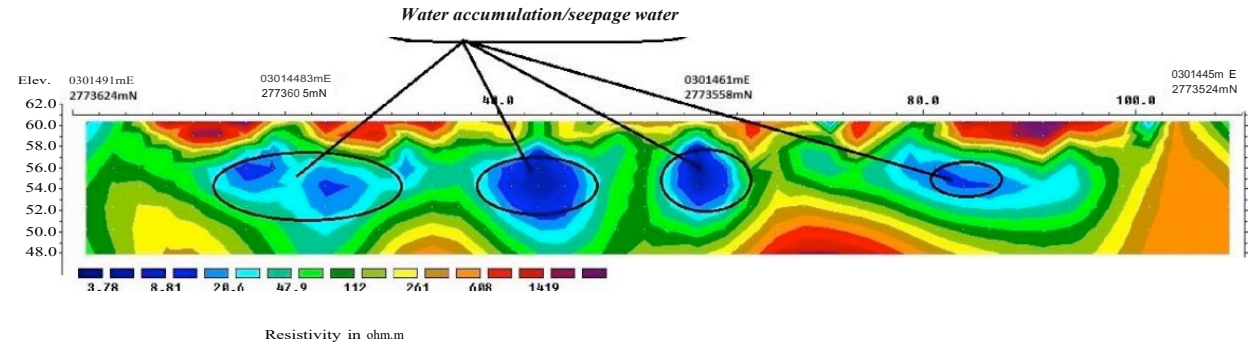
The geophysical investigations carried out for the project included electrical resistivity tomography (ERT) along the proposed route for the pipeline component of the project to obtain information on groundwater, soil moisture and soil characteristics to inform the proposed excavation and trenching solution and cost for the pipeline. The investigation included a total of eight cross sections, perpendicular to the canal spanning 87 to 145 m. The main objective of the ERT was to search for evidence of any subsurface seepage water accumulation. The results revealed that the study area can be mainly divided into three zones, as low, moderate and high electrical resistivity zones. The prominent low resistivity zones are interpreted as possible saturated material or seepage water, while the moderate resistivity zones are interpreted as semi permeable dry material, and high resistivity zones are interpreted as highly resistive/impervious material or rock.

ERT results are shown below for three of the eight cross sections to illustrate subsurface seepage water accumulation and variability. It is also assumed that subsurface water accumulation would have varied over time when seepage cracks were repaired, and seepage would have decreased accordingly. In almost all subsurface cross-sections the blue colour shows a prominent low resistivity zone along all the profile and is interpreted as saturated material or seepage water. The red, orange and purple zones in the subsurface cross sections indicate a high resistive zone and it is interpreted as impervious material/rock. The full ERT report is included in Appendix D.

ERT-1

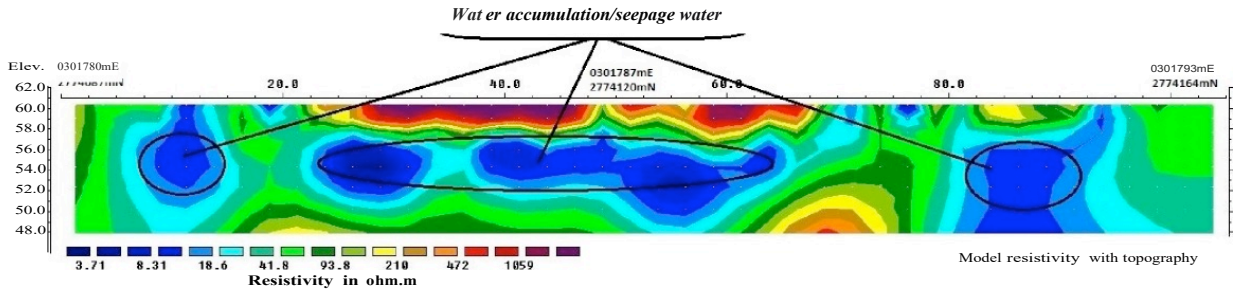


ERT-5



[9] Further information and results from geotechnical investigations are presented in the technical due diligence annexes.

ERT-6



7.1.3. Seismicity

The Seismic characteristics of this area have been analysed in the GEOTECHNICAL REPORT and the GEOPHYSICAL REPORT.

In both reports there are parameters that show that this area does not possess many or strong earthquake generating sources in close proximity to the project area, however, distant seismic sources are strong and active, and result in frequent moderate level shakings felt from earthquakes occurring in distant areas such as the Hindukush region.

The project area lies in Zone 2B according to the earthquake zoning of Pakistan (refer to the figure in this section below). The probability of earthquakes in the project area is low, with an intensity range of V to VI according to the MMI scale. The corresponding PGA (peak ground acceleration) is 0.16g to 0.24g. Seismic parameters for the Karachi area are summarised in the following table.

Seismic Parameters for Karachi	
Magnitude (Richter)	5.5 – 6.5
Intensity – I (MM)	VI-VIII
Peak Ground Acceleration (PGA) %	28 %
Zone (UBC)	2B
Description of EQ Hazard	Upper Moderate

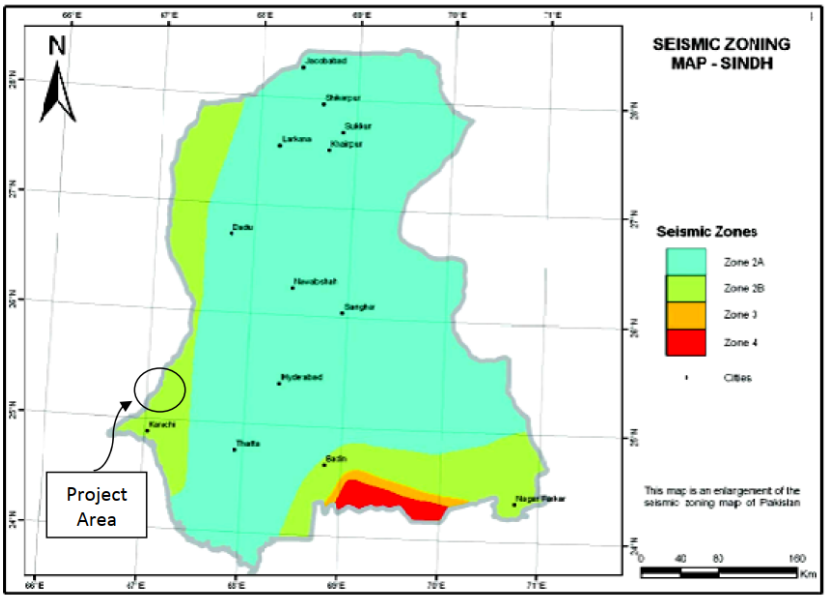


Figure 14: Source: Building Code of Pakistan – Seismic Provision 2007

During the visual site inspections, it was observed that the structural elements of the canal are sufficiently sized, and the rebar detected in these elements appear adequate. No major cracks indicating seismic damage were observed on the structures built around 40 years ago. The seismic assessment for the project therefore observed that the structures have withstood past earthquakes that have occurred since its construction.

7.1.4. Climate

Located near the coast, the project area has an arid climate with low average precipitation levels (approx. 250 mm per annum), the bulk of which occurs during the July–August monsoon season. Winters are warm and dry, while the summers are hot and humid; the proximity to the sea maintains humidity levels at a near-constant high and cool sea breezes relieve the heat of the summer months. December through February is dry and pleasant as compared to the warm summers that dominate through the late spring (March) to the pre-monsoon season (June).

The historical meteorological data has been obtained from the Solargis database. The following table presents a typical meteorological year (TMY) including monthly average global horizontal irradiance (GHI), diffuse horizontal irradiance (DHI) and temperature for the area:

Table 5. Meteorological data for the area

Month	GHI (kWh/m2)	DHI (kWh/m2)	T^a (ºC)
January	134.0	50.5	18.8
February	147.4	53.2	21.2
March	194.8	71.9	24.7
April	210.3	84.0	27.8
May	216.8	100.1	30.2
June	180.6	102.3	31.3
July	135.1	97.0	30.4

August	130.3	91.5	29.2
September	158.7	84.0	28.8
October	171.7	65.7	27.8
November	137.9	52.8	24.2
December	126.4	47.4	20.4
Year	1,944.0	900.4	26.3

The average temperature throughout the year is 26.3ºC. The estimated yearly global irradiation is 1,944 kWh/m^2 and the diffuse irradiation is estimated at 900.4 kWh/m^2 (46%). The location shows high irradiation values, which makes the site quite optimal for the installation of a photovoltaic solar plant. The diffuse component is also high. The graph[10] below shows average monthly temperature and rainfall for Karachi.

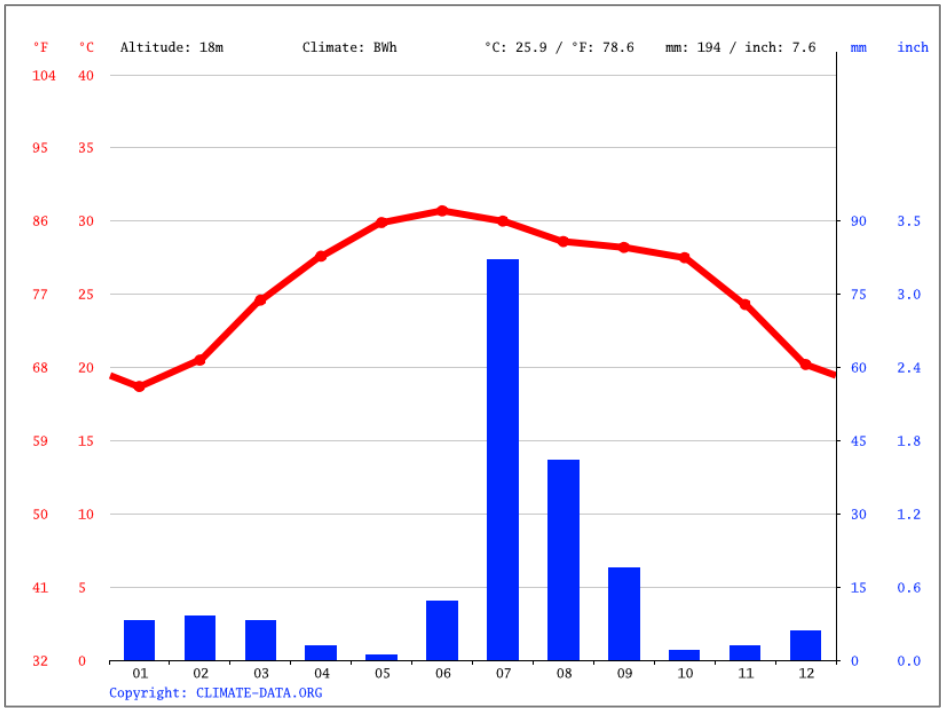


Figure 15: Average monthly temperature and rainfall, Karachi.

The wind rose for Karachi in the following figure[11] shows the prevailing wind is from the West-South-West and South West.

[10] https://en.climate-data.org/asia/pakistan

[11] Source: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/karachi_pakistan_1174872

Figure 16: Wind rose, Karachi.

7.1.5. Air Quality

Air quality in Karachi is very poor. The city is ranked amongst the top 10 cities in the world for most polluted city according to the Air Quality Index (AQI)[12], attributed to smoke produced by factories, burning coal, garbage, oil or tyres and is exacerbated during the winter.

The following activities were noted during the site visits that impact air quality in the project area:

- The marble dust waste dump located on the east side of the canal approximately 0.5 m upstream from the KWSB WTP.
- The Jam Chakro Landfill site located approximately 1.4 km upstream from the KWSB WTP, where the Karachi waste is dumped. Open burning of the waste was observed therefore generating environmental issues due to the open burning of the waste.
- The use of the canal for bathing and washing, recreational use and the disposal of waste into the canal creates unpleasant odours, as well as encourages the breeding of mosquitoes (and pollutes the water in the canal which is a hazard to the health of the downstream water users).
- A stone crushing plant is located near the downstream reaches of the canal.
- Trees lining the roads along the canal are sometimes used for firewood by recreational users of the canal.

[12] https://www.iqair.com/world-air-quality-ranking

7.1.6. Surface Water

The main surface water body in the project area is the Hub River. The Hub Dam does not have any outlets, spillways or structures that release ecological flows to the downstream Hub River, aerial imagery (Google Earth) shows that some seepage may be occurring at the toe of the embankment where vegetation is visible. The main outlet from the dam is the WAPDA canal outlet (other details such as the dam's emergency spillway capacity, dam safety programme, emergency management are not known). The canal was designed to convey 100 MGD from the Hub Dam to the KWSB water filtration plant. The first 8 km section of the canal belongs to WAPDA (Water & Power Development Authority) and ends at a head regulator located at a bifurcation which splits flow between the water going to the KWSB water filtration plant and the Lasbela canal that supplies Balochistan. KWSB owns and operates the remaining 22 km of canal ending at the pumping station and filtration plant.

The Hub River riverbed is mostly dry downstream from the Hub Dam and receives flows from tributary streams as it progresses towards the city of Karachi and the coast.

The canal aqueducts cross over some seasonal streams, some of which appear to reach the Hub River. Most aqueducts along the canal exhibit significant seepage which appears to contribute water to small ponds, wetlands and streams on the west side of the canal. A description of seepage from each aqueduct is presented in the following table as observed during the site visits between August and November 2020. Photographs of each aqueduct are included in Figure 16.

Table 6. Seepage from Aqueducts

Aqueduct #	Presence of seepage, ponding, or flowing stream under the aqueduct during site visit	Opinion as to whether streams are fully or partly due to canal seepage	Other comments
Aqueduct #1	Seepage from canal visible. Ponding/small wetland under canal, no clear flowing stream coming from upstream area.	The seepage is due to the cracks at corners of canal at many locations. Ponding due to seepage	Phragmites and grasses growing around ponded water/wetland. See Photo-1:
Aqueduct #2	Heavy seepage from the canal which has resulted in formation of permanent wetland to both sides of canal. See Photo -2	Stream is clearly attributable to canal seepage	Heavy reed beds
Aqueduct #3	Heavy phragmites around the canal area. No access to aqueduct	Stream is clearly attributable to seepage as shown in Photo -3	
Aqueduct #4	Presence of seepage and ponding water	Ponding water is entirely attributable to canal seepage	Cattle found resting in seepage water as shown in Photo -4
Aqueduct #6	Ponding and flowing of water due to canal seepage.	Ponding water and flowing is entirely attributable to canal seepage as shown in Photo -5	

Aqueduct #7	Cracks in aqueducts are evident from the Photo -6	Ponding due to seepage	
Aqueduct #8	The aqueduct is surrounded by thick vegetation, no excess near the aqueduct, however visible cracks can be seen in Photo -7	No visible seepage of water from the NIP (Non-Inspection Path) section	
Aqueduct #9	Stream of water can be seen from the Photo -8. Water seems to be traveling on the left side of canal due to natural slope.	The water stream is clearly due to canal water	
Aqueduct #10	No access to aqueduct, however cracks are visible in aqueduct, refer to Photo -9	Seepage cannot be determined	
Aqueduct #11	Heavy seepage and stream of water was flowing from aqueducts. This has resulted in ponding water as shown in Photo -10.	The stream and ponding water is clearly due to canal. However, the ponded water as shown in Photo -11 is the sewage water which is coming from the other far end.	

Figure 17. Photographs of aqueducts, seepage, and surrounding vegetation.

Photo -1: Aqueduct No 01

Photo -2: Aqueduct No 2

Photo -3: Aqueduct No 03

Photo -4: Aqueduct No 04

Photo -5: Aqueduct 06

Photo-6: Aqueduct 07

Photo -7: Aqueduct 08

Photo -8: Aqueduct 09

Photo -9: Aqueduct 10

Photo -10: Aqueduct 11

One of the most critical aspects to be considered when analyzing the possible project alternatives is to identify the water availability in the Hub Dam Reservoir and its ability to be delivered to Karachi. This input strongly conditions the proposed solutions.

The analysis of the available water resources for the Hub Canal has been highlighted as one of the key objectives of the due diligence process. In this regard and based on provided hydrological data. The data set is considered as reasonably representative of historic hydrological trends and sufficient to draw sound conclusions with regards to historical flows in the Hub Canal. Calculations and studies have been conducted to assess the available water resources provided by the Hub Dam watershed (refer to the Due Diligence Report, 2021). A review of the available data has concluded that historical Hub Reservoir storage values along with the Karachi Hub Canal outflows managed by WAPDA are the most robust and reliable data to assess the availability of water resources to the Hub Canal system. The following figure presents monthly data from the 20-yr data series. Available daily data is shown in Figure 17.

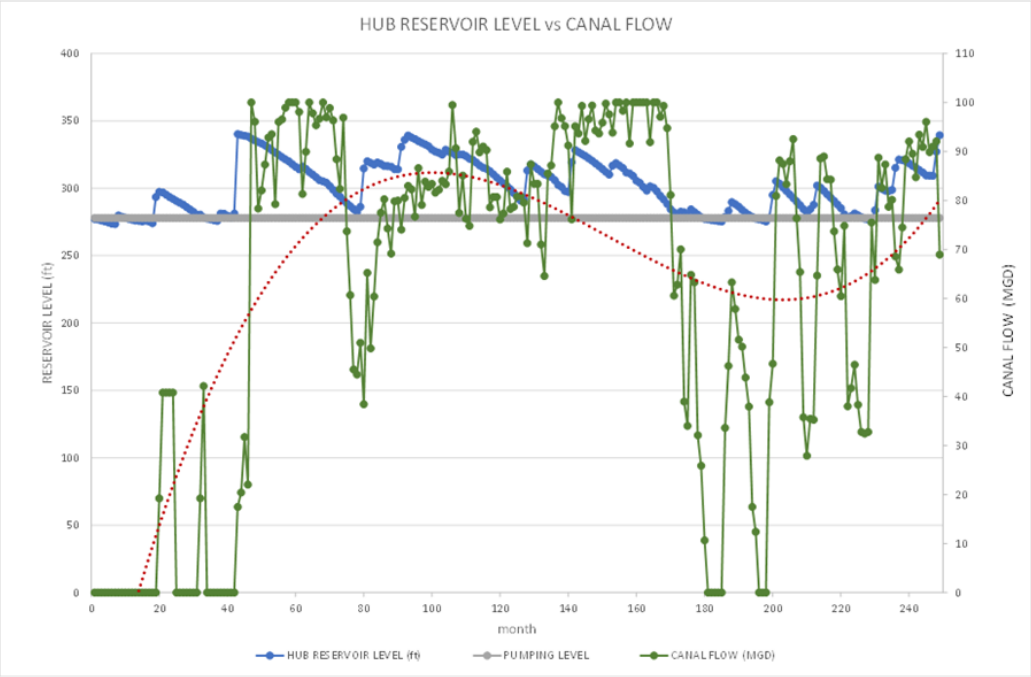


Figure 18: Analysis of the historical Karachi Canal average monthly flow data

The main conclusions obtained from the studies show the following:

Hub Reservoir Water Levels:

- The Hub Reservoir storage values appear to depend on rainfall. However, correlation coefficients are not significant between rainfall data from nearby meteorological stations and the Reservoir level data.
- From the 20-yr period of record for monthly Reservoir level data, the following results can be drawn:
  - Average monthly reservoir level: 301.56 ft (average daily reservoir level: 298.51 ft)
  - Median monthly reservoir level: 300.53 ft (median daily reservoir level: 303.40 ft)
- The probability of having reservoir levels above the elevation of the sill of the intake (i.e. 278 ft) that feeds the WAPDA Main Canal is the following:
  - 89.6% of the time (based on daily reservoir level data)
  - Below the Reservoir level of 278 ft, water needs to be pumped to the WAPDA Main Canal and no outflows are allocated for the Karachi Water Canal.
- The resilience of the reservoir is determined as follows based on the daily data:
  - 82.8% of the time, the reservoir recovers from levels below 278 ft[13] (on the next day)

[13] 278 ft is the elevation below which no flow can be diverted to the Karachi Canal (sill of intake).

- 91.3% of the time, the reservoir recovers from levels below 283 ft[14] (on the next day)

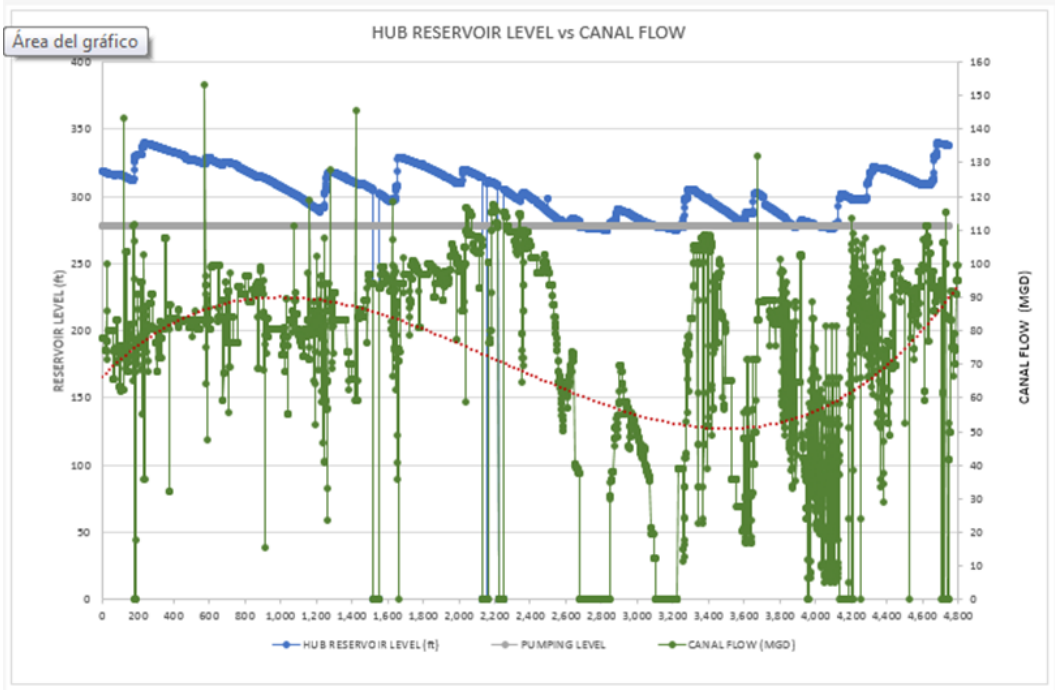


Figure 19: Analysis of the historical Karachi Canal average daily flow data

KWSB Canal Flows:

- Depending on whether daily of average monthly data is used, the Karachi Water Canal has conveyed a median of 81.8 MGD (4.3 m^3/s) or 78.3 MGD over the 20-yr period of record. The average value is 70.5 MGD (3.7 m^3/s).
- 90% of the time, the Karachi Water Canal has conveyed water. 10% of the historical daily data shows no flow in the canal (see figures above).
- Based on the existing data, the amount of time the canal has guaranteed the maximum canal capacity flow (100 MGD) is approximately 10% of the time.
- The Reliability of the Karachi Water Canal is defined by the following probabilities for these flow rates:
  - For 80 MGD it has been 56%
  - For 100 MGD it has been only 12%
- The resilience of the KWC to recover from outflows below a threshold is very small on a daily basis:

[14] 283 ft is the reservoir level below which restrictions on flows to the Karachi Hub Canal are triggered.

- 6% of the time the KWC recovers back to 80 MGD (one day after the discharge drops below 80 MGD)
- 1% of the time the KWC recovers back to 100 MGD (one day after the discharge drops below 100 MGD)

- Significant periods with the KWC out of service (without flows) are observed in the data.

Based on the historical data, 80 MGD is a flow that is more coherent with the actual water conveyed by the KWC, based on the water resources availability at the Hub Reservoir. However, around 10% of the time the KWC has historically conveyed 100 MGD.

According to the data received, losses in the canal due to seepage and other causes could represent over 25% of the outflows from the Hub Reservoir. It is estimated that currently, only around 70 to 80 MGD would be reaching the pumping station.

While the pumping station could convey a total of 120 to 140 MGD (combining the Hub and "Karachi-III" Canals), the theoretical capacity of the pumping station is only 120 MGD, so an upgrade would be needed to increase the daily flows in the future.

At the same time, the Water Filtration Plant currently has a capacity of 80 MGD, which is lower than the potential volume of water that could be conveyed to it from both the Hub and K-III Canals. Several long-term water supply scenarios could be considered, depending on KWSB's planning. After sharing the available data with KWSB and the GoS, it has been decided that the rehabilitation of the KWSB Canal should ensure it has a conveyance capacity of 100 MGD, which is the capacity of the original canal design. Due to the water stress situation in Karachi, KWSB and the GoS have determined that whenever 100 MGD are available at the Hub Reservoir, that the Karachi Canal System must be capable of supplying those outflows to the population.

7.1.7. Groundwater

During the geotechnical investigations, water was encountered in only one borehole (BH-4) during the investigations in October 2020. The average depth in the borehole was 1.6 mbgl. Because the water level was inconsistent with other boreholes, it was concluded that this could not be actual depth of the groundwater table at that location. Further studies during the ESIA stage should be carried out to determine groundwater levels.

Some of the communities use well water. Consultation with Mr. Shahid Saleem, Additional Agriculture Director, revealed that bore water is used by communities for drinking purposes. The agriculture which is done by tube wells is not near the canal but some distance from the canal. Mr. Shahid Saleem explained that tube wells depth is around 200 to 300 ft deep whereas wells are 40 to 50 ft deep.

7.1.8. Water Quality

The intensive use of the canal by nearby communities for bathing and washing is expected to impact canal water quality. Water quality sampling and testing was carried out as part of TYPSA´s scope of work. Three grab samples were obtained from the following five locations within the system:

1. Head Regulator (Sample taken before Head regulator)
2. Karachi Canal (Sample taken after Head regulator)
3. Distribution Chamber (Filtration Plant)
4. Withholding Tank (Filtration Plant)
5. Reservoir (Filtration Plant)

Samples were collected for microbiological, chemical, and metal testing. HNO_3 was added as a preservative for the metal sample bottles, at each mentioned location.

Table 7. Water quality observations during sampling

S.No	Sampling Location	pH	Temperature (°C)
01	Head Regulator	6-7	32.2
02	Karachi Canal	6-7	32.3
03	Distribution Chamber	6-7	34.5
04	With holding Tank	6-7	32.8
05	Reservoir	6-7	32.6

During the field visit it was ensured that samples were collected according to the standard operating procedure and preserved properly to acquire accurate results during testing. After sample collection from each sampling point, temperature and pH was noted on the spot and then the samples were placed in an ice box filled with ice to maintain the temperature inside the icebox and to preserve the samples for further testing at the SGS lab.

The main findings from the water quality analyses results are:

The parameter values seem quite similar at all three locations (outside and inside the Filtration Plant) on both days. The results were checked against WHO Limits and Drinking Water Standards in Pakistan. The parameters which do not comply with both standards are (samples from 18/09/20):

- Turbidity in the three samples (at the three locations) is greater than 5 NTU. Values range from 6 to 9 NTU.
- Aluminium in the three samples is greater than the WHO recommended limit of 0,2 mg/l. Values range from 0,25 to 0,63 mg/l.

The parameters, which do not comply with both standards are (samples from 01/10/20):

- Turbidity in the three samples (at the three locations) is greater than 5 NTU. Values range from 7 to 12 NTU.
- Aluminium in the three samples is greater than 0,2. Values range from 0,27 to 0,43 mg/l.
- Temperature is quite high in both sets of samples (higher than 30°C). As a result, one would expect to find organic matter in the reservoir because it has not been cleaned since 2004. However, BOD5 is very low at the three locations (less than 0,02 mg/l).

- Faecal coliforms were not found in any of the samples taken in September, however, faecal coliform results may not be accurate and additional water quality testing will be required during the ESIA.

The following tables show the obtained values against the limit values (WHO & Pakistan Standards):

Table 8: Results from Samples taken on 18th of September.

Parameters	Head Regulator	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
pH	7,01	7,00	6,96	6,50-8,50	6,50-8,50
Odour	Odourless	Odourless	Odourless		
Taste	Sweet	Sweet	Sweet		
Colour (Pt-Co)	<5	<5	<5	≤15	≤15
Turbidity (NTU)	9	6	7,5	≤5	≤5
Total dissolved solids (TDS – mg/l))	200	292	262	<1000	<1000
Total Hardness (mg/l)	109,86	135,73	130,26		<500
Fluoride (mg/l)	0,12	0,10	0,12	1,5	≤1,50
Nitrate Nitrogen (NO_3 – mg/l)	0,31	0,33	0,3	50,0	≤0,50
Nitrite Nitrogen (NO_2 – mg/l)	0,006	0,025	0,004	3,00	≤3,00
Aluminium (mg/l)	0,25	0,33	0,63	0,20	≤0,20
Arsenic (mg/l)	<0,005	<0,005	<0,005	0,01	≤0,50
Boron (mg/l)	0,13	0,078	0,068	0,30	0,30
Barium (mg/l)	0,057	0,057	0,077	0,70	0,70
Cadmium (mg/l)	<0,0030	<0,0030	<0,0030	0,003	0,01
Chromium (mg/l)	<0,005	0,012	0,010	0,5	≤0,50
Copper (mg/l)	<0,0050	<0,0050	<0,0050	2,00	2,00
Manganese (mg/l)	0,014	0,023	0,014	0,5	≤0,50
Nickel (mg/l)	<0,0050	<0,0050	<0,0050	0,020	≤0,020
Lead (mg/l)	<0,0050	<0,0050	0,027	0,01	≤0,050
Antimony (mg/l)	<0,0050	<0,0050	<0,0050	0,02	≤0,0050
Selenium (mg/l)	<0,0050	<0,0050	<0,0050	0,01	0,01
Zinc (mg/l)	<0,0050	0,008	<0,0050	3,00	5,00
Mercury (mg/l)	≤0,0010	≤0,0010	≤0,0010	0,0010	≤0,0010
Chloride (mg/l)	27,47	58,38	54,95	250,0	<250,0
Chlorine residual (mg/l)	<0,02	<0,02	<0,02	<0,02	0,2-0,5
Cyanide (mg/l)	<0,01	<0,01	<0,01	0,07	≤0,05
Total Phenols (mg/l)	<0,002	<0,002	<0,002	≤0,002	
Chloro Pesticides (µm/l)	<1,00	<1,00	<1,00		
Total PAH (mg/l)	<0,5	<0,5	<0,5	10,00	
Total Alkalinity (mg/l)	74,24	77,72	74,24		
Acidity as $CaCO_3$	<5,00	<5,00	<5,00		

Parameters	Head Regulator	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
BOD_5	<2,00	<2,00	<2,00		
T^a	32,00	32,40	32,00		
Faecal Coliform (E. Coli – cfu/100ml)	Absent	Absent	Absent	Absent	Absent
Total Coliforms (cfu/100ml)	12	16	Absent	Absent	Absent

Table 9: Results from Samples taken on 1st of Oct 2020.

Parameters	Before Pumping St.	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
pH	7,045	7,47	7,50	6,50-8,50	6,50-8,50
Odour	odourless	odourless	odourless		
Taste	Sweet	Sweet	Sweet		
Colour (Pt-Co)	12	15	12,5	≤15	≤15
Turbidity (NTU)	7	5	12	≤5	≤5
Total dissolved solids (TDS – mg/l))	184	196	204	<1000	<1000
Total Hardness (mg/l)	114,18	113,81	115,27		<500
Fluoride (mg/l)	0,10	0,10	0,12	1,5	≤1,50
Nitrate Nitrogen (NO_3 – mg/l)	0,14	0,16	0,15	50,0	≤0,50
Nitrite Nitrogen (NO_2 – mg/l)	<0,003	<0,003	<0,003	3,00	≤3,00
Aluminium (mg/l)	0,43	0,095	0,27	0,20	≤0,20
Arsenic (mg/l)	<0,005	<0,005	<0,005	0,01	≤0,50
Boron (mg/l)	0,16	0,012	0,098	0,30	0,30
Barium (mg/l)	0,12	0,064	0,084	0,70	0,70
Cadmium (mg/l)	<0,0030	<0,0030	<0,0030	0,003	0,01
Chromium (mg/l)	0,007	<0,0050	0,006	0,5	≤0,50
Copper (mg/l)	<0,0050	<0,0050	<0,0050	2,00	2,00
Manganese (mg/l)	0,015	0,009	0,017	0,5	≤0,50
Nickel (mg/l)	<0,0050	<0,0050	<0,0050	0,020	≤0,020
Lead (mg/l)	<0,0012	<0,0050	<0,0050	0,01	≤0,050
Antimony (mg/l)	<0,0050	<0,0050	<0,0050	0,02	≤0,0050
Selenium (mg/l)	<0,0050	<0,0050	<0,0050	0,01	0,01
Zinc (mg/l)	0,021	<0,0050	0,007	3,00	5,00
Mercury (mg/l)	≤0,0010	≤0,0010	≤0,0010	0,0010	≤0,0010
Chloride (mg/l)	30,61	27,21	29,76	250,0	<250,0
Chlorine residual (mg/l)	<0,02	<0,02	<0,02	<0,02	0,2-0,5
Cyanide (mg/l)	<0,01	<0,01	<0,01	0,07	≤0,05

Parameters	Before Pumping St.	Distribution Chamber	Reservoir Tank	WHO Limits	Pakistan Standards
Total Phenols (mg/l)	<0,002	<0,002	<0,002	≤0,002	
Chloro Pesticides (µm/l)	<1,00	<1,00	<1,00		
Total PAH (mg/l)	<0,5	<0,5	<0,5	10,00	
Total Alkalinity (mg/l)	89,83	85,11	81,56		
Acidity as $CaCO_3$	<5,00	<5,00	<5,00		
BOD_5	<2,00	<2,00	<2,00		
T^a	31,20	32,40	32,00		
Faecal Coliform (E. Coli – cfu/100ml)	9	10	Absent	Absent	Absent
Total Coliforms (cfu/100ml)	15	30	Absent	Absent	Absent

7.1.9. Waste Management

The Jam Chakro landfill site located on the east side of the canal north of the By-Pass Road is one of three waste disposal sites used by the City of Karachi (along with Dhabeji, Mehran Town and Govnd Pas). These waste disposal sites are not engineered landfill sites. In recent years, the amount of waste generated within the City of Karachi has substantially increased up to approximately 14,000 to 16,000 tons per day. It was estimated that by the end of 2020, solid waste generation would reach 18,000 to 20,000 tons per day.

The Jam Chakro landfill site accepts municipal solid waste, hazardous waste, and includes recycling of plastics, paper/cardboard, scrap metal, and includes composting facilities. The site can also be used for municipal and inert type wastes during the rehabilitation of the project.

Open burning of the waste at Jam Chakro was observed during the site visits, impacting air quality. For more information on Jam Chakro landfill see the information box in section 7.3.4.

Management of waste streams from the water filtration plant include washwater sludge that will be thickened on site in thickener gravity tanks and dewatered further in centrifuges such that the dewatered sludge can easily be loaded into trucks for disposal at designated sites outside the plant. The volume of sludge may increase depending on the flow capacity increase of the plant and the final process design. The disposal site of the current facility's sludge is not known. Waste management options for the facility's waste will be explored during the ESIA stage, as needed, if improvements to current practice are warranted.

7.2. Biological Environment

7.2.1. Brief Background of the Hub Dam Canal and its Environment

The Hub Dam Canal was commissioned around 1984. In its 27 years of life, the canal has suffered from increasing deterioration, particularly water seepage and water losses.

The canal passes through mostly flat and the plain areas along small hills, with hilly arid areas to the East and the Hub river plains to the West of the canal. The canal alignment runs parallel to the Hub River, perpendicularly crossing the east to west-flowing tributary streams that flow towards the river. The landscape is predominantly characterised by semi-arid land with scarce vegetation, riverine seasonal vegetation, some agricultural fields/orchards and a few settlements.

The following image, from Google earth dated 1986, shows the vegetation land cover of the area. Bare soil and arid zones are common along the canal, both to the east and west, with some darker zones showing the existence of bushes or trees along the streams and natural drainage paths.

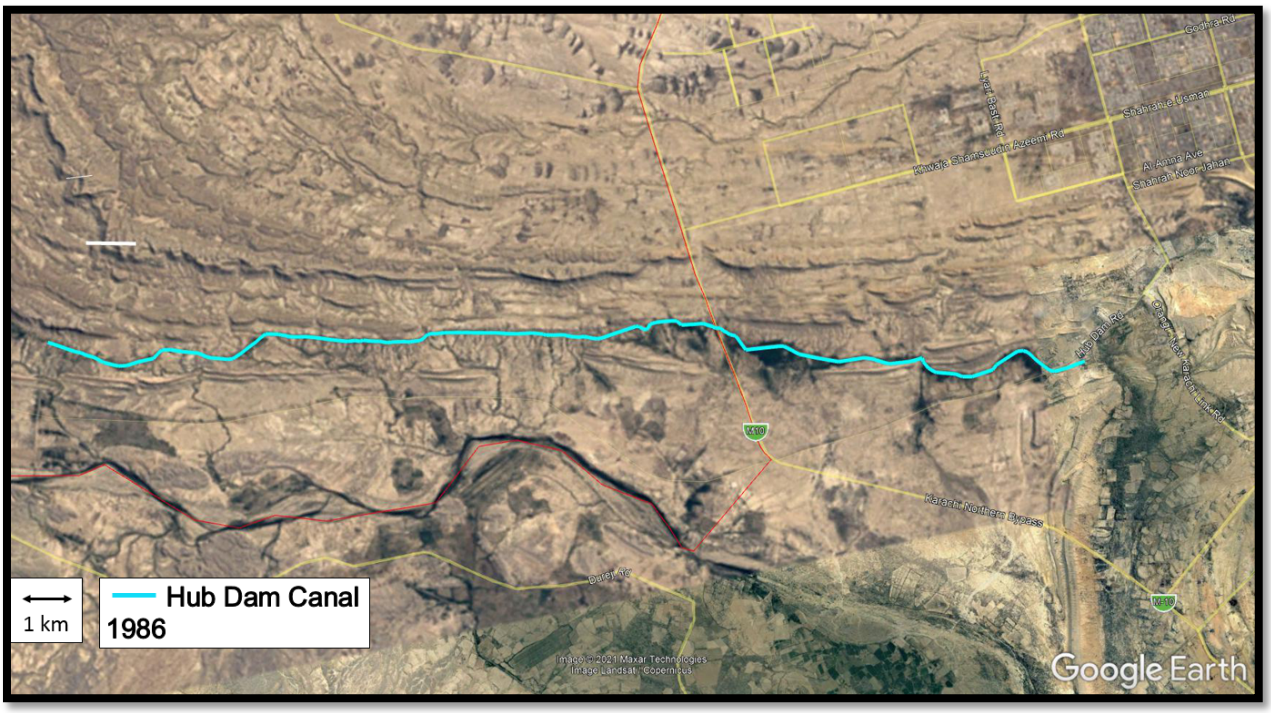
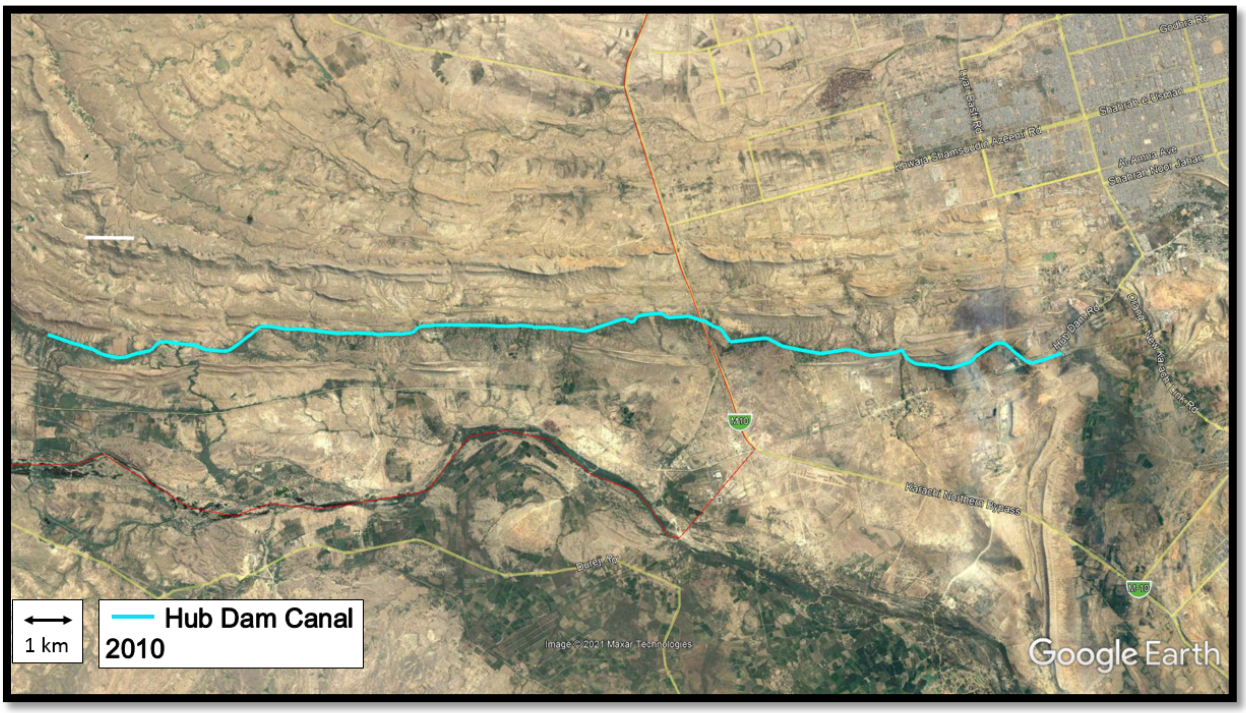
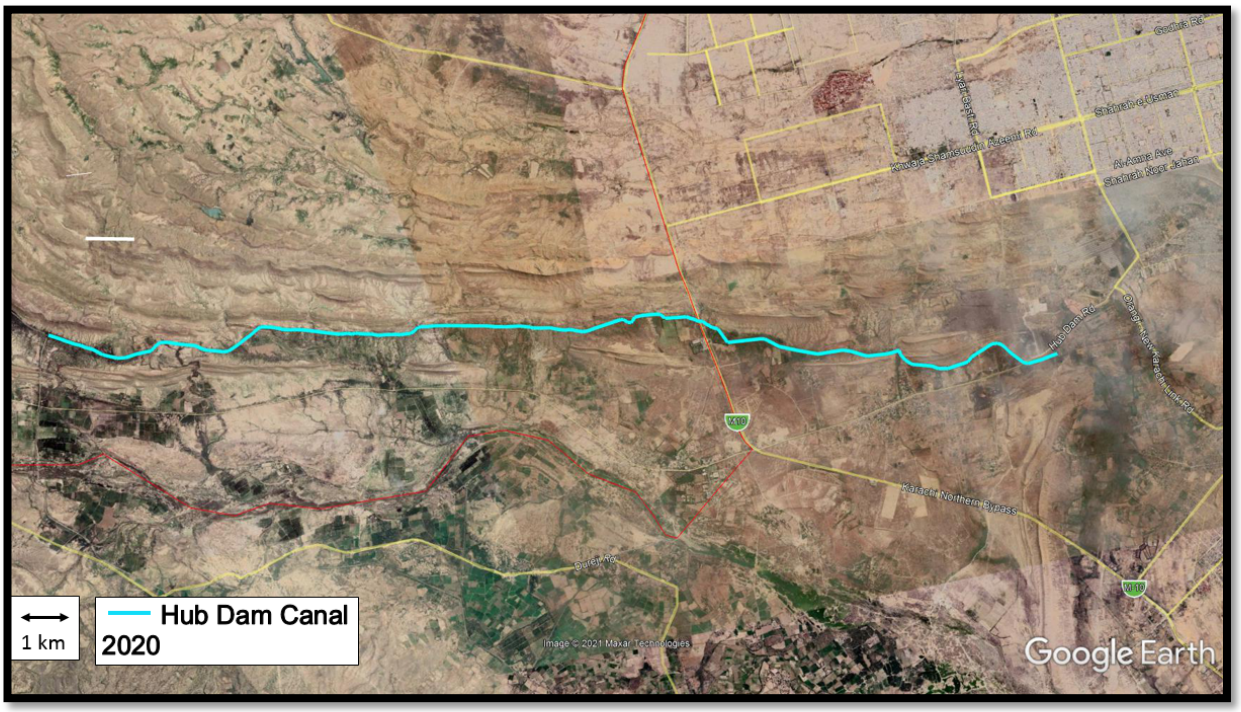


Figure 20. Google Earth Imagery 1986

In the following images, from Google earth dated 2010 and 2020, some “green” “dark” areas of land are seen on downstream side of the canal, not visible in 1986, can be observed at some sections of the canal.

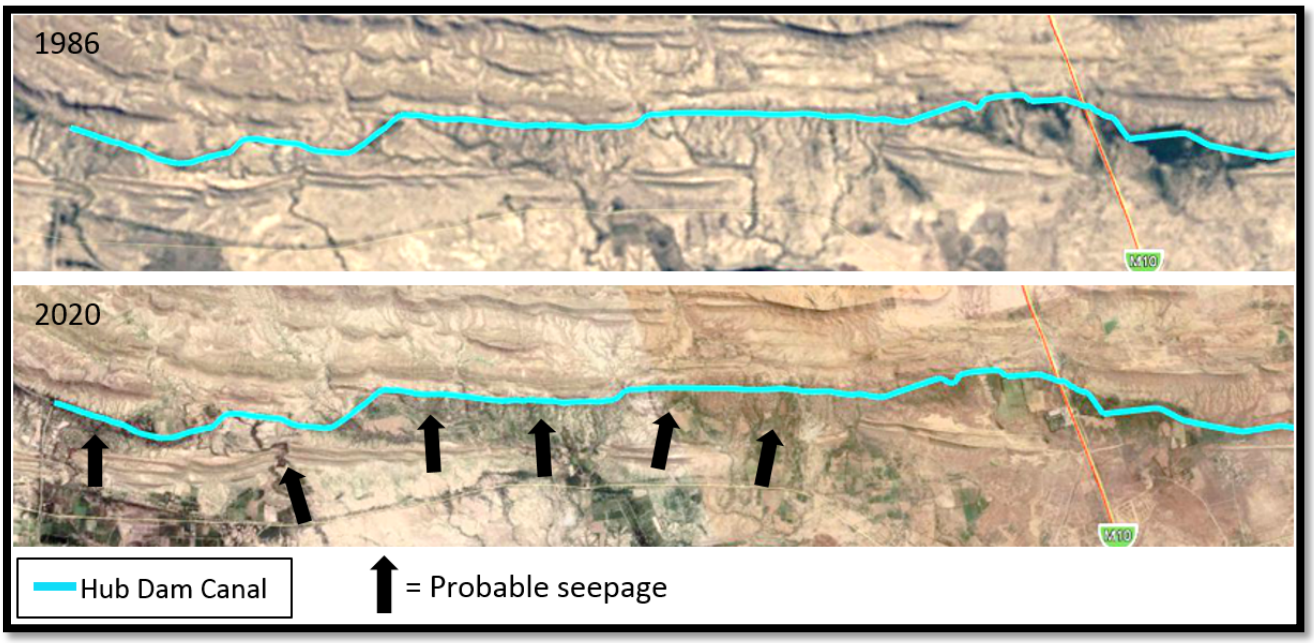
Figure 21. Google Earth Imagery 2010 and 2020





The following image shows changes of land cover in some locations due of growing vegetation over the period 1986 - 2020. These areas can reveal the canal sections that are damaged, where subsequent seepage has facilitated the growth of vegetation in this arid landscape.

Figure 22. Probable seepage areas where natural vegetation could have grown due to availability of water (comparison 1986 and 2020)



Thus, the seepage has created a number of areas where soils maintain humidity, preferably on the west side of the canal, which has contributed to vegetation growth. The seepage and resulting vegetation provide water and food resources for wildlife, as well as places to hide.

7.2.2. Trends in Land Use and Habitats

Based on satellite imagery from the past 20 years, the trends in land use changes are the following:

- Bushland and rangeland have increased in surface area over dry desert surfaces, due to seepage water from the canal.
- Over time, agricultural fields increase in extension over the rangeland and bushland areas.
- Over time, altered areas have increased in extension, taking over dry / desert areas and rangeland in the southernmost section of the project's area of influence.

As a result, agriculture fields and other altered areas such as settlements, roads and other infrastructure are at present slightly increasing, this situation is leading towards a degradation of the ecological values of the Wildlife Sanctuary in this area. This loss of ecological values in the area has been also confirmed, verbally, by Sindh Wildlife Department officials.

7.2.3. Integrated Biodiversity Assessment Tool (IBAT)

IBAT is an integrated Biodiversity tool which integrates three key global biodiversity datasets: The IUCN Red List of Threatened Species; the World Database on Protected Areas (WDPA) and the Key Biodiversity Areas (KBA).

The results from the IBAT query are summarised in this section. The 50 km buffer area around the project site, as shown in the figure below, includes marine ecosystems, therefore the IBAT query includes marine species. These marine species should be not considered in our assessment as they will not be impacted by project activities and are outside of any ecological appropriate area of analysis for the project. Table 10 shows a list of Protected Areas and Key Biodiversity Areas reported by IBAT to be within the 50 km buffer area. Fourteen species are identified by IBAT as potential critical habitat triggers (Table 11).

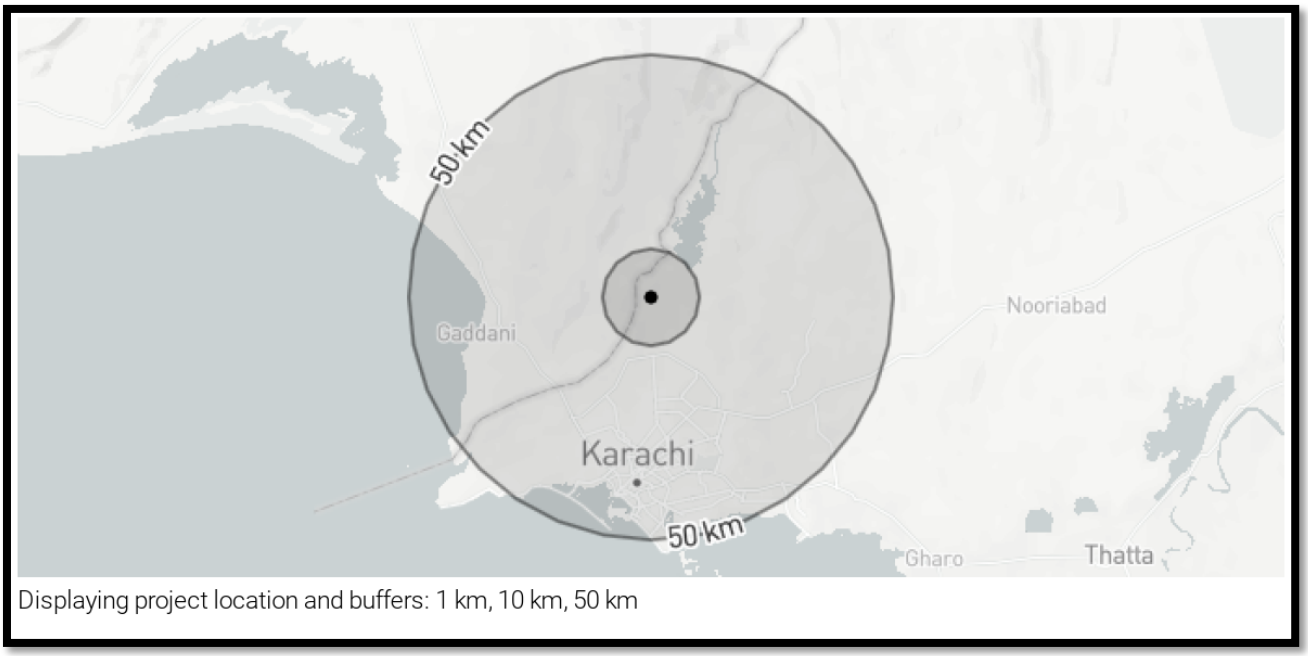


Figure 23. IBAT Query 50km Buffer area surrounding Project site.

Table 10. IBAT List of Protected areas found within 1, 10 and 50 km of project site.

Area name	Distance	IUCN Category	Status	Designation	Recommendation
Hab Dam	1 km	IV	Designated	Wildlife Sanctuary	Assess for biodiversity risk
Hub (Hab) Dam	1 km	Not Reported	Designated	Ramsar Site, Wetland of International Importance	Assess for biodiversity risk
Dureji	50 km	IV	Designated	Wildlife Sanctuary	Assess for biodiversity risk
Hawkes Bay/Sandspit Beaches	50 km	Not Reported	Proposed	Other Area	Assess for biodiversity risk
Kirthar	50 km	II	Designated	National Park	Assess for critical habitat
Mahal Kohistan	50 km	IV	Designated	Wildlife Sanctuary	Assess for biodiversity risk

(*)

(*) = Coastal area, not relevant in this assessment.

Table 11 presents the list of priority species identified in the IBAT report that could potentially occur in the project area. This table of potential critical habitat (CH) triggers gives a preliminary picture of biodiversity and can include species not relevant by the IBAT analysis, and in particular *Commiphora wightii* which has been found on site and is a CR species and is considered in the biodiversity analysis.

Table 11. Preliminary list of priority species that could occur within the 50km buffer provided by IBAT.

Species	Common name	Taxonomic group	IUCN Category	Population Trend	Biome	Migratory (M) / Resident (R) at local level	Species observed within area of influence (*)
Vanellus vanellus	Sociable Lapwing	AVES	CR	Decreasing	Terrestrial	M	
Gyps bengalensis	White-rumped vulture	AVES	CR	Decreasing	Terrestrial	R	
Sarcogyps calvus	Red-headed vulture	AVES	CR	Decreasing	Terrestrial	Unknown	
Manis crassicaudata	Indian pangolin	Mammalia	EN	Decreasing	Terrestrial	R	x
Axis porcinus	Hog Deer	Mammalia	EN	Decreasing	Terrestrial, Freshwater	R	
Oxyura leucocephala	White-headed Duck	AVES	EN	Decreasing	Terrestrial, Freshwater	M	
Sypheotides indicus	Lesser Florican	AVES	EN	Decreasing	Terrestrial, Freshwater	?	
Sterna acuticauda	Black-billed Tern	AVES	EN	Decreasing	Terrestrial, Freshwater	M	
Haliaetus leucoryphus	Pallas' Fish Eagle	AVES	EN	Decreasing	Terrestrial, Freshwater	M	
Neophron percnopterus	Egyptian vulture	AVES	EN	Decreasing	Terrestrial, Freshwater	R	
Aquila nipalensis	Steppe eagle	AVES	EN	Decreasing	Terrestrial, Freshwater	M	x
Falco cherrug	Saker Falcon	AVES	EN	Decreasing	Terrestrial, Marine, Freshwater	M	x
Leptopilus dubius	Greater Adjutant	AVES	EN	Decreasing	Terrestrial, Marine, Freshwater	Unknown	

(*): Species that been seen in the project area of influence in the last 10 or 5 years.

7.2.4. Protected Areas

The initial desktop review of existing information and data at the national level indicates the Project site's Area of Influence is within a portion of the Hub Dam Wildlife Sanctuary and near the Kirthar National Park. These protected areas are part of what is informally known as the Kirthar Protected Areas Complex (KPAC) which covers a total area of 4350 square kilometres and is comprised of the following four categories of protected areas in accordance with the Sindh Wildlife Protection Ordinance 1972 (re-notified as The Sindh Wildlife Protection Act, 2020).

1) Kirthar National Park 308,726 ha.
2) Mahal Kohistan Wildlife Sanctuary 70,574 ha.
3) Hub Dam Wildlife Sanctuary 27,218 ha.
4) Hothiano Eri Sumbak, Surjan Game Reserve 40,632 ha.

During September 2012 and onwards, the KPAC area's biodiversity was extensively surveyed for a Baseline Survey and Environmental Impact Assessment, undertaken as a legal requirement to initiate oil and gas exploration in this area. As far as wildlife is concerned, the following were the counts/results of these extensive surveys:

- Avifauna/Birds: 207 species
- Mammalian fauna: 33 species
- Reptiles: 41 species

A map of the KPAC is included in Figure 19 and indicates that the Hub Dam Wildlife Sanctuary boundaries are the Hub River down to the Karachi Bypass road and include the section of the canal that is located upstream from the Karachi Bypass road.

The project footprint does not overlap with Kirthar National Park, Mahal Kohistan Wildlife Sanctuary or the Hothiano Eri Sumback Surgan Game Reserve.

7.2.4.1. Kirthar National Park

Located in Sindh and established in 1974, Kirthar National Park occupies an area of 3,087 km^2. It is governed by the Sindh Wildlife Parks Department of Provincial Government. It is located in Kirthar Range and is an area of outstanding natural beauty and cultural heritage. The only National Park of Sindh Province was notified to conserve primarily wild ungulate species: Sindh Wild Goat (also called as Sindh Ibex), Urial (locally known as Gad) and Chinkara gazelle. Among the avifauna, raptors and waterbirds visiting the Hub Reservoir are also worth mentioning.

Because of its biological significance and proximity to the Provincial Capital, Karachi, it remained a focus of civil society organizations (CSO) and media. It was first highlighted at the national level in 1991 when the government proposed to route the Indus Highway through the Park. But due to strong campaigns by the CSOs and media, its proposed route was modified. The Park again came into limelight during 1997 when an oil/gas company was awarded a concession for oil/gas exploration. CSOs again launched a strong campaign as the provisions of the Sind Wildlife Ordinance of 1972 did not allow mining activities (including oil/gas exploration) within the National Park. However, the Government of Sindh in view of badly needed

hydrocarbon deposits, accommodated such activities through special amendments in the law subject to strict monitoring as proposed under the environmental impact assessment. After a detailed baseline and biodiversity assessment and widely participated EIA process, very limited oil/gas exploration was conducted and under a strict code of conduct. Fortunately (or unfortunately), no economically viable deposit could be tapped. Comprehensive reports/scientific publications about biodiversity of KPAC were published in scientific journals.

7.2.4.2. Hub (Hab) Dam Wildlife Sanctuary

The Hub (or Hab) Dam Wildlife Sanctuary with an area of 27,218 hectares was notified during 1974 concurrently with Kirthar National Park. At the time of its notification, it was an important bird site and provided important habitat for migratory birds. The List of Important Fauna and Flora when designated as a Wildlife Sanctuary was presented in Table 4 of the report. Due to the proximity of the Karachi Metropolitan area and its industrial zone, the area lost its ecological significance. The Northern By-pass with heavy traffic linking Sindh with Balochistan Province has further deteriorated its importance. There is currently no conservation or other management plan in place for this Wildlife Sanctuary. As described in Section 5.1.6, the Project will require an NOC from the Sindh Forests & Wildlife Department.

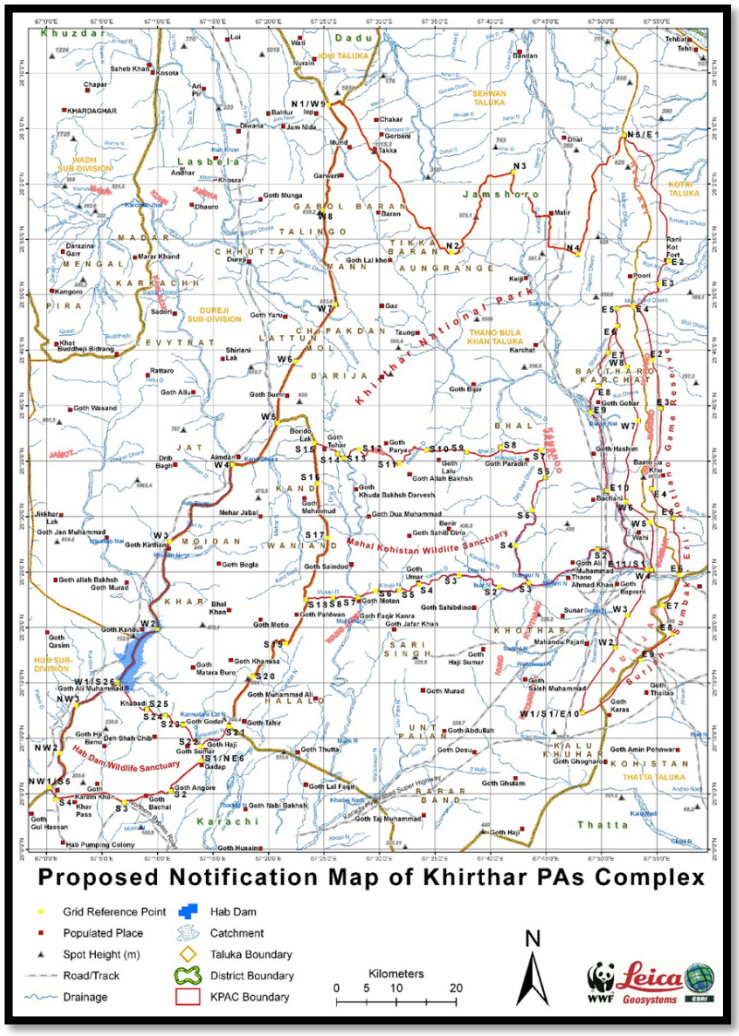


Figure 24. Kirthar Protected Areas Complex (KPAC)

Habitats within the Project´s area of influence, and therefore within the Wildlife Sanctuary have been identified, their characterization and discussion on IFC PS6 criteria can be found in the related section of this report.

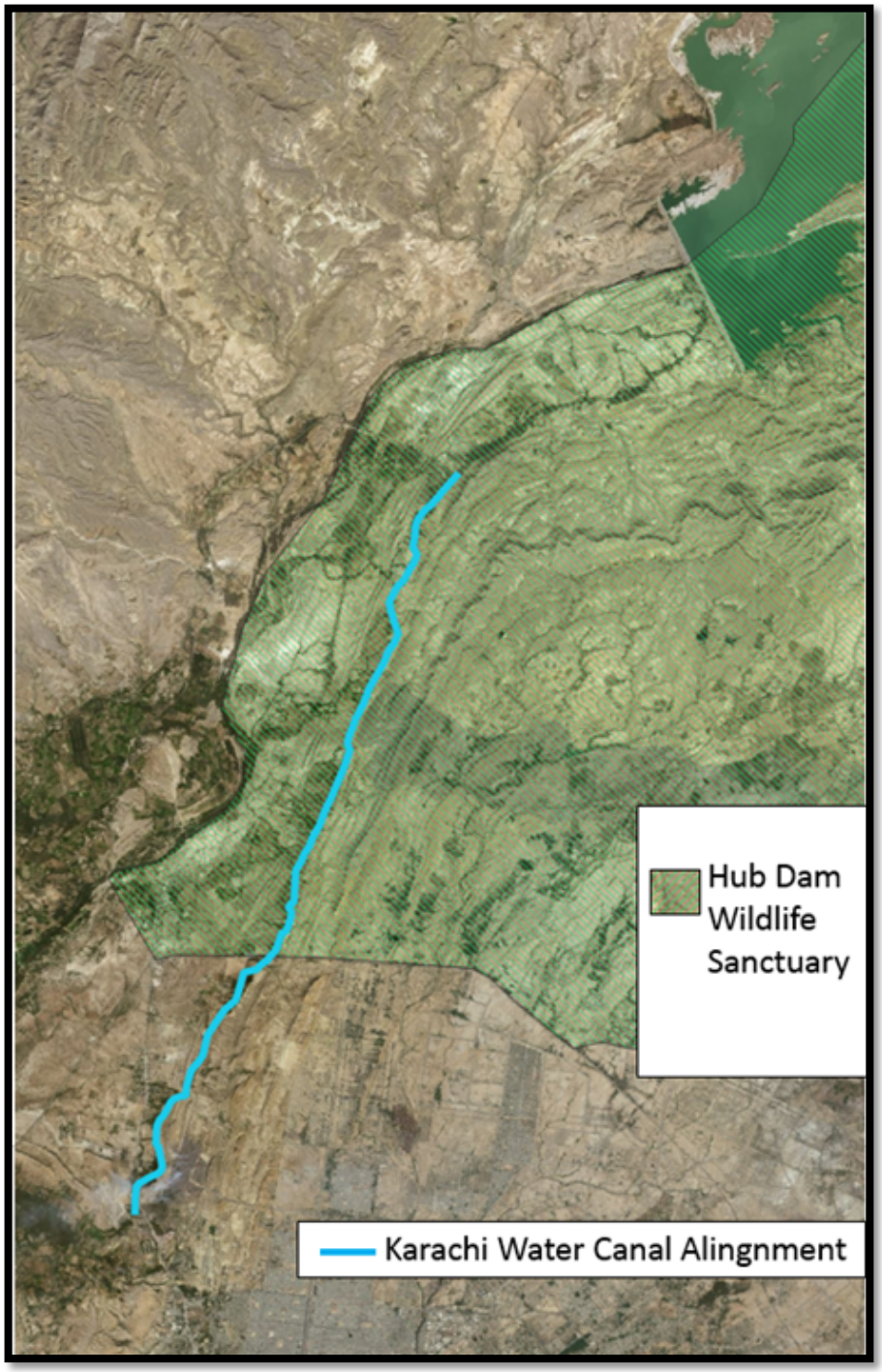


Figure 25. Hub Dam Wildlife Sanctuary (Kirthar PAs Complex)

7.2.5. Key Biodiversity Areas

7.2.5.1. Hub Dam Ramsar Site No. 1064 [15]

Located in Sindh, Balochistan, this Ramsar site has a surface area of 27,000 ha. The Hub Dam is a large water storage reservoir constructed in 1981 on the Hub River on the arid plains north of Karachi. The reservoir supplies water for irrigation in Lasbela District and domestic and drinking water for the city of Karachi. It is an important staging and wintering area for an appreciable number of waterbirds and contains a variety of fish species which increase in abundance during periods of high water.

The Hub Reservoir receives water mainly from the Hub River and its tributaries originating from Kirthar Range and catchment areas in Balochistan. It is heavily dependent upon monsoon rains which are now largely erratic. In some cases, the reservoir was completely dried up to zero level and sometimes overrun like the last year 2020).

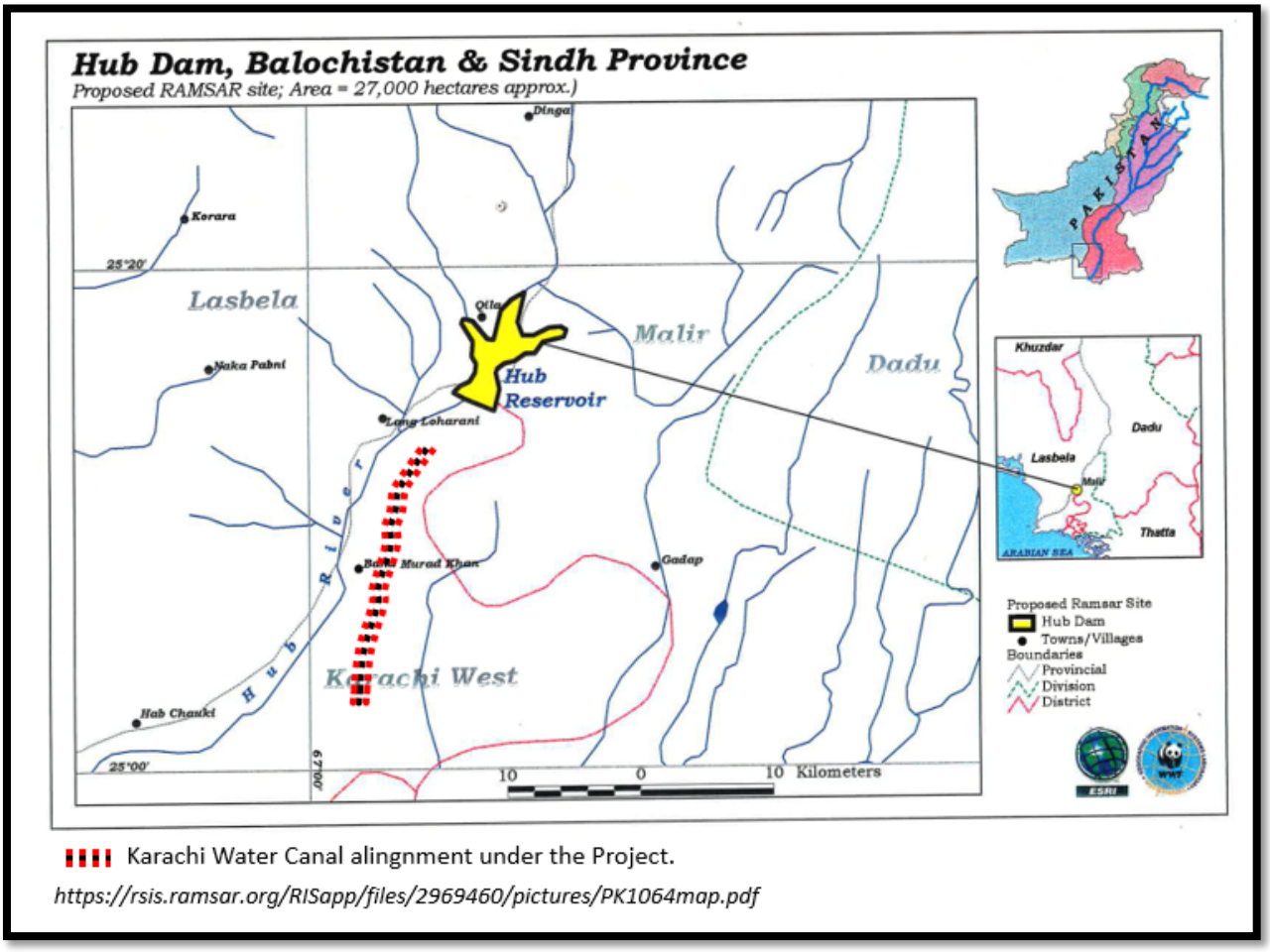


Figure 26. Extent of Hub Dam Ramsar site.

[15] https://rsis.ramsar.org/

7.2.5.2. Important Bird Area (IBA) Kirthar National Park (including Hub Dam)[16]

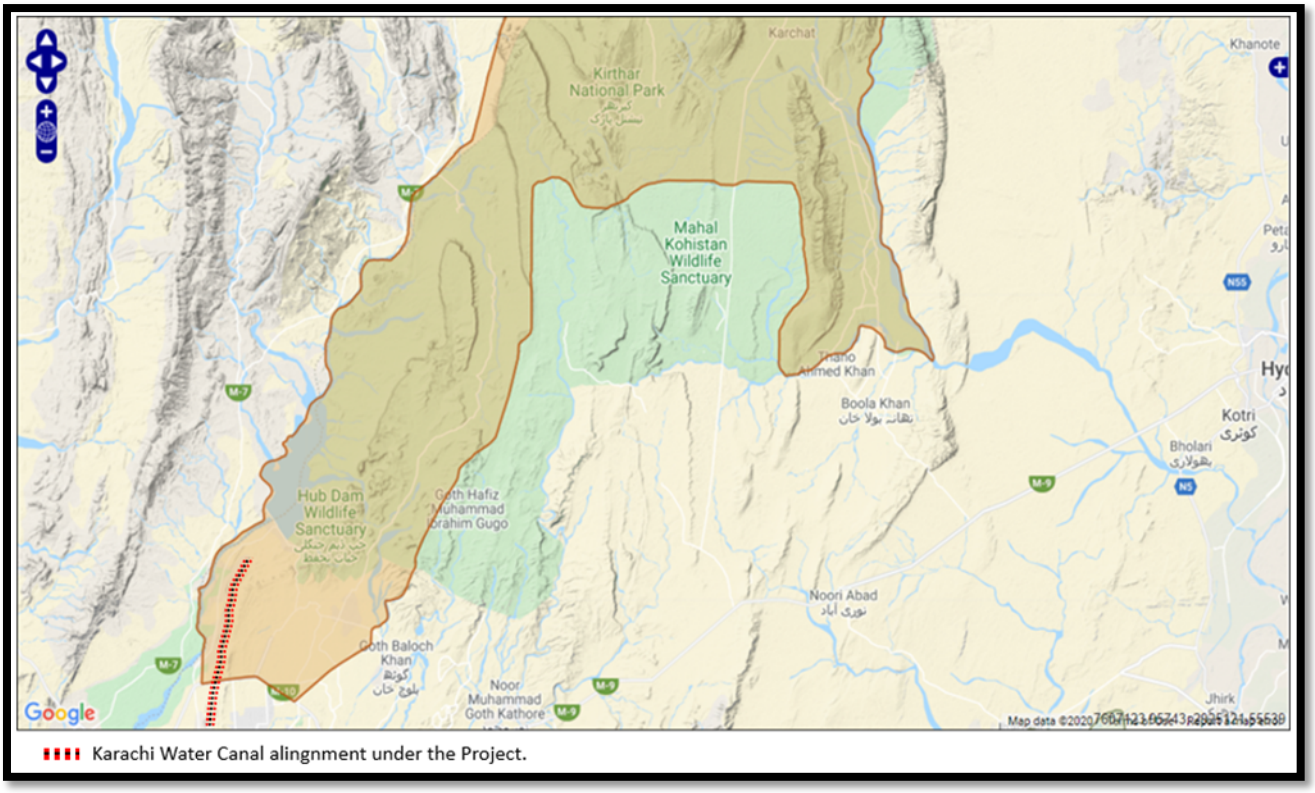


Figure 27. Extent of IBA that overlaps with Project Area.

The project footprint doesn't overlap with the Hub Dam Ramsar site, which is limited to the reservoir, but does overlap with the Kirthar National Park (including Hub Dam) IBA.

The species for which this IBA was designated are all tied to freshwater habitats and the Hub Dam reservoir (similar to the IBAT results).

Table 12. List of IBA trigger species.

English name	Scientific name	Migratory Status in South Pakistan	IUCN status
Red-crested Pochard	*Netta rufina*	X	LC
Black-necked Grebe	*Podiceps nigricollis*	X	LC
Common Coot	*Fulica atra*	Mainly resident	LC
Dalmatian Pelican	*Pelecanus crispus*	X	NT
Great White Pelican	*Pelecanus onocrotalus*	X	LC

[16] BirdLife International (2020) Important Bird Areas factsheet: Kirthar National Park (including Hub Dam). Downloaded from http://www.birdlife.org on 17/12/2020

English name	Scientific name	Migratory Status in South Pakistan	IUCN status
Sociable Lapwing	*Vanellus gregarius*	X	CR
Indian Skimmer	*Rynchops albicollis*	X	EN
Eastern Imperial Eagle	*Aquila heliaca*	X	VU
Pallas's Fish-eagle	*Haliaeetus leucoryphus*	X	EN

None of the species listed above (IBA) have been observed within the area of influence, these species are predominantly linked to water bodies (freshwater bodies in the area) thus for the IBA site the species are probably linked to the Hub Dam reservoir.

The justification for the IBA designation therefore lies in the Hub Dam and reservoir, rather than in the areas downstream of the dam (Hub Dam Wildlife Sanctuary) where the project activities will take place.

7.2.5.3. Summary on Key Biodiversity Areas and Protected Areas

The following table summarizes the Project location with respect to KBAs and Protected Areas, with distances and bearing.

Key Biodiversity Area / Protected Area	Location / distance of project
Kirthar National Park	Project not within National Park boundaries. Distance of 7400 m from Project "Zero point" up to Hub Dam.
Hub Dam Wildlife Sanctuary	Project within Sanctuary boundaries; Project Section between "Zero point" down to Karachi Northern By-pass road.
Important Bird Area (IBA) Kirthar National Park	Project within IBA boundaries; Project Section between "Zero point" down to Karachi Northern By-pass road.
Hub Dam Ramsar Site No. 1064	Project not within Ramsar site. Distance of 7400 m from Project "Zero point" up to the Hub Dam reservoir.

7.2.6. Consultation with Sindh Wildlife Department

As described in Section 5.1.6, consultation with Mr. Javed Mahar, Conservator with the Wildlife Department, Government of Sindh indicated that the proponent of the project (or KWSB) must submit a formal request for a no objection certificate (NOC), in writing, stating the purpose of the subject activity seeking NOC from the of the Government of Sindh. The formal request should be addressed to the Secretary of the Government of Sindh Forests & Wildlife Department. This process can take time and should be initiated as soon as possible. The Sindh Wildlife Department also provided information on the Wildlife Sanctuary, as presented in Section 5.1.7. The request is followed by a site visit by Wildlife Department specialists to the project area to get an appreciation of the type of impacts the project may cause. The Project proponent shall work closely with the

Wildlife and Forest departments to develop any mitigation and/or compensation measures that may be necessary, as described in the project ESIA

7.2.7. Segmentation of Karachi Water Canal Project area

The Karachi Water Canal Project area can be divided into three sections based on the status of the area and respective management, as follows and shown in Figure 22.

1. From the Hub Dam to the head regulator (bifurcation to Lasbela canal) or "Zero Point", which is owned and operated by WAPDA and is within the Hub Dam Wildlife Sanctuary.
2. From "Zero Point" to the Northern Bye-pass road. This section is owned and operated by the Karachi Water and Sewerage Board (KWSB) and is within the Hub Dam Wildlife Sanctuary.
3. From the Northern Bye-pass road downstream up to the KWSB Pumping Station and WTP (not within a protected area).

Sections 1 and 2 are the ones that are located within the Hub Dam Wildlife Sanctuary.

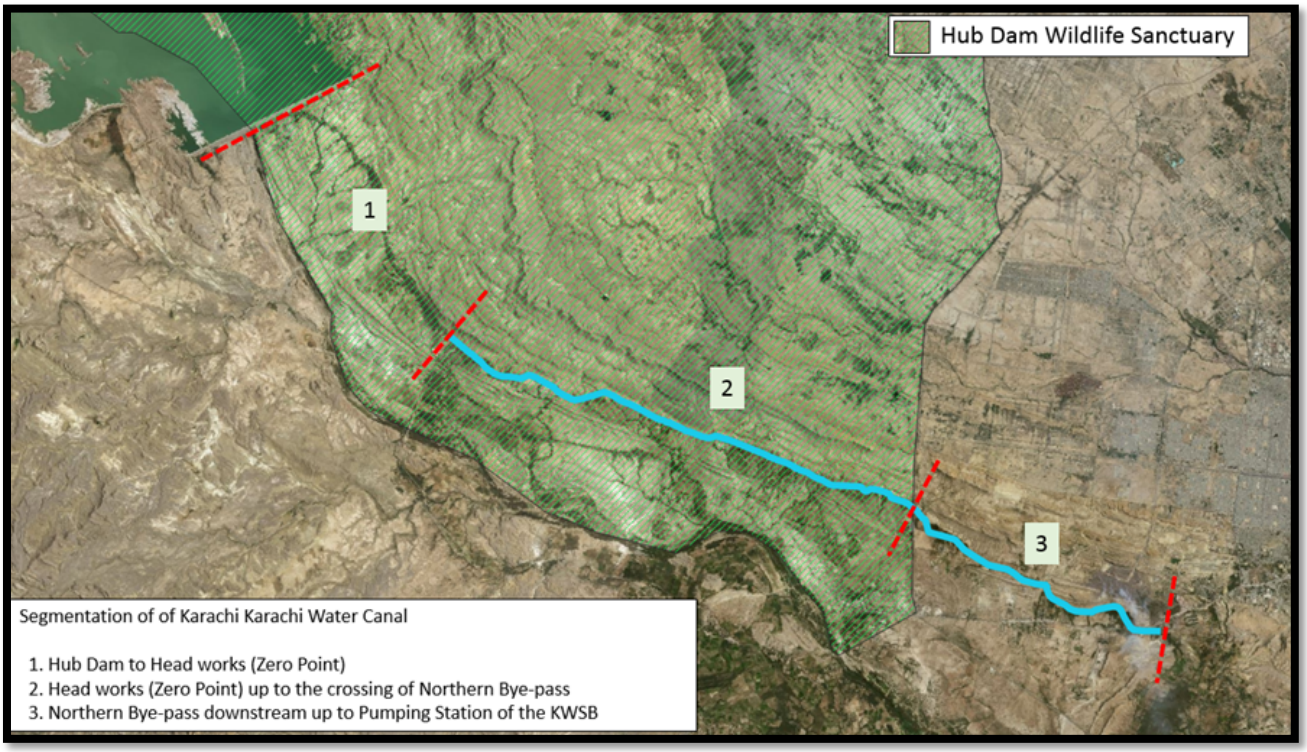


Figure 28. Segmentation of Karachi Water Canal

7.2.7.1. From the Hub Dam to Head works "Zero Point"

The canal section between the dam and the head regulator at the bifurcation that leads to the Lasbela canal is owned and operated by WAPDA and is not within the scope of the project. However, part of it was covered in both surveys for assessment of biodiversity as part of it is located within the project's Area of influence (AOI).

This segment of the canal (WAPDA Canal), is about 8 km long, starts at the Hub Dam. The Hub Dam and reservoir enjoys the status of a Ramsar Site, and the WAPDA canal section is within the Hub Dam Wildlife

Sanctuary and part of the Kirthar Protected Areas Complex (KPAC). The Hub Dam and surroundings are also very important due to the status as an Important Bird Area (IBA), recognized by Birdlife International.

Most of the area is rocky, the vegetation is sparse, but due to recent rains in this area before the 2020 field surveys, it appears relatively lush. Typical bushes of Thohar (*Euphorbia caducifolia*) are present. The reservoir area and surroundings are wintering habitat for migratory birds (see Tables 11 and 12). Reptiles and resident avian species are also recorded (refer to the next Tables for details). Some observations of Chinkara/Gazelle (*Gazella bennettii* – LC) were also reported by the media during the lockdown period when people remained at home due to Covid-19.

7.2.7.2. From Head works "Zero Point" downstream to the Northern By-pass Road crossing.

This segment of the Karachi Canal is the most important area regarding habitat for fauna and flora: the canal flows through mostly plain areas, along small hills and agricultural fields/orchards. The seepage from the canal, due to the deterioration of the structure (including the main canal and aqueducts), is frequent. The seepage has created a number of small wetlands on both sides of the canal which have a thick vegetative cover of grasses and reeds (*Typha* and *Phragmites*) and trees/bushes of mainly mesquite/Devi (*Prosopis juliflora*). At some points, trees of neem (*Azadirachta indica*) and bargad (*Ficus benghalensis*) are also planted providing shade to local communities and nesting places for avian species and squirrels (See next tables for details).

Thick vegetative cover provides shelter to local avian species including Black and Grey partridge (*Francolinus francolinus* and *Francolinus podicerianus,* both not within IUCN red list) small mammals and herpetofauna. The wetlands created by seepage water and hill torrents are wintering habitat for a number of migratory waterbirds. One Common sandpiper, (*Actitis hypoleucos* – LC), early arrival was recorded/photographed along the Canal bank. Cattle egrets (*Bubulcus ibis* – LC*)* were common on these wetlands (both species not listed as IBA triggers). See next tables for details.

7.2.7.3. From the Northern By-pass crossing downstream up to the KWSB pumping station and WTP.

This section of the canal passes through an area under intense urban development with growing industries and quick changing land use. These include a large landfill site where solid waste from the Karachi Metropolitan area is being dumped. Actually, no fresh solid waste containing food waste or waste from butcheries are brought to this site. The solid waste was very old and being extracted from nullahs/streams of Karachi city which had been used as solid waste dumps during the last many years, the type of waste dumped at the site isn't attractive to birds. Only Black kites (*Milvus migrans*, not on IUCN Red List) were observed in flight in te land fill site during the August visit.

This part of the canal is not covered by any protected area as the boundary of the Wildlife Sanctuary ends at the Northern By-Pass Road. However, as per provisions of The Sindh Wildlife Protection Act, 2020, a buffer of one km radius around the sanctuary boundary provides protection to wildlife.

Planted trees (Neem and Conocarpus) and electricity transmission line pylons and distribution poles provide shelter and roosting places for birds such as Black kites (*Milvus migrans*), House crows (*Corvus splendens*)

and Blue Rock/feral pigeons, which are all categorized as least concern by IUCN. Tall grasses and cavities in buildings are habitat for common reptiles.

7.2.8. Findings - Field Survey

The field surveys for biodiversity assessment of the Karachi Water Canal Project were conducted in two parts. The first reconnaissance survey was conducted in August 2020. The second proper survey was undertaken in November 2020. The following team of specialists from Halcrow Pakistan undertook a detailed survey of the project area for the confirmation of presence and frequency of occurrence of different species of fauna (birds, mammals and reptiles) and flora:

- Mr. Umeed Khalid (Biodiversity Specialist)
- Mr. Abdur Razaq Khan (Wildlife Expert) and local Biodiversity Specialist
- Mr. Ameen Ahmad (Professional photographer).

7.2.8.1. Habitats identified in the Project Area of Influence

Dry / desert with scarce vegetation including hills/cliffs.

In most of the linear belt of the KWC starting from the Hub Dam down to the pumping station, the project area is bounded by small hills/cliffs running in a north to south direction. This hilly and rocky terrain is influenced by the flora of the Kirthar Range with scrub vegetation. Some species are: *Calotropis procera, Euphorbia caducifolia Ziziphus nummularia Aristida funiculate, Cynodon dactylon Capparis decidua Prosopis juliflora* (all not threatened) among others, and *Commiphora wightii* as Critically endangered species (IUCN Red List). Non-native species like *Aristida adscensionis*, *Acacia nilotica* also can be found. Some of the flat areas have sandy conditions and are covered by grasses. Cliffs outside the area of influence (1 km buffer from canal) to the East, can provide roosting cliffs for migratory raptors and some resident species, Saker falcon (*Falco cherrug*) was recorded on these cliffs, during field visit some points were having visible defecation marks, indicating regular roosting. The vegetation is very sparse, hence not supporting larger mammals such as Urial and Sindh goat. Most of the raptors and some passerines were recorded in this habitat type.

Bushland/Rangeland.

In between the Karachi Canal and the linear belt of hills, the driest part of the landscape may be characterised as Bushland/Rangeland. This habitat type has scattered trees, scrubs and grasses in between. The trees are mostly native except for Mesquite (*Prosopis juliflora*) which was introduced through areal broadcast like in other dryer areas of Pakistan. Other trees include Kikar (*Accacia nilotica*), Jangli Ber (*Ziziphus nummularia*), Gum Accacia (*Ziziphus nummularia*) and in a few places, the typical plant/bush of the Kirthar Range, Thohar (*Euphorbia caducifolia*).

This habitat type is occupied by Passerines, Grey partridge, small mammals, and reptiles. Species of Concern are the Indian pangolin (*Manis crassicaudata*), a globally endangered (EN).

Most of the raptors in flight were noticed in this habitat type as their roosting places on cliffs are present nearby.

Riverbed vegetation including areas influenced by seepage.

This habitat includes the mention above bottom valleys with hygrophytic vegetation the riverbed vegetation likely supported by the seepage from the canal. The regular supply of this freshwater supports thick vegetation including reeds (*Typha*, *Phragmites*) and mesquite. Flora species at this habitat are *Prosopis juliflora, Ficus benghalensis, Conocarpus acuminatus*, *Saccharum spontaneum, Phragmites karka* and *Typha latifolia* (all of them not threatened). Seasonal streams bring rainwater to low lying valleys and ultimately to the Hub River on the western side of the project area. Most of the wetlands are seasonal, but some depressions, usually under the aqueducts, receive seepage water from the canal year-round. The thick vegetation of mesquite an invasive plant and reed beds provides cover for larger mammals including Wild boar, Asiatic (golden) Jackals and Foxes (*Vulpes vulpes*). Roosting birds were also noticed in these thick patches. The bottom valleys also provide shelter to Grey partridges where adequate cover and roosting trees/bushes are present. Species of Concern for this habitat are the Indian pangolin (*Manis crassicaudata*), a globally endangered (EN) species was also reported in bottom valleys, with some thick vegetative areas. Presence of livestock in some areas affect Galliformes such as Black partridge where they are not in good number.

Seasonal agricultural fields

Where possible, most of the plains on both sides of the canal have been levelled for seasonal agriculture, which is dependent upon precipitation. Some of these patches are being cultivated with tube well water or from other sources. Other than staple crops, vegetable crops were also observed. These cultivated patches are the main attraction for avian fauna and small mammals. The presence of insects and grains are an attraction for avifauna. Such croplands are also visited by Desert hare (*Lepus nighicollis*) and Asiatic (golden) jackals for foraging.

Settlements and Built Environment

This ever-increasing microhabitat is in the form of human settlements and commercial buildings in the KWC project area. The fruit and other trees are a source of attraction for avifauna and small mammals such as Five striped palm squirrels (*Funambulus pennantii* – LC). Most of the passerines were observed on trees and electric supply wires. The hotels, mosques and shops have been constructed mostly around the highway.

7.2.8.2. Habitat Mapping

A habitat map was prepared, based on secondary data and the fieldwork carried out to date. The habitat map covers the area likely to support natural or modified habitats within the Project area of influence which includes a 1 km buffer from the existing water canal. Thus, the area downstream from the Northern Bypass to the pumping station and WTP is not covered due to its high level of anthropogenic influence and human disturbance.

The habitat mapping is included in Appendix E, considers the following Habitat Units:

1) Dry / desert with scarce vegetation including hills/cliffs.
2) Bushland/Rangeland

3) Riverbed vegetation including areas influenced by seepage.
4) Seasonal agricultural fields
5) Settlements and Built Environment
6) Altered Areas

Based on the field observations described in the previous sections (Reconnaissance survey of August 2020 and Field survey of November 2020) of the Karachi Canal AOI, a summary of the flora and fauna observations is provided in the following sections.

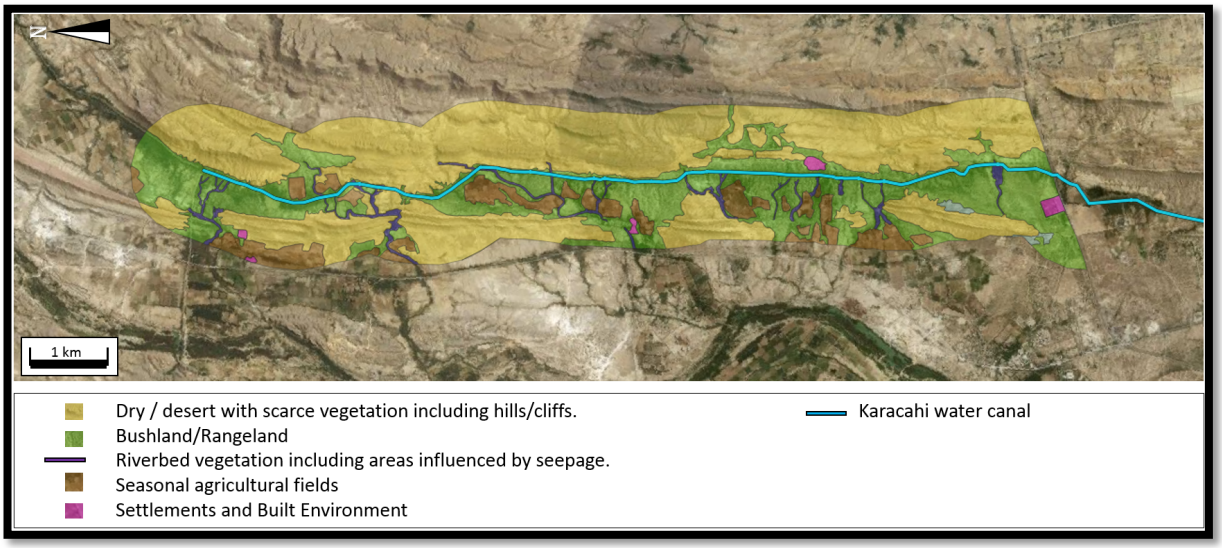


Figure 29. Habitat map: Habitats identified within the 1 km buffer area of influence (See Appendix E for details)

7.2.8.3. Preliminary estimation of habitat areas within the 1 km buffer of the Area of Influence.

A preliminary estimation has been made of the total area covered by each identified habitat within the 1 km buffer.

It should be noted that total areas may change over time since land use change processes are ongoing.

Table 13. Preliminary estimation of total area for identified habitats within the 1 km buffer

Habitat	Area		
	m^2	Hectares (ha)	Percentage of Total Area (%)
Dry / desert with scarce vegetation including hills/cliffs.	15,883,517	1,588.35	55.3 %
Bushland/Rangeland	9,010,258	901.03	31.4 %
Riverbed vegetation including areas influenced by seepage.	1,286,700	128.67	4.5 %
Seasonal agricultural fields	2,318,703	231.87	8.1 %
Settlements and Built Environment	180,435	18.04	0.6 %
Altered areas	58,925	5.89	0.2 %
Total	28,738,536	2,873.85	

7.2.8.4. Floral Attributes

During the vegetation survey, different sampling locations were selected in various identified habitats of the project area. Sampling locations in each habitat of the project area were selected at random (locations/intervals) in order to identify a maximum number of species. The flora survey did not include the ephemerals which are observed just after rainfall events. Both field visits were undertaken during the dry season which prevails in the project area (therefore the ESIA will need to include wet season surveys). A total of 26 plant species were recorded within the project area, mostly the prominent trees and bushes. Table 13 gives the common and scientific names of the recorded species. The flora species recorded from the project area are quite common, except for Guggar/Gugel (*Commiphora wightii*), which is a critically endangered tree species (CR) and was recorded at only one location of project area. The location of this single important medicinal plant is shown in Figure 23 (coordinates are 25, 10, 24.7 N, 67, 03, 24.4 E).

Table 14. Flora recorded in the Project Area.

S. No.	Local / Common Name	Scientific Name	Habitat type				Species range			IUCN Red List Conservation Status
			Dry Desert Vegetation	Bushland/ Grassland	Sesoanla Agriculture	Riverbed vegetation	Widely distributed (Global to regional)	Regional to National - distribution	Restricted – local endemism	
1	Ak	*Calotropis procera*	x	x	x			x		
2	Bargad	*Ficus benghalensis*			x	x		x		
3	Bhabar	*Acacia nilotica*	x	x	x			x		
4	Bhang	*Canabis sativus*			x			x		
5	Booh	*Aerva javanica (Burm.f.) Juss. ex. J.A. Shultes*	x	x	x		x			
6	Common Grass	*Cynodon dactylon*	x	x	x		x			
7	Conocarpus	*Conocarpus acuminatus*			x	x	x			
8	Devi/Mesquite	*Prosopis juliflora*	x	x	x	x	x			
9	Ghora wal	*Cassia italica (Mill.) F.W.Andr.*	x	x				x		
10	Gum Acacia	*Senegalia senegal/Acacia senegal*	x	x				X		
11	Imli	*Tamarindus indica*			x			x		
12	Guggar/Gugal/ Mukul tree	*Commiphora wightii*	x	x				X		CR
13	Jangli Ber	*Ziziphus nummularia*	x	x	x			x		
14	Jhil	*Indigofera oblongifolia Forssk.*			x			x		
15	Kana	*Saccharum spontaneum*			x	x	x			
16	Karir	*Capparis decidua*	x	x	x			x		
17	Khajoor/Dates	*Phoenix dactylifera*						x		
18	Khip	*Leptadenia pyrotechnica*	x	x	x		x			
19	Lawi/Tamarix	*Tamarix aphylla*	x	x	x			x		
20	Lumb gaah	*Aristida adscensionis Linn.*	x	x			x			
21	Lumb gaah	*Aristida funiculata Trin. & Pupr.*	x	x			x			

S. No.	Local / Common Name	Scientific Name	Habitat type				Species range			IUCN Red List Conservation Status
			Dry Desert Vegetation	Bushland/ Grassland	Sesoanla Agriculture	Riverbed vegetation	Widely distributed (Global to regional)	Regional to National - distribution	Restricted – local endemism	
22	Nara/Phragmites	*Phragmites karka*				x	x			
23	Neem	*Azadirachta indica*			x		x			LC
24	Sufaida/Eucalyptus	*Eucalypus globulus*			x		x			
25	Thohar/Euphorbia	*Euphorbia caducifolia*	x	x				x		
26	Typha/Koondar	*Typha latifolia*				x	x			

Notes:

CR: Critically Endangered

LC: Least Concern

IUCN Not listed: blank cell

No local endemism has been identified.

7.2.8.5. Faunal Attributes

The faunal attributes (birds, mammals and reptiles) recorded during the surveys are discussed in detail in this section.

Birds

During the field visits, a total of 74 avian species were recorded. The maximum number of avian species was recorded within the immediate vicinity of the canal, getting cover/protection and food from the bushes and trees. The raptors were recorded mostly in flight or perching on tall trees, pylons of transmission lines and on nearby cliffs/hills. Out of the total 74 recorded species, 26 are migratory and 48 are resident of the project area. Out of total 74 recorded birds, 10 are abundant, 48 are common, 4 are less common and the remaining 12 are rare species. Only 6 birds are on the IUCN Red list, and 8 are listed in the CMS (Convention on the Conservation of Migratory Species of Wild Animals) Appendices.

The diversity of habitats in the project area of the Karachi Water Canal area is not very high and the linear belt exhibits similar conditions throughout. The left bank is influenced by scrub vegetation as seen at lower elevations of the Kirthar range. The canal banks are lined with planted trees but scattered. The remaining bare areas are dominated by the invasive Mesquite (*Prosopis juliflora*) trees. Among the recorded species, Common myna, Bank myna, Crested lark, House crow, Little green bee-eater, House sparrow, Indian tree-pie, Red-vented Bulbul, White cheeked bulbul, Little brown dove and Common babbler are commonly and widely observed. Black and Grey Partridges were recorded relatively in low number as these game birds are famous for sport hunting and are used as cage birds. They are protected by the thorny Mesquite and tall *Typha* and *Phragmites* reeds. Raptors (birds of prey) are also in variety and widely but thinly distributed as observed during the survey. An analysis of Raptors visiting the Karachi Water Canal Project area and surrounding hills is provided in following paragraphs.

Raptors recorded in the Project Area.

Ten (10) species of Raptors have been recorded in the project (KWC) area. These include Black winged kite, Black kite (resident species), Common buzzard, Long legged buzzard, Lagger falcon, Saker falcon, Steppe eagle, Golden eagle, Imperial eagle and Common kestrel (IUCN and migratory status is given in table 14). Most of the raptors (except for Black kite and Black winged kite) were recorded as single individuals and mostly in flight mode. The raptors including endangered species of eagles listed above are sometime recorded sitting near highways, landfill sites and butcheries. Saker and Lagger falcons are comparatively shy and try to roost away from human settlements/roadside.

Since the project area is close to the Kirthar Protected Areas Complex (KPAC), they will not be affected much due to project activities. Rather, they will have better protection in the neighbouring KPAC.

The coordinates of the roosting places of observed raptors, Saker falcon, Black kite and Black winged kite, are given below (See Figure 23):

- Cliffs/Hills close to Canal; 25 06 21.2 N - 67 03 21.3 E
- On transmission line; 25 05 20.6 N - 67 02 28.0 E

A complete list of recorded avian species from both field visits of the project area are given in Table 14.

Mammals

During both field visits, a total of 20 mammalian species were recorded/reported from project area. The presence of large and small mammals was confirmed through direct sightings, local reports and observation of signs of their presence such as footprints, tracks, faeces and dens/holes. Out of these 20 recorded species, 16 are commonly found in similar areas, and 4 are rare species. Two mammalian species are important. One is the Chinkara gazelle (*Gazella bennetti*), which although not resident of the canal area, is found in the nearby hilly terrain of the Kirthar Range. The other is the Indian pangolin (*Manis crassicaudata*) an endangered species, which had been recorded in the buffer range (north/east of Head Works/Zero Point). Both these species are hunted/captured for meat (Chinkara) and scales (Indian Pangolin). Thick vegetation of Devi/Mesquite, Kana/Saccharum and Common reed/Phragmites provide refuge to Wild boar, Asiatic jackal, Foxes and other small mammals.

In a few scattered sites of the project area, loamy clay/soil found in plains and on the banks of the canal is convenient for burrow systems, these locations provide habitat for small mammals/rodents for making burrow systems/colonies.

Table 15. List of birds observed in and around project area. (listed in alphabetical order of their English name).

No.	English Name	Scientific Name	August 2020	November 2020	Status		Species range/ occurrence				Listing			Habitat type		
					Migratory	Resident	Globalto regional distribtion	National-Regional endemism	Restricted local endemism	SWPA 2020	IUCN Red List	CMS	Dry Desert Vegetation	Sesoanal Agriculture	Riverbed vegetation	Bushland / Rangelend
1.	Bank Myna	*Acridotheres ginginianus*	x	x		x	x							x		
2.	Bay-backed Shrike	*Lanius vittatus*		x		x	x								x	
3.	Black Crowned finch lark	*Eremopterix nigriceps*	x	x		x	x									x
4.	Black Drongo/King Crow	*Dicrurus macrocercus*	x	x		x	x							x		x
5.	Black Partridge	*Francolinus francolinus*	x	x		x	x								x	
6.	Black Redstart	*Phoenicurus ochruros*		x	x		x							x		
7.	Black Kite	*Milvus migrans*	x	x		x	X			x			x	x	x	x
8.	Black-winged Kite	*Elanus caeruleus*		x		x	x			x			x			x
9.	Blue Rock Pigeon	*Columba livia*	x	x		x	x							x		
10.	Blue-cheeked Bee-eater	*Merops superciliosus*		x	x			x						x	x	
11.	Brown Hill Warbler	*Prinia criniger*	x			x	x						x			x
12.	Cattle Egret	*Bubulcus ibis*	x	x		x	x			x				x		
13.	Chiffchaff	*Phylloscopus collybita*		x	x		x							x	x	x
14.	Common Babbler	*Turdoides caudatus*	x	x		x	x							x	x	x
15.	Common Buzzard	*Buteo buteo*		x	x		X			x			x			x
16.	Common/Indian Myna	*Acridotheres tristis*	x	x		x	x							x	x	
17.	Common Kestrel	*Falco tinnunculus*		x	x		x			x	LC	II	x			x

No.	English Name	Scientific Name	August 2020	November 2020	Status		Species range/ occurrence				Listing			Habitat type		
					Migratory	Resident	Globalto regional distribtion	National-Regional endemism	Restricted local endemism	SWPA 2020	IUCN Red List	CMS	Dry Desert Vegetation	Sesoanal Agriculture	Riverbed vegetation	Bushland / Rangelend
18.	Common/Blue Kingfisher	*Alcedo atthis*		x		x	x								x	
19.	Common Sandpiper	*Actitis hypoleucos*	x	x	x		x								x	
20.	Common Wood Shrike	*Tephrodornis pondicerianus*		x	x		x							x		
21.	Crested Lark	*Galerida cristata*	x	x		x	x						x			x
22.	Desert Lark	*Ammomanes deserti*		x		x	x						x			x
23.	Desert wheatear	*Oenanthe deserti*		x	x		x						x			x
24.	Golden Eagle	*Aquila chrysaetos*		x	x		x			x		II				x
25.	Great Grey Shrike	*Lanius excubitor*	x	x		x	x							x		
26.	Greater Spotted Eagle	*Aquila clanga*		x	x		x			x	VU	I/II	x			x
27.	Green Sandpiper	*Tringa ochropus*		x	x		x					II			x	
28.	Green Shank	*Tringa nebularia*		x	x		x					II			x	
29.	Grey Partridge	*Francolinus podicerianus*	x	x		x	x						x	x		
30.	Grey Wagtail	*Motacilla cinerea*		x	x		x							x		
31.	Honey Buzzard	*Pernis apivorus*		x	x		x			x	LC		x			x
32.	Hoopoe	*Upupa epops*	x	x	x		x							x		
33.	House Crow	*Corvus splendens*	x	x		x	x							x	x	
34.	House Sparrow	*Passer domesticus*	x	x		x	x						x	x	x	

No.	English Name	Scientific Name	August 2020	November 2020	Status		Species range/ occurrence				Listing			Habitat type		
					Migratory	Resident	Globalto regional distribtion	National-Regional endemism	Restricted local endemism	SWPA 2020	IUCN Red List	CMS	Dry Desert Vegetation	Sesoanal Agriculture	Riverbed vegetation	Bushland / Rangelend
35.	House Swift	*Apus affinis*		x		x	x							x	x	
36.	Imperial Eagle	*Aquila heliaca*		x	x		x			x	VU	I/II				x
37.	Indian / Common Moorhen	*Gallinula chloropus*		x		x	x								x	
38.	Indian Crow Pheasant	*Centropus sinensis*		x		x	x								x	
39.	Indian Robin	*Saxicoloides fulicata*		x		x		x						x		
40.	Indian Roller	*Coracias benghalensis*	x	x		x		x						x		
41.	Indian Tree-Pie	*Dendrocitta vagabunda*	x	x		x	x							x		
42.	Intermediate Egret	*Egretta intermedia*		x	x		x			x				x	x	
43.	Isabelline Wheatear	*Oenanthe isabellina*		x	x		x						x			
44.	Jerdon's Babbler	*Chrysomma altirostre*		x		x		x			VU		x			
45.	Jungle Babbler	*Turdoides striata*		x		x		X					x			
46.	Koel	*Eudynamys scolopacea*	x			x	x							x		
47.	Lagger Falcon	*Falco jugger*		x		x		x		x	NT	II				x
48.	Little Brown Dove	*Streptopelia senegalensis*	x	x		x	x						x	x		
49.	Little Egret	*Egretta garzetta*		x	x		x			x			x	x		
50.	Little Grebe	*Tachybaptus ruficollis*		x		x	x								x	
51.	Little Green Bee-eater	*Merops orientalis*	x	x		x	x						x	x		
52.	Long-legged Buzzard	*Buteo rufinus*		x	x		x			x	LC					x

No.	English Name	Scientific Name	August 2020	November 2020	Status		Species range/ occurrence				Listing			Habitat type		
					Migratory	Resident	Globalto regional distribtion	National-Regional endemism	Restricted local endemism	SWPA 2020	IUCN Red List	CMS	Dry Desert Vegetation	Sesoanal Agriculture	Riverbed vegetation	Bushland / Rangelend
53.	Long-tailed Grass Warbler	*Prinia burnesii*		x		x		x					x			
54.	Paddy Bird/Indian Pond Heron	*Ardeola grayii*	x	x		x	x			x					x	
55.	Pied Bushchat	*Saxicola caprata*	x	x		x		x						x		
56.	Pied/Variable Wheatear	*Oenanthe picata*		x	x		x							x		
57.	Plain Prinia	*Prinia inornata*		x		x	x							x		
58.	Persian Rock Pipit	*Anthus similis*		x		x	x						x			
59.	Purple Sunbird	*Nectarinia asiatica*	x	x		x		x			LC			x	x	
60.	Red-vented Bulbul	*Pycnonotus cafer*	x	x		x	x						x	x	x	x
61.	Red-wattled Lapwing	*Hoplopterus indicus*	x	x		x	x							x	x	
62.	Ring/Collared Dove	*Streptopelia decaocto*	x	x		x	x						x	x		x
63.	Rosy pastor	*Sturnus roseus*		x	x		x			x				x		
64.	Rufous Warbler / Scrub Robin/Long tailed Shrike	*Cercotrichas galactotes*		x		x	x				LC			x		
65.	**Saker Falcon**	***Falco cherrug***		**x**	**x**		**x**			**x**	**EN**	**II**				**x**
66.	Short-toed Eagle	*Circaetus gallicus*		x		x	x			x	LC					X
67.	**Steppe Eagle**	***Aquila nipalensis***		**x**	**x**			**x**		**x**	**EN**					**X**
68.	Striated Babbler	*Turdoides earlei*		x		x	x						X			

No.	English Name	Scientific Name	August 2020	November 2020	Status		Species range/ occurrence				Listing			Habitat type		
					Migratory	Resident	Globalto regional distribtion	National-Regional endemism	Restricted local endemism	SWPA 2020	IUCN Red List	CMS	Dry Desert Vegetation	Sesoanal Agriculture	Riverbed vegetation	Bushland / Rangelend
69.	Tawny Pipit	*Anthus campestris*		x	x		x						x			
70.	White throated Munia/Indian Silverbill	*Eodice malabarica*		x		x	x							x		
71.	White-browed Fantail Flycatcher	*Rhipidura aureola*		x		x	x							x		
72.	White-cheeked Bulbul	*Pycnonotus leucogenys*	x	x		x	x						x	x	x	
73.	White Wagtail	*Motacilla alba*		x	x		x							x	x	
74.	Yellow bellied Prinia	*Prinia flaviventris*		x		x	x								x	

Notes:

EN: Endangered
VU: Vulnerable
IUCN Not listed: blank cell
NT: Near Threatened
LC: Least Concern
No local endemism has been identified.
CMS: Convention on the Conservation of Migratory Species of Wild Animals
SWPA 2020: Sindh Wildlife Protection Act, 2020

The rodents were noticed through their burrow systems none were directly observed. These rodents, other small mammals and reptiles are the main source of food for raptors and carnivore species. The sandy plains, canal banks and agricultural fields provide a suitable habitat and forage for Black napped/desert hare which is quite common in the project area. The trees provide food and shelter to the Five striped palm squirrel which is quite common along the canal banks.

Out of total 20 recorded species of mammals, 4 enjoy protection under the Sindh Wildlife Protection Act 2020 and one (Indian Pangolin) is listed on the IUCN Red List as endangered (EN) due to the large scale exploitation owing to international demand for Chinese medicines and lust for its meat. The coordinates of the possible habitat of the Indian pangolin (*Manis crassicaudata*) within the project area are 25 10 25.5 N, 67 03 24.1 E (see Figure 24). Refer to Table 15 for a list of mammals observed in the project area.

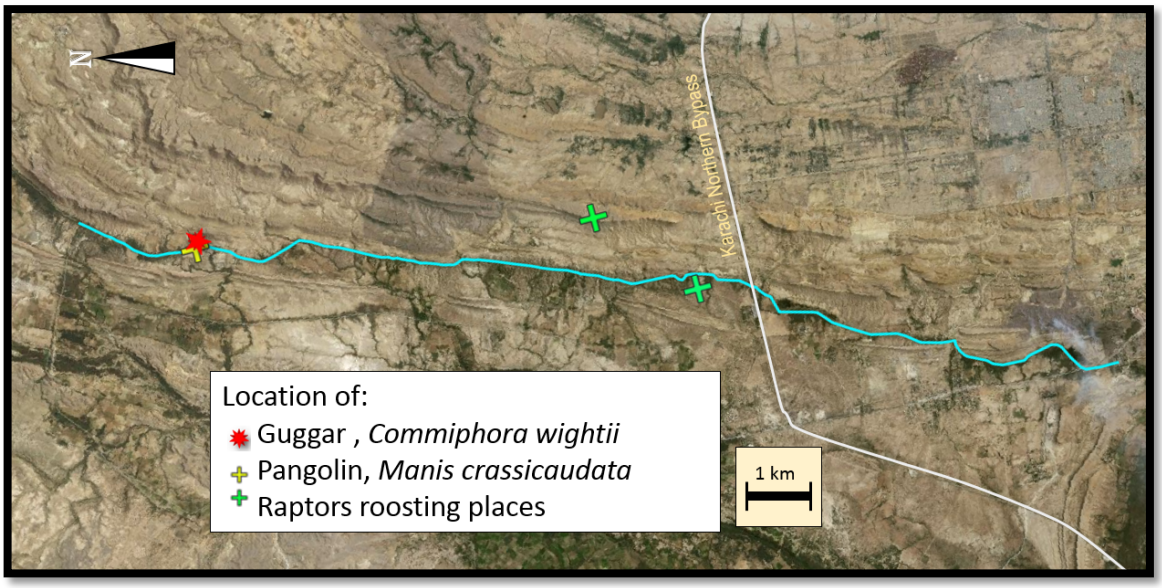


Figure 30. Location of Commiphora wightii, Manis crassicaudata and raptor roosting locations.

Reptiles

During both field visits, a total of 18 species have been recorded. The number and density of recorded species remained quite low as the surveys were conducted during August and November (2020) when most of reptiles were not very active. Some of the species were directly sighted, such as Indian monitor, House geckos and Indian fringe toed sand lizard within the project area. The presence of other species was confirmed through the observation of their signs and reports from local knowledgeable community members. A very low presence of Saw scaled viper, and Indian cobra was reported. Indian/Bengal monitor is present close to canal area and was directly sighted and photographed. Two species of House gecko (yellow bellied and spotted) are quite common in villages and the human habituated areas. Two rare species of reptiles were also recorded in the project area. One is the Fat tailed gecko, which had been widely exploited in the recent past for international trade and another is the Indian sand boa. During the summer season, the presence of more reptiles may be expected within the project

area as the reptiles become active during warmer periods. Out of a total of 20 recorded reptiles, 5 are protected under the Sindh Wildlife Protection Act 2020, and none of the reptilian species are on IUCN Red list. A complete list of the reptilian species observed/reported in the project area can be seen in Table 16.

The wetlands around the canal and the canal itself may have amphibian species. They were reported by the local staff, but none could be sighted/photographed during the surveys.

Table 16. List of mammals observed in the project area.

No	English Name	Scientific Name	August 2020	November 2020	Species range			Listing		Habitat type			
					Global to regional distribution	Rgional to National distribution	Restrictted local endemism	SWPA 2020	IUCN Red List	Dry Desert Vegetation	Sesoanla Agriculture	Riverbed vegetation	Bushland / Rangelend
1.	Asiatic Jackal	*Canis aurius*	x	x	x							x	x
2.	Balochistan Gerbil	*Gerbillus nanus*	x	x	x					x			x
3.	Chinkara	*Gazella bannettii*	x			x		x		x			
4.	Common Red Fox	*Vulpes vulpes*	x	x	x					x			x
5.	Five Stripped Palm Squirrel	*Funambulus pennanti*	x	x	x						x		
6.	House Mouse	*Mus musculus*	x	x	x						x		
7.	House Rat	*Rattus rattus*	x	x	x						x		
8.	Indian Crested Porcupine	*Hystrix indica*	x	x	x					x	x		x
9.	Indian Desert Jird	*Meriones hurrionae*		x	x					x			x
10.	Indian Gerbil	*Tatera indica*	x	x		x				x			x
11.	Indian Grey Mongoose	*Herpestes edwardsi*	x	x	x					x	x		x
12.	Indian Hare/Desert Hare	*Lepus nigricollis*	x	x	x					x			x
13.	Indian Pangolin/Scaly Ant Eater	*Manis crassicaudata*		x		x		x	EN	x			
14.	Indian Wild Boar	*Sus scrofa*	x	x	x						x	x	
15.	Jungle Cat	*Felis chaus*	x	x		x		x			x	x	

No	English Name	Scientific Name	August 2020	November 2020	Species range			Listing		Habitat type			
					Global to regional distribution	Rgional to National distribution	Restrictted local endemism	SWPA 2020	IUCN Red List	Dry Desert Vegetation	Sesoanla Agriculture	Riverbed vegetation	Bushland / Rangelend
16.	Long-eared Desert Hedgehog	*Hemiechinus auritus*	x	x	x					x			
17.	Small Indian Mongoose	*Herpestes javanicus*	x	x	x					x	x		
18.	Little Indian Field Mouse	*Mus booduga*	x	x	x						x		
19.	Ratel/Honey Badger	*Mellivora capensis*	x		x			x		x			x
20.	House Shrew	*Suncus murinus*		x	x						x		

EN: Endangered
VU: Vulnerable
IUCN Not listed: blank cell

NT: Near Threatened
LC: Least Concern
No local endemism has been identified.

CMS: Convention on the Conservation of Migratory Species of Wild Animals
SWPA 2020: Sindh Wildlife Protection Act, 2020

Table 17. List of reptiles observed/reported in the project area.

No.	English Name	Scientific Name	August 2020	November 2020	Species range/			Listing		Habitat type			
					Global to regional distribution	Regional to National-distribution	Restrictted local endemism	SWPA 2020	IUCN Red List	Dry Desert Vegetation	Sesoanla Agriculture	Riverbed vegetation	Bushland / Rangelend
1.	Black Rock Agama	*Laudakia melanurus*	x			x				x			
2.	Brilliant Agama	*Trapelus (Agama) agilis isolepis*		x	x					x			
3.	Dhaman/Rat Snake	*Ptyas mucosus*	x	x	x			x			x	x	
4.	Eastern Diadem Snake	*Spalerosophis diadema diadema*		x		x		x			x	x	
5.	Fat tailed/Leopard Gecko	*Eublepharis macularius*	x			x				x			x
6.	Garden Lizard	*Calotes versicolor*	x	x		x				x	x		
7.	Glossy-Bellied Racer	*Coluber ventromaculatus*	x	x	x					x			
8.	Indian Cobra	*Naja naja naja*	x	x		x				x	x		
9.	Indian Desert Monitor	*Varanus griseus*	x	x		x		x		x	x		
10.	Indian Fringed Toed sand Lizard	*Acanthodactylus cantoris cantoris*		x	x					x			
11.	Indian Monitor	*Varanus bengalensis*	x	x	x			x		x	x	x	
12.	Indian Sand Boa	*Eryx johni*	x	x		x				x			
13.	Indian Spiny-tailed Lizard	*Uromastyx hardwicki*	x	x	x					x			
14.	Krait	*Bungarus caeruleus*	x	x		x					x		
15.	Saw scaled Viper	*Echis carinatus*	x	x	x					x			x

No.	English Name	Scientific Name	August 2020	November 2020	Species range/			Listing		Habitat type			
					Global to regional distribution	Regional to National-distribution	Restricted local endemism	SWPA 2020	IUCN Red List	Dry Desert Vegetation	Sesoanla Agriculture	Riverbed vegetation	Bushland / Rangelend
16.	Spotted House Gecko	*Hemidactylus brookii brookii*	x	x	x						x		
17.	Yellow-bellied House Gecko	*Hemidactylus flaviviridis*	x	x	x						x		
18.	Pakistan Ribbon Snake	*Psammophis leithii*	x	x		x		x		x			

EN: Endangered
VU: Vulnerable
IUCN Not listed: blank cell

NT: Near Threatened
LC: Least Concern
No local endemism has been identified.

CMS: Convention on the Conservation of Migratory Species of Wild Animals
SWPA 2020: Sindh Wildlife Protection Act, 2020

Other Biodiversity

In addition to above mentioned vertebrate species, invertebrates are quite common, but their complete record requires extensive surveys. Among the prominent species, butterflies, moths, grasshoppers/locust, honeybee, spiders, dragonflies, house flies, mosquitoes, scorpions, ants and beetles are widely distributed, and they are important components of the food chain and part of the ecosystem. But none of these species are endangered or at risk due to project activities.A photographic record of the surveys is provided below in Figure below.

Figure 31. Photographic record of surveys (August and November 2020)

Habitats/Plants in KWCP

Euphorbia plant in hilly terrain

Good view of Karachi Canal with tree line

A perennial wetland near Northern By-pass

Guggar/Gugal, critically endangered (CR) plant

Saccharum on flowering

Agricultural practice

Birds of KWCP

Steppe eagle a winter visitor in flight

Common Buzzard

Little green bee eaters

Common sandpiper

Indian pond heron

Pair of Red Wattled Lapwing

Small India mongoose

Footprint of Indian porcupine

Rodent hole with Fox pug marks

A pair of Five striped palm squirrel

Urine and faeces of Desert hare

Rodent hole near Canal bank

Reptiles and other biodiversity of KWCP

Juvenile Indian monitor lizard

Fringe toed sand lizard

Locust recorded between Kirthar range and Karachi Canal

Red wattled lapwing looking at its destroyed habitat

Possibility of some amphibians

Possible habitat of Indian pangolin in buffer zone

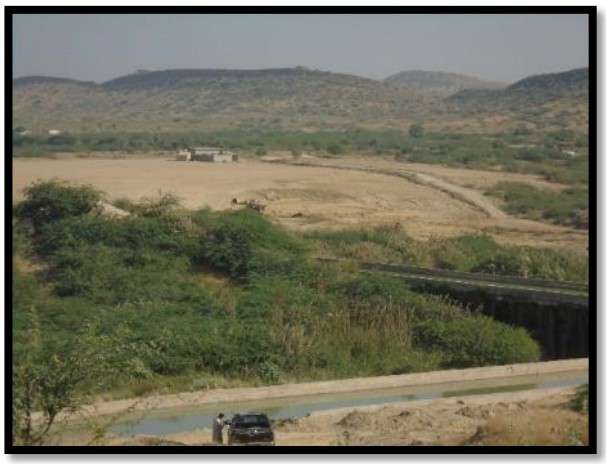
Problems/Issues of KWCP

Shifting of stones and soil

Raising livestock

Use of heavy machinery to change land use

Solid waster dumping in landfill site



New field under preparation

New settlements, Hamlets near landfill

Data collection in KWCP

Discussion about possible site of small dam in Hub Dam Wildlife Sanctuary

Field observation. Heavy machinery in operation on other side

Observation under the Aqueduct

Farmer sharing his experience about wildlife

Professional photographer taking pictures of the Hub Reservoir

Bird photography in progress

7.2.9. Threats to Biodiversity

There are a number of ongoing activities which are posing a substantial threat for the survival of sensitive species of fauna and flora. These existing and future threats are summarised below:

- **Change in land use:** The change in land use is the most significant threat to the existence of the present habitats. New access roads, the levelling of land, filling of wetlands, cutting of trees and vegetation may cause a threat for the survival of biodiversity in the area.
- **Agriculture extension:** The relatively flat plain areas which can be irrigated by rain or tube wells is being exploited for new farmlands.
- **Invasive plants:** Can modify the flora community and compete for water resources, grow, and quickly cover disturbed soil and areas, especially mesquite/Devi (*Prosopis juliflora*) and *Acacia nilotica.*
- **Urbanization:** At a number of places, large chunks of land are being walled for possible small industry or farmhouses. The newly constructed structures may create hurdles or obstacles for naturally flowing rainwater that would flow towards low lying wetlands and the existing course of the Hub River.
- **Landfill site:** The dumping of solid waste from Karachi city at the Jam Chakro landfill site is a significant threat for the survival of biodiversity. The toxic waste and gases from the landfill may cause an unfavourable environment for the human population and wildlife. Moreover, land being covered with the solid waste will become non-productive and will spoil the soil biodiversity.

7.2.10. Natural, Modified and Critical Habitat

7.2.10.1. Modified habitat

According to IFC Performance Standard 6, the definition of modified habitat is:

"Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands."

The following habitats can be classified clearly as modified habitat according to PS6:

- Seasonal agricultural fields
- Settlements and other built environments

The following habitat could also be classified as Modified habitat since its current extension and conditions are subject to human activity and largely dependent on man-made infrastructure such as the water canal and seepage water.

- Riverbed vegetation including areas influenced by seepage.

- Bushland/Rangeland disturbed by pastoral, livestock and other human activities.

It is probable, as is shown in the satellite images prior to 1986, that these two habitats were found in the area but with a lesser extension and without the presence of exotic plants such as mesquite/Devi (*Prosopis juliflora*), *Acacia nilotica*, and to some extent in this area *Azadirachta indica* and *Ficus benghalensis*. Current flora communities are dependent on seepage water and human interventions (e.g., crops/plantations), thus associated wildlife communities show a wider range of widely distributed common species than the original ones (*Corvus splendens, Passer domesticus, Milvus migrans, Acridotheres tristis*).

7.2.10.2. Natural habitat

"Dry / desert with scarce vegetation including hills/cliffs" occurring in the project area can be considered a Natural Habitat.

"Riverbed vegetation" and "Bushland/Rangeland" could be classified as Natural habitat at some places under natural regional climatic conditions, less human intervention and no seepage from canals.

7.2.10.3. Critical Habitat

Habitat level

According to IFC Performance Standard 6, the definition of critical habitat is:

"Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities."

Critical habitats are areas with high biodiversity value, (GN52, Guidance Note 6, PS6) including:

1. habitat of significant importance to Critically Endangered and/or Endangered species.
2. habitat of significant importance to endemic and/or restricted range species.
3. habitat supporting globally significant concentrations of migratory species and/or congregatory species.

Habitats identified in the Project area don't meet Criterion 4 "Highly threatened and/or unique ecosystems" and Criterion 5: "Key evolutionary processes".

Species Level

At the species level, critical habitats criterion for habitat qualification as critical are:

1. Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species
2. Criterion 2: Endemic or restricted-range species
3. Criterion 3: Migratory or congregatory species

An assessment has been done for the following Critically Endangered (CR) and/or Endangered (EN) species observed directly or for which tracks, footprints and other evidence were recorded during field visits: *Commiphora wightii, Aquila nipalensis, Falco cherrug and Manis crassicaudata* (*Vanellus gregarious, Rynchops albicollis and Haliaeetus leucoryphus* are within IBA list, but were not recorded, we have assumed that these species are extremely rare in the area of influence). Data for each identified species and further discussion is presented hereinafter.

Species and habitats discussion

Following table summarizes EN and CR species according to IBAT query and IBA data and species observed in the AOI. 1 flora species, 12 birds and two mammals are listed. Based on UICN red list species data file.

Table 18. EN and CR species according to IBAT query and IBA data and species observed in the AOI.

No.	English Name	Scientific Name	IBAT query	IBA list	Observed on the field	UICN status
Flora species						
1	Guggar/Gugal/ Mukul tree	*Commiphora wightii*			*1*	CR
Fauna species						
Aves						
1	Black-billed Tern	*Sterna acuticauda*		*1*		EN
2	Greater Adjutant	*Leptopilus dubius*		*1*		EN
3	White-headed Duck	*Oxyura leucocephala*		*1*		EN
4	Indian Skimmer	*Rynchops albicollis*	*1*	*1*		EN
5	Sociable Lapwing	*Vanellus gregarius*	*1*	*1*		CR
6	Lesser Florican	*Sypheotides indicus*		*1*		EN
7	White-rumped vulture	*Gyps bengalensis*		*1*		CR
8	Red-headed vulture	*Sarcogyps calvus*		*1*		CR
9	Egyptian vulture	*Neophron percnopterus*		*1*		EN
10	Steppe Eagle	*Aquila nipalensis*		*1*	*1*	EN
11	Pallas's Fish-eagle	*Haliaeetus leucoryphus*	*1*	*1*		EN
12	Saker Falcon	*Falco cherrug*		*1*	*1*	EN
o						
1	Indian Pangolin	*Manis crassicaudata*		*1*	*1*	EN
2	Hog Deer	*Axis porcinus*		*1*		EN

The Greater Adjutant (*Leptopilus dubius*) is currently extinct in Pakistan and the Pallas's Fish-eagle (*Haliaeetus leucoryphus*) is currently extinct in centre and south Pakistan (UICN red list).

Black-billed Tern, White-headed Duck and the Indian Skimmer (*Sterna acuticauda, Oxyura leucocephala and Rynchops albicollis*), are close related to water bodies, lakes, lagoons, large rivers (sandspits and islands) occasionally small ponds (in the vicinity of larger ones). These species need therefore the occurrence of water bodies, this type of habitat is only present within the AoI as small wetlands or ponds isolated from other

water bodies that poorly can give nesting or foraging places for the said species and could not be considered (based on the information collected) as potential areas of critical habitat, even more the small wetlands within the EOI does not represent important areas for these species within a local set of grouped small wetlands.

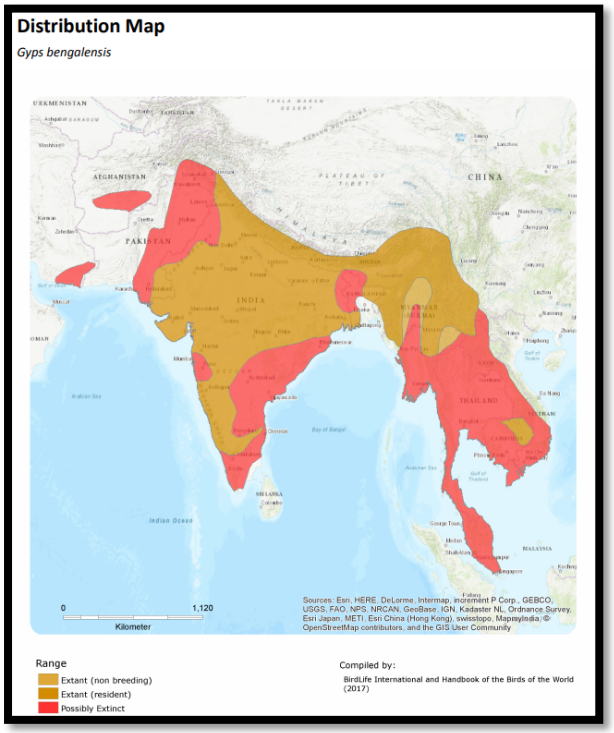
Regarding vultures, the White-rumped vulture, Red-headed vulture and Egyptian vulture (*Gyps bengalensis, Sarcogyps calvus* and *Neophron percnopterus*) are wide ranged species and foraged over a large area, could be found near human settlements and modified habitats even when nesting or congregatory places are located hundreds km away.

To determine the presence of critical habitat for vultures, the Steppe eagle and the Saker Falcon, wide-ranging species, an ecologically appropriate area of analysis has been define taking into account the distribution of each species within and extending beyond the project's area of influence. Applicably, some critical habitat may be informed by areas of aggregation, recruitment, or other specific habitat features of importance to the species.

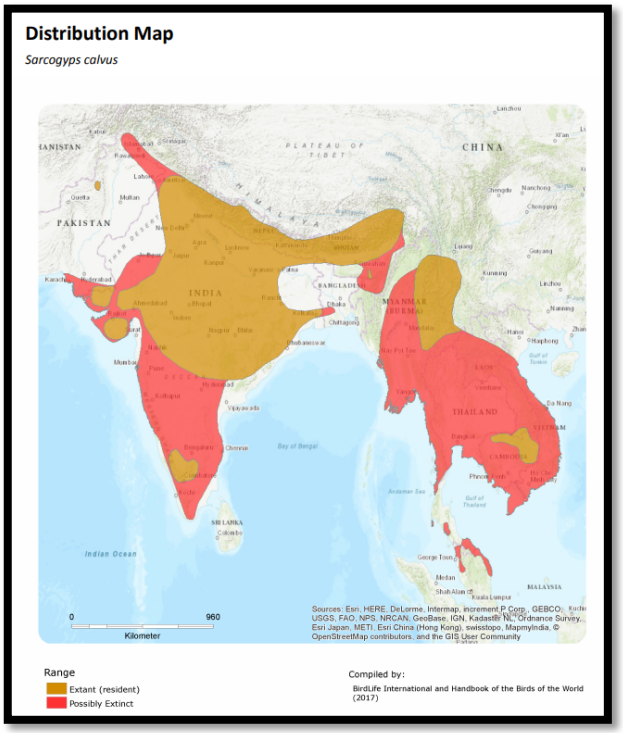
Areas of nesting and foraging for the vulture, eagle and falcon species considered, are linked to hilly and rocky cliffs or tall trees for nesting, and arid to semiarid and steppe ecosystems for foraging. These landscape and geomorphological features extends widely over the Sindh and Balochistan provinces, south and West south Pakistan, including the large Kirthar Protected Area Complex; (around 446.424 hectares). These landscape and geomorphological features could be found within and around the AoI, but no areas within the AoI can be considered to be important or determinant areas for aggregation and recruitment for the vultures and raptors species.

For the Hog Deer (*Axis porcinus*), EAAA could be defined as the riverbed ecosystems along the Indo river. Based on recent research Hog Deer in Pakistan can be found along the Indo river and its catchment (Distribution and status of Hog deer (*Axis porcinus*) in Indus eco-region Pakistan, W. Ahmad, 2015) its habitat is strong related to riparian and riverbed vegetation. Presence of the Hog deer in Hub river is at present not known (Project area of influence lies within Hub river catchment).

The distribution maps of the species discussed above are provided below.

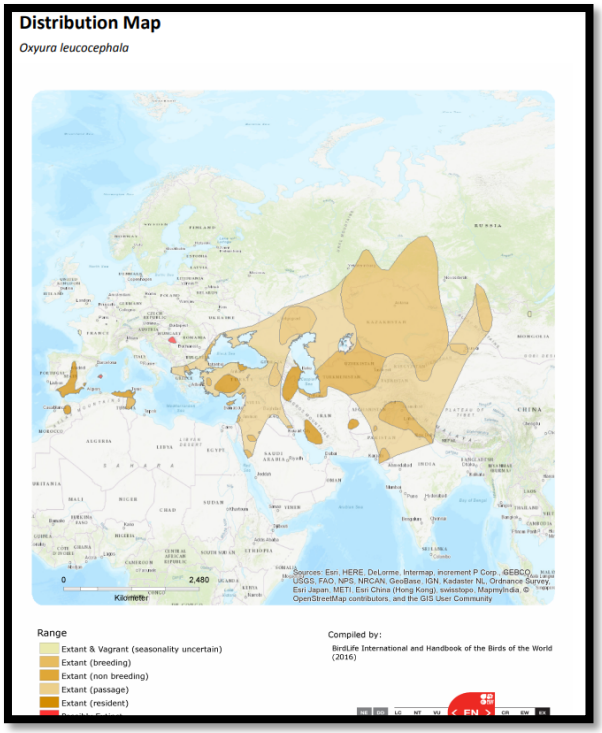


Gyps Bengalensis

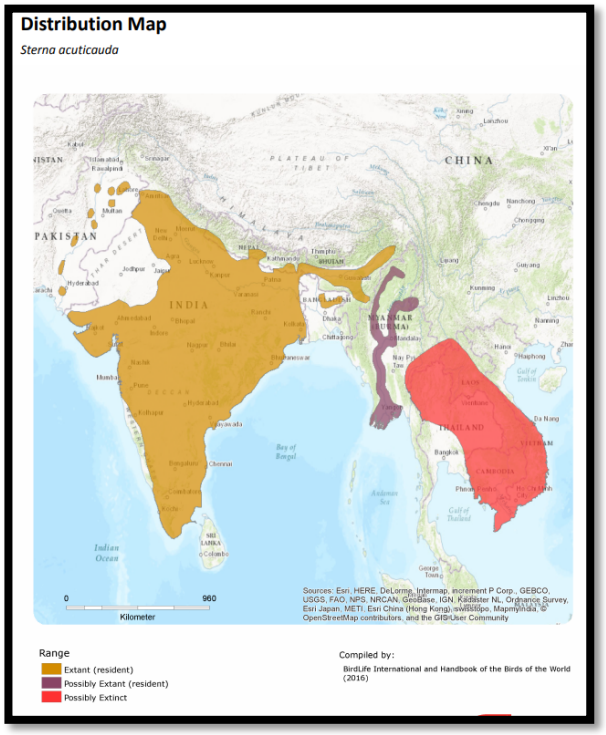


Sarcogyps calvus

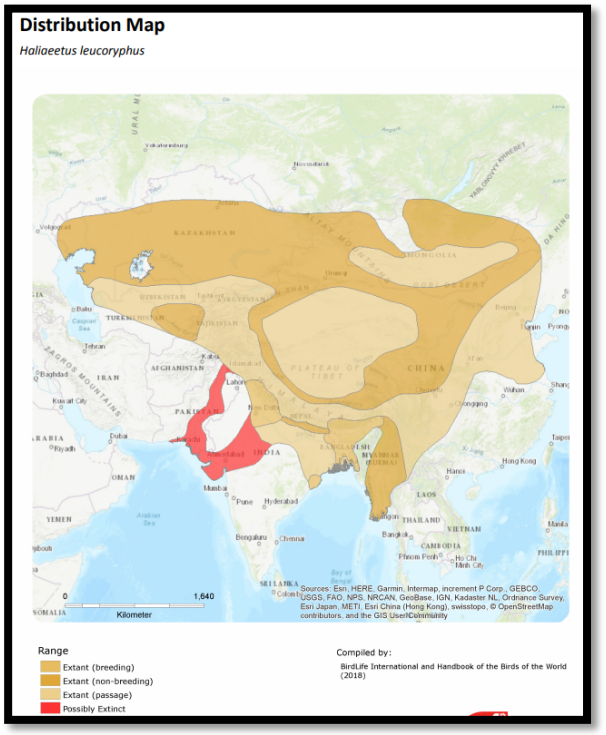
Axis porcinus



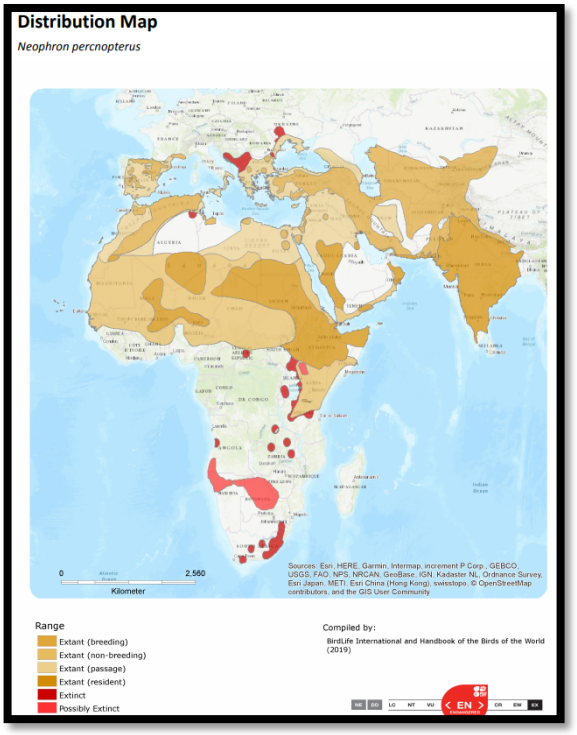
Oxyura leucocephala



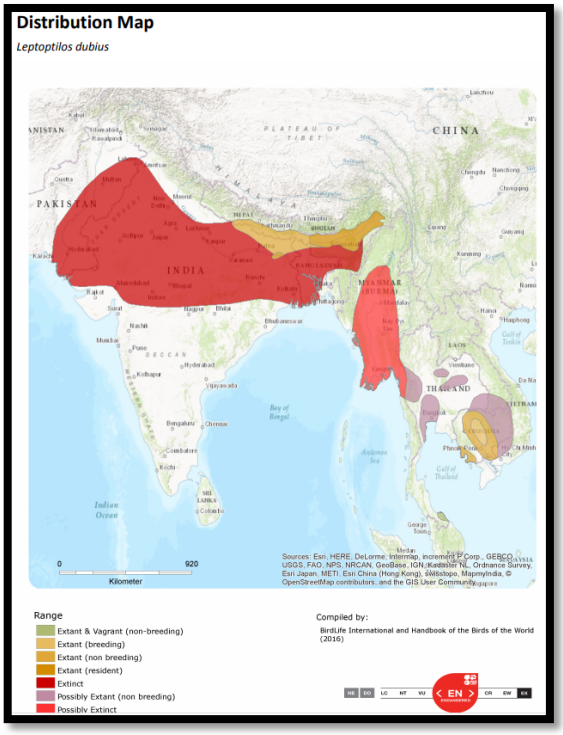
Sterna acuticauda



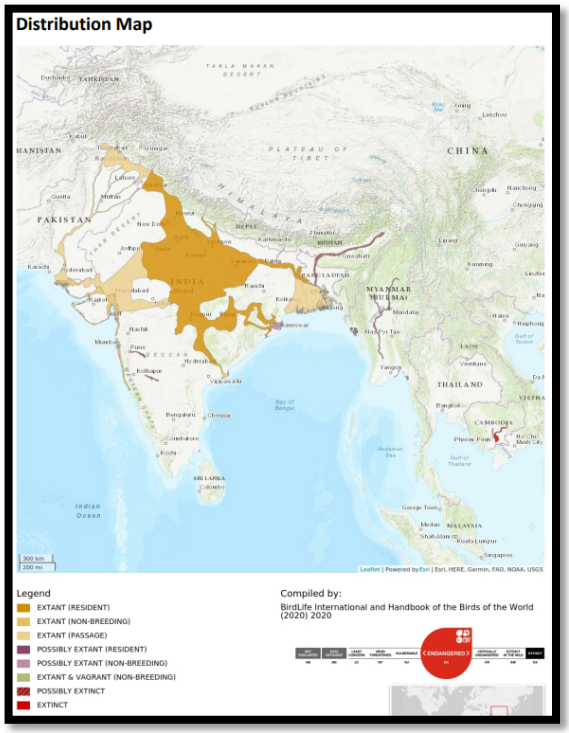
Haliaeetus leucoryphus



Neophron percnopterus



Leptoptilus dubius



Rynchops albicollis

The following species require a wider discussion since their possibility of occurrence within the AOI and nearest landscapes and ecosystems might be relevant, adding the Steppe Eagle and Saker Falcon since they were directly observed on the field:

- *Commiphora wightii*
- *Vanellus gregarius*
- *Sypheotides indicus*
- *Aquila nipalensis*
- *Falco cherrug*
- *Manis crassicaudata*

Relevant information, summarized from IUCN, is presented below for Critically endangered and Endangered species identified in the Project area. Bibliography cited and references has not been included for easier presentation of data.

- *Commiphora wightii* (CR)

  Geographic Range

  The global distribution of *Commiphora wightii* is restricted to dry regions of western India and adjoining regions of Pakistan.

  Distribution map

  Not available

  Habitat

It grows well in arid and semi-arid climates and is tolerant to poor soil. It prefers sandy, loamy, clayey and gravelly soil types and grows well in open canopy cover. The highest density (41.2 per ha) of the species has been recorded from loamy soil. The habitat of the species receives low rainfall, which varies between 327 mm- 434 mm and the temperature ranges from 4.6° C in winter to 45 ° C in summer. The species has been recorded in undulating terrain, flat and hilly areas and dry riverbeds. This species is found to be associated with *Acacia nilotica, Acacia senegal, Zizyphus nummu-laria, Euphoriba nivullia, Prosopis juliflora, Capparis decidua, Grewia tenax* and *Cassia auriculata*. It has a generation length of 28 years.

Threats

The gum has high importance in international trade, and it has been extracted at unsustainable rates with faulty extraction methods causing declines in population. Unsustainable collection of multiple parts, high volume trade and loss of habitat are the major threats to this species.

Additional Data Fields

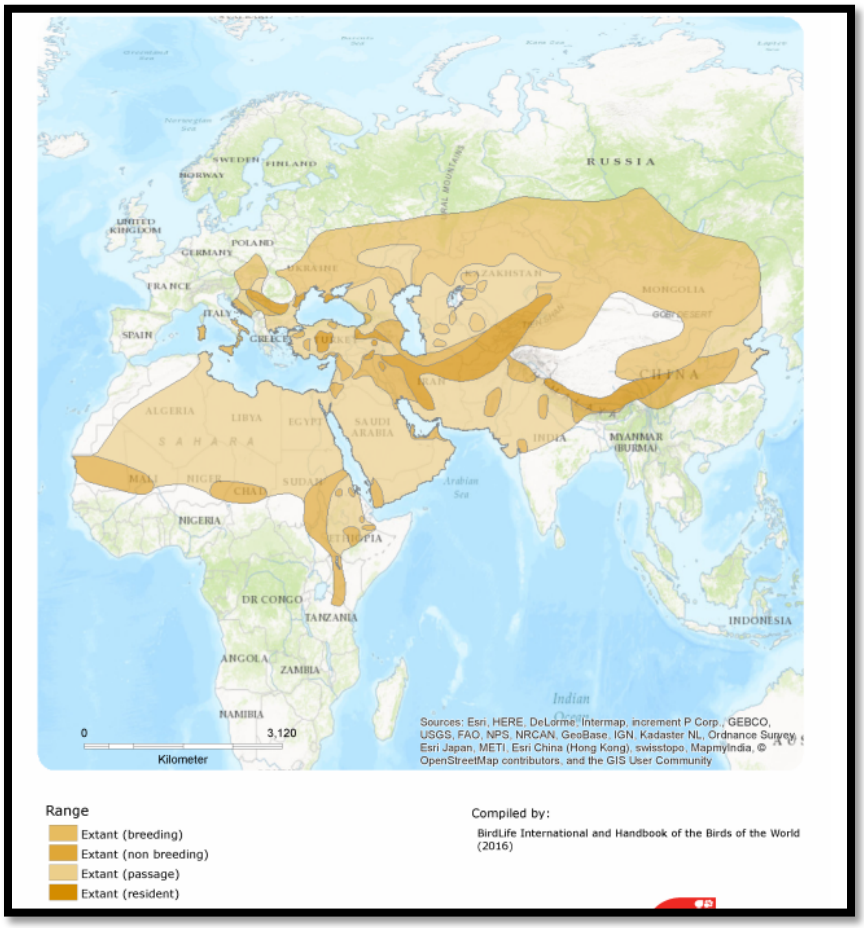
Estimated extent of occurrence (EOO) (km²): 20,000-22,000-21,000

- *Falco cherrug* (EN)

Geographic range:

This species occurs in a wide range across the Palearctic region from eastern Europe to western China, breeding in Armenia, Austria, Bulgaria, Croatia, Czech Republic, Georgia, Hungary, Macedonia, Moldova, Romania, Russia, Serbia, Slovakia, Turkey, Ukraine, Iran (Islamic Republic of), Iraq, Armenia, Uzbekistan, Tajikistan, Kyrgyzstan, Kazakhstan, Mongolia and China, and at least formerly in Turkmenistan and probably Afghanistan, possibly India (Ladakh), with wintering or passage populations regularly in Italy, Malta, Cyprus, Israel, Jordan, Egypt, Libya, Sudan, South Sudan, Tunisia, Ethiopia, Kenya, Saudi Arabia, Yemen, Oman, U.A.E., Bahrain, Kuwait, Iran, Pakistan, India, Nepal, Afghanistan and Azerbaijan, with much smaller numbers or vagrants reaching many other countries.

Distribution map



Population

The global population is estimated to number c.12,200-29,800 mature individuals, based on national population estimates of breeding pairs, that total c.6,100-14,900 pairs (median c.10,500).

Habitat

It is physically adapted to hunting close to the ground in open terrain, combining rapid acceleration with high manoeuvrability, thus specialising on mid-sized diurnal terrestrial rodents (especially ground squirrels *Spermophilus*) of open grassy landscapes such as desert edge, semi-desert, steppes, agricultural and arid montane areas.

Threats

In Europe, this species has suffered mainly from electrocution on power lines and decreased prey availability due to the loss and degradation of steppes and dry grasslands through agricultural intensification, plantation establishment and declines in sheep pastoralism, while offtake for falconry has also been a serious problem, which has caused local extinctions in the past.

Additional Data Fields

Estimated extent of occurrence (EOO) (km²): 21,100,000

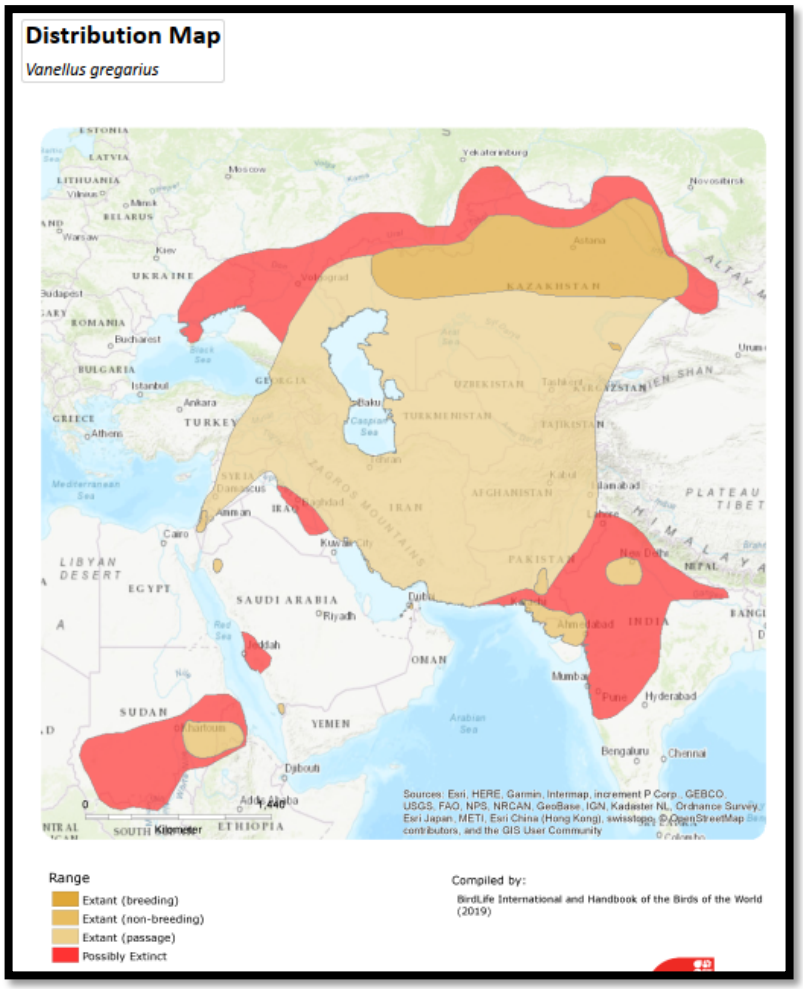
Number of mature individuals: 12,200-29,800

- *Vanellus gregarious* (CR)

Geographic Range:

The species breeds in northern and central Kazakhstan and south-central Russia, dispersing through Kyrgyzstan, Tajikistan, Uzbekistan, Turkmenistan, Afghanistan, Armenia, Georgia, Azerbaijan, Iran, Iraq, Saudi Arabia, Syria, Turkey and Egypt, to key wintering sites in Sudan, Pakistan (a flock of 28 birds was recorded near Ahmedabad village in Jaffarabad district in 2015) and north-west India. Small numbers of birds winter regularly in Saudi Arabia, Oman and UAE.

Distribution map



Population

Surveys in 2006 in Kazakhstan estimated 376 breeding pairs in an area of 145,000 km2. Extrapolating this population density across the breeding range yields a possible total population size of 5,600 breeding pairs, i.e. 11,200 mature individuals, roughly equivalent to 16,000-17,000 individuals in total.

Habitat

It breeds mainly in the transition zones between Stipa and Artemisia grassland steppes where bare saline areas occur near water-bodies. It uses dry wasteland, cultivated, ploughed and stubble fields. Nests are preferentially placed in areas of Artemisia where there is a high dung abundance and vegetation is short.

Threats

Illegal hunting during migration and on the wintering grounds may now be the primary threat. On the breeding grounds, it was probably formerly threatened by the conversion of steppe to arable cultivation, plus, perhaps less likely, the reduction in grazing by large herds of native ungulate.

Additional Data Fields Distribution

Estimated extent of occurrence (EOO) (km²): 1620000

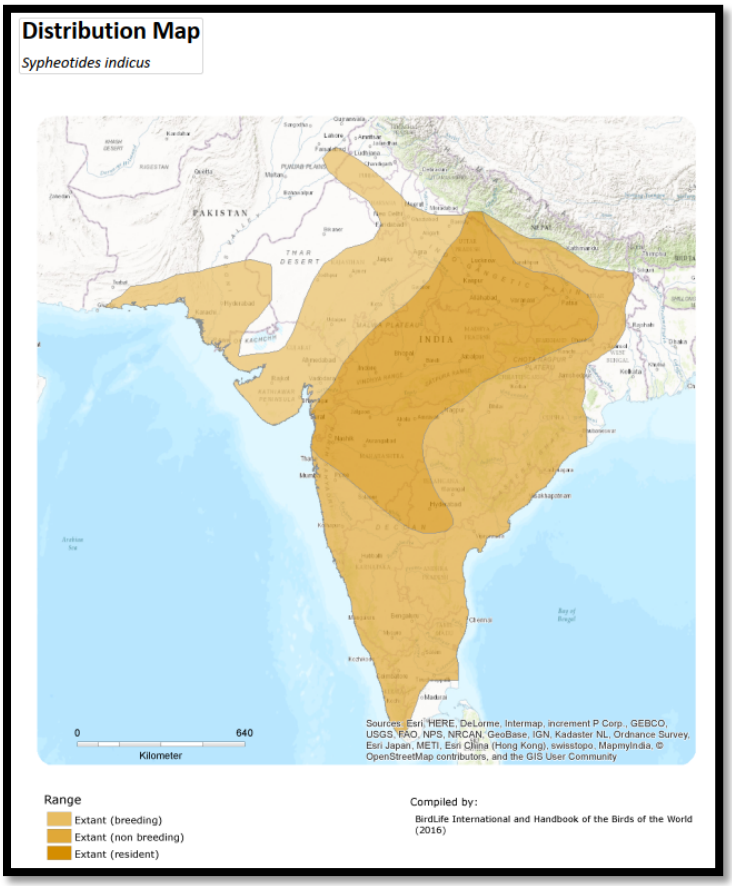
Number of mature individuals: 11200

- *Sypheotides indicus* (EN)

Geographic Range:

Breeds in India in Gujarat, Rajasthan, Maharashtra (25-30 breeding pairs in Akola District [P. Patil in litt. 2012]), Madhya Pradesh and Andhra Pradesh (Raha and Prakash 2001, Kasambe and Gahale 2010, Bharadwaj et al. 2011, Anon. 2014, P. Patil in litt. 2016), with some dispersal to south-east India in the non-breeding season.

Distribution map



Population

The species' population was estimated at c.2,200 birds in the mid-1990s, and based on this the number of mature individuals is put at c.1,500.

Habitat

It occurs in productive dry grasslands, in lowland areas (below 250 m), particularly dominated by *Sehima nervosum* and *Chrysopogon fulvus*, with scattered bushes and scrub.

Threats

Severe hunting pressure, particularly of males for sport and also food, precipitated its decline. More recently, declines have been caused by rapid reductions in the area of grassland owing to conversion to agriculture.

Additional Data Fields Distribution

Estimated extent of occurrence (EOO) (km²): 2160000

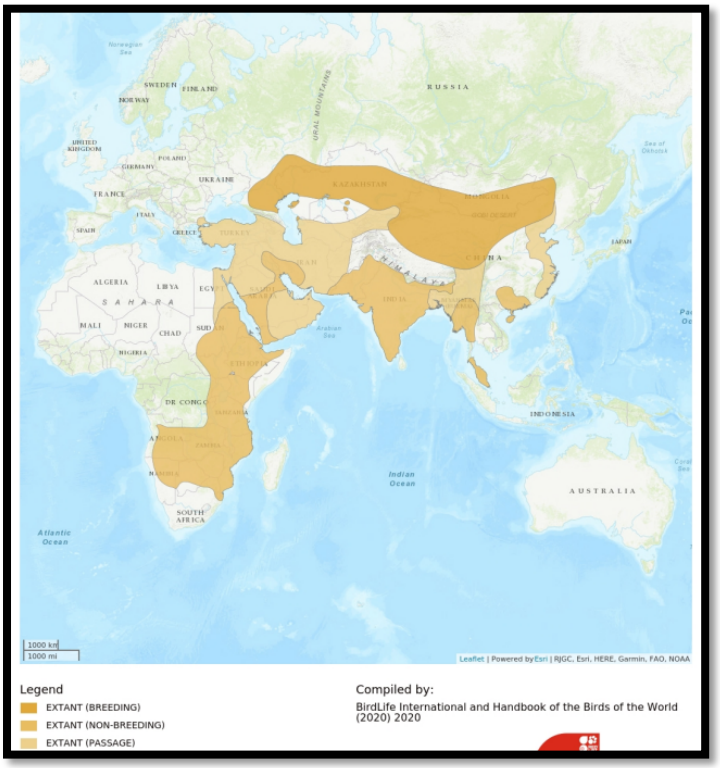
Number of mature individuals: 1500

- *Aquila nipalensis* (EN)

Geographic Range:

This species breeds east of 43°E in European Russia from the Republic of Kalmykia, across Kazakhstan into Kyrgyzstan, China and Mongolia. It formerly bred in Moldova, Romania and Ukraine. An isolated breeding population exists in Turkey. Birds from European Russia, eastern Kazakhstan and Turkey (*A. n. orientalis*) winter in the Middle East, Arabia and east and southern Africa. Birds from Turkey also winter in the Eastern part of the Sahel. Birds from Altai, Siberia eastwards (*A. n. nipalensis*) winter mainly in south and south-east Asia.

Distribution map



Population

Combined totals from across the whole range estimate the number of pairs at 31,372 (26,014-36,731), which equates to 62,744 (52,028-73,462) mature individuals or 94,116 (78,042-110,193) individuals. The global population is hence below 37,000 pairs.

Trend Justification The population is declining owing to habitat destruction (especially conversion of steppe into agricultural land), persecution, and collisions with power lines.

Habitat

It inhabits areas of steppe and semi-desert and is recorded breeding up to 2,300 m in mountainous regions. It feeds mainly on small mammals on its breeding grounds.

Threats

conversion of steppes to agricultural land combined with direct persecution. It is also adversely affected by power lines and is very highly vulnerable to the impacts of potential wind energy developments.

Additional Data Fields Distribution

Estimated extent of occurrence (EOO) (km²): 12,600,000

Population Number of mature individuals: 50,000-75,000

- *Manis crassicaudata* (EN)

Geographic Range

This species is distributed in South Asia from northern and south-eastern Pakistan through much of India south of the Himalayas (excluding far north-eastern portions of the country), southern Nepal, and Sri Lanka. The species is likely to occur in northern and western Bangladesh. Some reference works refer to the occurrence of the species in Yunnan Province, southwestern China.

This species is very locally distributed in Pakistan but has been recorded in all four provinces. In the north it has been recorded in Sialkot, Jhelum and Gujrat Districts in Punjab, extending across the Salt Range into Kohat District, and from Attock District (formerly known as Campbellpur) up to Mardan and Peshawar in the North West Frontier Province (Roberts 1977). There are also records from before 2009 in Nowshera and Swabi (F. Abbas, unpubl. data). It has also been found in the Potohar Plateau Range upwards into the Himalayan foothills (up to 750 m asl). This species is also present in the districts of Kotli, Mirpur and Bhimber in Azad Jammu and Kashmir (R. Hussain, unpubl. data). There are records of the species within the last five years from the Indus River floodplain, including the districts of Bhakar and Jhang (F. Abbas, unpubl. data). Further south there are records from the hilly regions in the western part of the Dadu and Larkana deserts (Sindh), extending southward through Las Bela and Mekran. It also occurs east of the Indus in Hyderabad district and Tharparkar, extending eastwards to Kutch (Roberts 1977).

Population

There is very limited information or data on population of this species at any level, and generally there is a lack of research on abundance. Historical accounts suggest the species is uncommon, rarely observed and occurs at low densities. In the Potohar Plateau, Pakistan, Irshad et al. (2015) estimated population density based on counts of active burrows between 2010 and 2013. Across the four districts studied estimated density declined by ~79% between 2010 and 2012 (Irshad et al. 2015), which has been attributed to illegal capture and killing for international trade in pangolin scales (Mahmood et al. 2012). Similarly, in 2012 estimated densities comprised 0.37 ± 0.12 individuals/km² in Chakwal, 0.12 ± 0.08 individuals/km² in Jhelum, 0.10 ± 0.00 individuals/km² in Rawalpindi, and 0.33 ± 0.24 individuals/km² in Attock (Irshad et al. 2015). Using the same method, Mahmood et al. (2015a) estimated an average density 0.36 individuals/km² in Margalla Hills National Park, and 0.00044 individuals/km² in Maneshra district of Khyber Pakhtunkhwa Province, Pakistan (Mahmood et al. 2018). However, it should be noted that there are limitations to the methods used here; it can be inferred from other species of pangolin that this species likely uses multiple burrows in a very short period and as such these estimated should be treated with caution (see Willcox et al. 2019 for discussion on methods).

Habitat

Generally, little is known about the natural history of this species, but it is understood to occur in various types of tropical forests as well as open land, grasslands, arid areas and degraded habitat, including in close proximity to villages. The species is thought to adapt well to modified habitats, provided its ant and termite prey remains abundant and provided it is not subject to hunting pressure.

Threats

The Indian Pangolin is primarily threatened by overexploitation including hunting and poaching for both its meat and scales which are used and consumed at a local, subsistence level, but increasingly for illegal international trade.

Discussion on Critical Habitat

Commiphora wightii, Aquila nipalensis and Falco cherrug share similar habitats: arid and semi-arid, deserts, dry steppe, open grassland. This kind of habitats are well represented in the KWC area of influence, named in this document as Dry / desert with scarce vegetation including hills/cliff. Some areas with scarce vegetation of Bushland/Rangelands (not influenced by seepage from the canal) also can be within the wide habitat type of the said species.

Dry / desert with scarce vegetation including plains, hills/cliffs and stony foothills, are well represented habitats in the Kirthar complex, including the Hub Dam wildlife Sanctuary and well distributed in the Sindh District as well.

The estimated extent of occurrence (EOO) (in km²) for these three species are: *Commiphora wightii;* 20,000-22,000, 21,000, *Vanellus gregarious*; 1,620,000, *Sypheotides indicus*; 2.160,000, *Aquila nipalensis*; 21,100,000 and up to 12,600,000 for *Falco cherrug*.

The Project area of influence estimated as a 1 km buffer from the Canal is of about 28,50 km^2 while the area for Dry / desert with scarce vegetation including hills/cliffs is of 15,88 km^2 within the aforementioned 28,5 km^2. Bushland and Rangeland not influenced by seepages has not yet been estimated but a 9 km^2 area can be assumed as a conservative estimation of 50% of total habitat area. The total of 15,88 plus 9 km^2; 24,88 km^2 is approximately 0,12 % of the estimated extent of occurrence for *Commiphora wightii*. Even though this area of likely occurrence of impact is extremely low, such an impact on this species should be taken into account and some mitigation measures should be included within the next steps of Project implementation to avoid any kind of damage to Commiphora plants within the Project's area of influence.

Regarding the Sociable Lapwing, Lesser Florican, Steppe eagle and the Saker falcon, the Project's impact on its habitats cannot be considered as critical or even severe, discussion for the raptors has been made previously and should be similar for the Florican and the Lapwing due to their wide range of distribution. Notwithstanding that, measures should be taken to avoid impacts on these protected species (and other raptors in the area although not protected).

Regarding the Indian pangolin, this species has a wide distribution area: the Indian subcontinent and some adjacent areas. The species is found in a wide range of different habitats, from arid deserts to tropical forests. *Manis crassicaudata* could be found in any of the habitats identified in the Project area. Even if the population occurs in low density, IUCN alert that "it is suspected that populations may decline by 50% in the future over a time frame of three generations (i.e., 2019–2043) due to overexploitation (A3d) and it is inferred that populations will experience an ongoing decline exceeding 50% in the time frame of three generations (looking back one generation and forwards two generations, i.e., 2011–2035) because of overexploitation". Current conditions and threats of Indian pangolin deserves specific mitigation measures during Project

construction and operation not only for habitat conservation but particularly for individuals living/moving around and across the Project site. Such mitigation measures should be developed during the ESIA stage of the project.

Conclusion on Critical habitat

- Criterion 1: Critically Endangered and Endangered Species
    - The area of influence does not support globally important concentrations of an IUCN Red-listed EN, CR or even VU species (the loss of which would result in the change of the IUCN Red List status species) and the area does not contain important concentrations of a nationally or regionally listed EN or CR species.
- Criterion 2: Endemic and Restricted-range Species
    - The area does not hold relevant global population and or reproductive units of a species, except for *Commiphora wightii*
    - The extent of occurrence (EOO) of the Gugal; *Commiphora wightii*, 20,000 to 22,000 km^2 falls under the definition of restricted-range species, defined as those species that have an EOO of less than 50,000 km^2.
- Criterion 3: Migratory and Congregatory Species
    - The area does not sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle or predictably support ≥10 percent of the global population of a species during periods of environmental stress.

Based on the above, critical habitat is found for *Commiphora wightii*.

The following Table summarises the assessment of whether the identified habitats trigger criteria 1 to 3 or not. An assessment has been carried out for Critically Endangered (CR) and Endangered (EN) species observed directly or for which tracks, footprints and other evidence were recorded during field visits.

Table 19. Critical Habitat Area Summary Table of Species

Critical Habitat Area summary table for species											
No.	English Name	Scientific Name	IBAT Query	IBA List	Observed in the field	IUCN red list data IUCN Status	EOO (km²)	Potential natural and modified habitat within the AOI for the ranked species.	CH Criterion 1 (Y/N)	CH Criterion 2 (Y/N)	CH Criterion 3 (Y/N)
Flora species											
1	Guggar/Gugal	*Commiphora wightii*			*1*	CR	20.000-22.000	1,2	N	Y	N
Fauna species											
Aves											
1	Black-billed Tern	*Sterna acuticauda*		*1*		EN	4.490.000	3	N	N	N
2	Greater Adjutant	*Leptopilus dubius*		*1*		EN	1.200.000	1,2,3,4	N	N	N
3	White-headed Duck	*Oxyura leucocephala*		*1*		EN	14.100.000	3	N	N	N
4	Indian Skimmer	*Rynchops albicollis*	*1*	*1*		EN	1.400.000	3	N	N	N
5	Sociable Lapwing	*Vanellus gregarius*	*1*	*1*		CR	1.620.000	2,3,4	N	N	N
6	Lesser Florican	*Sypheotides indicus*		*1*		EN	2.160.000	1,2,3	N	N	N
7	White-rumped vulture	*Gyps bengalensis*		*1*		CR	7.370.000	wide range	N	N	N
8	Red-headed vulture	*Sarcogyps calvus*		*1*		CR	5.230.000	wide range	N	N	N
9	Egyptian vulture	*Neophron percnopterus*		*1*		EN	55.500.000	wide range	N	N	N
10	Steppe Eagle	*Aquila nipalensis*		*1*	*1*	EN	12.600.000	wide range	N	N	N

11	Pallas's Fish-eagle	*Haliaeetus leucoryphus*	*1*	*1*		EN	1.740.000	wide range	N	N	N
12	Saker Falcon	*Falco cherrug*		*1*	*1*	EN	21.100.000	wide range	N	N	N
			Mammalia								
1	Indian Pangolin	*Manis crassicaudata*		*1*	*1*	EN	No data	1,2,3,	N	N	N
2	Hog Deer	*Axis porcinus*		*1*		EN	4.322.971	2,3	N	N	N

7.2.11. Ecosystem Services

Under IFC's Performance Standard 6, Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Based on the framework used for the Millennium Ecosystem Assessment (2006) and presented in other such references as the World Resources Institute (WRI) Guidelines (2013), Ecosystem services are organized into four types:

i. provisioning services, which are the products people obtain from ecosystems (for example these may include food, freshwater, timber, fibers, medicinal plants);
ii. regulating services, which are the benefits people obtain from the regulation of ecosystem processes (for example, regulating services can be surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards);
iii. cultural services, which are the nonmaterial benefits people obtain from ecosystems (for example, these could be natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment)
iv. supporting services, which are the natural processes that maintain the other services (such as soil formation, nutrient cycling, primary production).

The following is preliminary baseline ecosystem services review identifying the main ecosystems services of the canal for the project area:

Provisioning Services: The main function of the canal is that of conveying freshwater to the city of Karachi, a city of 22 million people. The Karachi Water and Sewerage Board (KWSB) estimates the total demand for the city to be 1188 MGD. The Hub Dam and canal was commissioned in 1981 to provide the city with 100 MGD of water and seepage losses are estimated to be 20 to 30%. the current water sources for the city sum 550 MGD and therefore a shortfall in water supply of approximately 45%. Disruption of the Hub Dam water supply to the canal, the KWSB water treatment plant and the city must be minimised during Project implementation.

The canal also provides a source of fresh water to the communities living in the Project Affected Area that are not connected to the Karachi or other water distribution networks. These communities are highly dependent on the canal water. Canal water is used for drinking (both human and for livestock), domestic use (washing and bathing, etc.). There are significant differences across settlements in the specific ways in which canal water is accessed and used. The main issues for each community are summarized in the social baseline section of this report.

Regulating Services provided by the canal and seepage include a source of water for communities and crops during periods of prolonged drought. Although water availability and water levels in the Hub Dam reservoir may vary, the flow in the canal is generally constant, and therefore seepage losses are also constant and not seasonal. Water losses through seepage in the canal and aqueduct structures constantly contribute streamflow to the seasonal streams flowing under the aqueducts and moisture and water to the surrounding areas. Intermittent and seasonal streams flow west from the higher elevations at the east of the canal during the rainy season towards the Hub River riverbed located to the west of the canal.

Cultural Services include the recreational aspects that the areas along the canal provide to neighbouring communities and to people of Karachi. These areas are easily accessible by the KWSB service road that runs along the canal. The general public can be observed along the canal where they come for bathing, washing clothes and dishes (which are illegal), for camping and picnics and for recreational and leisure activities.

Supporting Services include those provided by seepage water that have contributed to the creation and maintenance of small wetlands, ponds and vegetated areas, and the contribution of water to surface water bodies (streams and ponds) and percolation into soil and groundwater. Some seepage water may contribute to the stored water ponds used to irrigate agricultural fields during dryer periods. In addition, seepage water may contribute to:

(i) subsistence agriculture in some communities and areas of the PAA, as well as larger crops belonging to wealthier landlords that provide employment opportunities to many of the community members in the PAA. The main economic activities and employment of the communities in the PAA are also described in the social baseline section of the report.

(ii) soil moisture supporting vegetation growth year-round and during dryer periods and droughts that support grazing areas and provide fodder for livestock.

7.3. Socio-economic Environment

7.3.1. Administrative organization and social institutions

7.3.1.1. Administrative divisions and local governance

The administrative units of Pakistan consist of four provinces (Balochistan, Khyber Pakhtunkhwa, Punjab, and Sindh), two autonomous territories (Azad Jammu and Kashmir, Gilgit-Baltistan) and one federal territory (Islamabad Capital Territory). Each province and territory are subdivided into divisions, which are further subdivided into districts. Districts (or “Zila” or Zillah” in Urdu), are further subdivided into tehsils, or taluka, which are further subdivided into union councils. The project site is located in the following districts and talukas within Karachi Central Division, in Sindh Province:

- Karachi West District
  - Mango pir sub-division
- Malir District
  - Shah Mureed Sub-division

The **District** is the first tier of local government. A District Government or a City District Government and Zillah Council form the governing body, with the District Coordination Officer serving as the administrative head. Their role is similar to district governors, with responsibility for implementing government strategy and developing initiatives arising out of it.

Taluka government is the second tier of local governance. It is where the functions, responsibilities and authorities of district governments are divided into more smaller units. The head of the Taluka government is "Taluka Nazim" who is assisted by the taluka Naib-Nazim. Every taluka has a Taluka Municipal

Administration, consisting of a Taluka council, Taluka Nazim, tehsil/taluka municipal officer (TMO), Chief officer and other officials of local council.

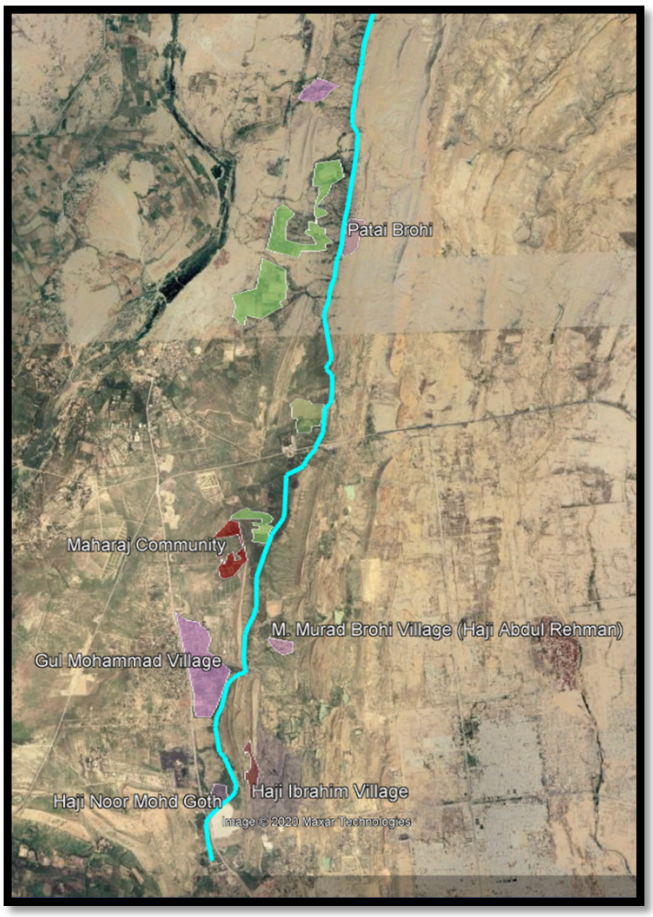
Members of the **Union Council** including the Union Administrator and Vice Union Administrator are elected through direct elections, based on adult franchise and on the basis of joint electorate. However, for the election to the reserved seats for Women in the Zila (or District) Council, these are proportionately divided among Talukas or Towns and shall be all members of the Union Councils in a Tehsil or Town. It is the responsibility of the Chief Election Commissioner to organize and conduct these elections.

7.3.1.2. Informal institutions

General disputes are tackled by the community leader through a Panchait system (or village council), as all community members pay respect to the elderly community leader. According to community members, they usually settle all quarrels in their village at the Panchait level and the communities abide by the community leader's decision. The community leader is consulted for all the decisions and disputes. The process avoids involving the police and/or the courts strictly following the traditional norms. In case of serious matters, the community leader coordinates with the district authorities to address the issue. The only exception to this trend is found in the Haji Gul Mohd Goth, where people usually follow the urban norms and make use of police resources for their disputes (very low influence of the community leader in this community).

7.3.1.3. Land Tenure

According to the Land Utilization Department spokesman, the land along the canal is divided into different categories which determine ownership status, distinguishing between residential areas for government workers, land owned by companies, and residential areas for the general public. In the project area, the land is typically owned by landlords of the area, who possess large extensions of land. However, some residents in the communities have also acquired titles over smaller portions of land (10 to 15 acres) and engage in agricultural activities during the seasonal rain season. These smaller plots are located some distance from the canal. The land registered in the area by Land Revenue Department in the form of plotting for 120, 200 and 500 Sq. yards residential plots. However, some informal settlers have moved to the area over the last few decades, for instance, Haji Ibrahim Goth (Deh Jam Chakra) has not acquired formal land rights for residential or agriculture use, but households have settled in the area for livelihood activities linked to the presence of the landfill site. Likewise, inhabitants of Maharaj Community have been informally residing in the area so they can engage in agriculture labour and other livelihood activities. The land rights ownership for women are acknowledged by law, however local norms, tradition and culture do not permit women in some communities to own land. The location of the main settlements and agricultural land are shown in the table below, detailed land use mapping is presented in Appendix F.



Informal (unregistered) settlements
Formal (registered) settlements
Agricultural (non-smallholding) land

Figure 32. Location of main settlements and agricultural land in PAA

Table 20. Land rights and ownership

S#	Village Name	Land rights*/Type of Settlement	Land Plot Sizes	Settled in the area	Men/Women Ownership	Administrative location
1.	Haji Noor Mohd Goth	Permanent / Formal settlement Revenue Land Form 7A + B	Plotting 120 sq. Yard	25 years	Both	Deh Jam Chakro, U.C Mai Garhi, Tapo Maghopir, West
2.	Haji Ibrahim Goth (Deh Jam Chakra)	Landless (Temporary / Informal User)	-	20 Years	-	Deh Bund Murad, U.C Mai Garhi, Tapo Maghopir, West
3.	Haji Gul Mohd Goth	Permanent / Formal settlement Revenue Land Form 7A + B	Plotting 120 and 80 sq. yard	25 years	Both	Deh Bund Murad, U.C Mai Garhi, Tapo Maghopir, West
4.	M. Murad Brohi Village (Haji Abdul Rehman)	Permanent / Formal settlement Revenue Land Form 7A + B	Plotting 120 and 500 sq. yard	25 years	Male	Deh Jam Chakro, U.C Mai Garhi, Tapo Maghopir, West
5.	Maharaj Goth	Landless (Temporary / Informal User)	-	20 Years	-	Deh Jam Chakro, U.C Mai Garhi, Tapo Maghopir, West

S#	Village Name	Land rights*/Type of Settlement	Land Plot Sizes	Settled in the area	Men/Women Ownership	Administrative location
6.	Patai Brohi Goth	Permanent / Formal settlement Revenue Land Form 7A + B	Plotting 120 sq. Yard	25 years	Male	Deh Mithadar, U.C Allah Pai, Tapo Songal, Malir
7.	Allah Dino	Permanent / Formal settlement Revenue Land Form 7A + B		+100 years		

Notes: * see Box below for definition of Revenue Land Forms 7A and 7B

LAND FORMALIZATION

Agricultural land

As per Land Revenue Department and Colonization Act 1967, Agriculture Land ownership is issued on forms VIIA and VIIB (or 7A and 7B)

- Form 7A is known as first ownership (standing)
- Form 7B is used for sales after 1st ownership. The subsequent changes are therefore made on form VIIB.

The last ownership record maintained in 1985 is called a Deh.

Residential plots (settlements)

When agriculture plots are re-zoned as residential plots, land ownership is issued on form II as is the case for all the residential and non-agriculture land.

The procedure is regulated by THE SINDH GOTHABAD (HOUSING Scheme) RULES, 2008

1) The Project Director shall constitute a Survey Team for one or more dehs in Taluka or Town, as the case may be, to carry out the Survey or demarcation in the deh or dehs for the purpose of Allotment of land under the Act.
2) The Survey Team shall carry out the survey of the house already constructed and existing in the deh. The Survey Team shall also carry out the survey and demarcation of the open state land suitable for allotment under the Act and shall record the result of the survey and demarcation of the houses and the open state land, in a Register.
3) The open state land shall be allotted under the Act in the shape of plots and not exceeding two ghuntas* with separate numbers:
4) Provided that the aforesaid limit shall not apply to the land or Asaish whereupon a deserving person has built a house before the coming into force of the Act with a view to make up permanent residence in the existing villages.
5) After completion of survey and demarcation of houses and land under these rules, the District Officer (revenue) may prepare a housing Scheme for the establishment of a new village or conferment of proprietary rights to a deserving person who has already built a house in an existing village:
6) Provided that no such Scheme shall be prepared on any private land which has not been acquired under section 8 of this Act or Government land has already reserved for any other purpose.
7) Layout plan or sketch of the Housing Scheme prepared under sub-rule (4) shall be prepared and approved by the District Officer (Revenue).
8) The allotment shall only be made after verification as well as on the recommendation of the Allotment Committee.
9) After allotment is made under the Act, the allottee shall be issued a "Sanad" in the Form attached to these rules.
10) A deed of conveyance conferring proprietary rights shall then be executed, stamped and registered at the cost of allottee which shall be termed as land grant document. On the basis of this deed an entry shall be made in Village Form-II.

*Note: 1 ghunta = 120.999 square yards or 101.1714 m^2

According to consulted community leaders who have already obtained legal recognition of their settlement, the process may take

7.3.2. Human Environment

7.3.2.1. Demography and migration patterns

There are six settlements located within the PAA along the canal. Two of the villages are larger in size, with more than 1,000 inhabitants. Approximate population figures, based on information provided during consultations with local leaders, are shown in Table 21. below. In the case of the community of Haji Gul Mohd, approximately half of the population is located between the canal and the service road located on the west side of the canal, and a few houses are within 100m from the canal, rendering these households very sensitive to nuisance impacts during the construction activities. Settlement patterns in these communities began near the canal where access to water was preferred and gradually spread away from the canal.

Table 21. Average population and household size in local communities

S#	Village Name	Population					Households (HH)
		Men	Women	Boys	Girls	Total	
1.	Haji Noor Mohd Goth	100	150	25	25	300	45
2.	Haji Ibrahim Goth (Deh Jam Chakra)	2500	2000	1000	1500	7000	1200
3.	Haji Gul Mohd Goth	12000	10000	5000	3000	30000	5000
4.	M. Murad Brohi Village (Haji Abdul Rehman)	200	190	60	50	500	65
5.	Maharaj Goth	50	60	20	20	150	22
6.	Patai Brohi Goth	120	100	30	40	290	40
7.	Allah Dino Goth	22	24	18	22	96	20
	Total	14992	12524	6153	4657	38336	6392

Except for the case of Haji Gul Mohd Goth, the communities living in the area have migrated from other communities or provinces over the last 20 to 25 years (more than 100 years in the case of Allah Dino). The communities have migrated to the area to seek employment and small business opportunities. Some households migrated due to drought conditions and inconsistent rain in their native places as a result of climate change.

Table 22. Communities Migration Pattern

Migration Pattern	Haji Noor Mohd Goth	Haji Ibrahim Goth (Deh Jam Chakra)	Haji Gul Mohd Goth	M. Murad Brohi Village	Maharaj Goth	Patai Brohi Goth	Allah Dino Goth
Migrated from	Quetta, Upper Punjab and some from rural areas of Sindh	Thatta district Sindh	Quetta, Upper Punjab and some from rural areas of Sindh	Balochistan	Upper side of the Sindh province called Kashmore.	Khuzdar & Punjgor of Balochistan Province.	Balochistan

7.3.2.2. Ethnicity, language, culture and beliefs

Communities living near the canal have different castes and religions but are mainly Muslim and Hindus. No ethnic or religious tensions are present in the area according to the consulted informants in the communities. Two of the communities, namely Haji Ibrahim Goth (Deh Jam Chakra) and Maharaj Goth, include mostly Hindu and a lesser number of Muslims, whereas the rest of communities are predominantly Muslim. There are no restrictions and disputes among the religions or sectarians within the communities.

Regarding castes, people in the communities have different castes and languages. Mostly they speak the local languages and are mixed in ethnicity due to the influence of the rapid urbanization of the nearby metropolitan City of Karachi. Extremist forms of religious or ideological doctrine are not present in the area and community members live together without interference of other religions and castes. However, according to consultations with local leaders and PAP, overall, the difference of caste, language and religion occasionally can become the cause of contention and disputes within communities. One of the castes, namely Brohi, is identified as somewhat stricter in their culture and religious values than the rest of the castes in the communities.

Table 23. Different castes, languages and religions in the local communities

S#	Village Name	Caste	Language	Religion	Muslim Shia	Muslim Sunni
1.	Haji Noor Mohd Goth	Gujjar, Soomro, Yusufzai, Khatak, Rana	Sindhi, Pashto, Balochi, Punjabi, Urdu	Muslim	-	Yes
2.	Haji Ibrahim Goth (Deh Jam Chakra)	Gaoji, Chanwan	Sindhi, Marwari, Urdu	Hindu & Muslim	-	Yes
3.	Haji Gul Mohd Goth	Brohi, Solangi, Muzra, Meerali, Zaonr, Lashari, Khaskheli, Soomro, Yousufzai	Sindhi, Pashto, Balochi, Punjabi, Urdu	Muslim	Yes	Yes
4.	M. Murad Brohi Village (Haji Abdul Rehman)	Brohi	Sindhi, Brohi, Balochi, Urdu	Muslim	-	Yes
5.	Maharaj Goth	Maharaj	Sindhi, Dhatki, Urdu	Mostly Hindu & few Muslim	-	Yes
6.	Patai Brohi Goth	Brohi	Sindhi, Brohi, Balochi, Urdu	Muslim	-	Yes
7.	Allah Dino Goth	Brohi	Sindhi, Brohi, Balochi, Urdu	Muslim	-	Yes

7.3.3. Housing

People in the local communities are used to living in small houses with an average family size of around 5 to 6 members in each household. PAP live under various types of houses depending on their financial stability and resources. Secure legal tenure of the land allows local communities to build concrete structures to avoid any adverse circumstances in case of displacement due to any proposed project, government policy for anti-encroachment or any other unexpected claim. Two of the communities, namely Haji Ibrahim Goth and

Maharaj Goth, are built almost entirely of Katcha[17] type of structures, as they don't have any legal tenure on the land. Both insecure tenure and poverty levels are the main causes of the lack of Pacca type of housing in these two communities. Figure 27 includes photographs of typical housing in Haji Gul Mohd Goth, Patai Goth and Haji Noor Mohd Goth.

Table 24. Household structure in the communities

S#	Village Name	Pacca	Katcha
1.	Haji Noor Mohd Goth	75%	25%
2.	Haji Ibrahim Goth (Deh Jam Chakra)	5%	95%
3.	Haji Gul Mohd Goth	90%	10%
4.	M. Murad Brohi Village (Haji Abdul Rehman)	50%	50%
5.	Maharaj Goth	0%	100%
6.	Patai Brohi Goth	85%	15%
7.	Alla Dino Goth	Majority of Pacca and a few semi-katcha	

Haji Gul Mohd Goth

Patai Goth

Haji Noor Mohd Goth

Figure 33. Photographs of typical housing in some communities

[17] Kutcha houses are built with readily available material like wood, stones, clay, mud, leaves, thatch or crops residue. These houses are not durable. Pacca houses are mostly found in urban areas and cities, and are built with cement, mortars and bricks.

7.3.4. Economic activity and livelihoods

7.3.4.1. Employment

The main source of livelihood of the local communities is unskilled labour. A very low percentage of the PAP hold semi-skilled or skilled jobs. Agricultural activities were not observed near the water canal except at one spot with a small, cultivated area. This is mostly due to the fact that communities do not hold tenure of the land and because of the high prices of land near the city. Alternatively, people usually perform labour work in agriculture fields that belong to influential landlords.

The general conditions of **Haji Ibrahim Village (Deh Jam Chakro)** reflect the highest level of poverty, as most villagers adopted the profession of selling different items collected from the nearby landfill. Most male members and children are scavengers. They collect the garbage and dump it into the village, where all household members are engaged in the sorting and sale of the items. The community is mostly dependent on selling the segregated items from solid waste, but some are also dependent on livestock (i.e., animal husbandry). A few people work as agricultural laborers in the nearby villages.

The village of **Haji Gul Mohd Goth** has the largest population amongst those near the canal. With notably higher living standards, they mostly have private and government jobs, many related to business of stone and marble. Some community members also have livestock and agriculture related livelihoods. Their main livelihood source is the private sector (hotels, drivers, electricians and mechanical work, etc.), with a significant number of people engaged in the marble business.

In the **Haji Abdul-ur-Rehman Village**, the livelihoods are mostly dependent on agriculture labour work, livestock as well as private sector and government jobs in the nearby towns.

Community members in **Maharaja** mostly roam around in search of agriculture labour. They have links with the landlords in the area and they are frequently called to join agricultural works in the nearby fields. Additionally, community members search for unskilled jobs like mason work, driving or sell toys and other miscellaneous things. Women in this community mostly work along with male family members in agricultural work, however, in the off seasons they are involved in petty jobs like selling balloons etc. All household members are commonly involved in income generating activities, including children.

Deh Chakro Landfill(*)`

- The landfill site known as Deh Chakro has a total surface area of 500 acres and has been in operation for 20 years. It receives waste from the following areas:
  - Malir District (GTS-Garbage Transportation service)
  - Korangi
- The transportation of Garbage is done through approved licensed contractors. There are five approved companies that collect waste from the above-mentioned area. Around 5,000 to 6,000 tons of solid

waste / day are dumped in this area. One solid waste dumper truck brings a maximum of 30 tons per trip. The government pays Rs. 500 / per ton (it varies depending on the distance and location) and 80 Rs / per ton for maintenance.

- The landfill site is used at 30% of its overall capacity. Its lifespan may be prolonged up to the next the 50 years. There are currently no plans for extension.
- There is no waste treatment facility in the area. It is just a landfill site for solid waste.
- The Solid Waste Management Board is not engaged with the Community. They are scavengers and search for valuable items such as plastic, iron, metals, copper etc. and sell it at the market to earn around 500 to 700 Rs / day per person.
- There is no social management plan for the informal community.
- There is not and extension or decommissioning plan anytime in the near future.

(*) Information gathered in consultation with the Assistant Director (AD) of Sindh Solid Waste Management.

The major occupation in **Patai Brohi** Village is livestock, however they also work as laborers, in the private sector, as agriculture laborers, drivers and in government jobs. The women in the village have good skills in handicraft and tailoring, which is not marketed but they do it for their own use and for the dowry of their daughters.

Table 25. Main livelihood sources of the local communities

S#	Village Name	Unskilled Jobs	Semi-Skilled Jobs	Skilled Jobs	Other Source
1	Haji Noor Mohd Goth	Labor, Stone crushing	Masonry, Driver	-	Small shop
2	Haji Ibrahim Goth (Deh Jam Chakra)	Scavenger, Ragman, livestock and agriculture labor in nearby town	-	-	-
3	Haji Gul Mohd Goth	Labor work, livestock and agriculture labor in nearby town	Masonry, Driver	Electrician, Mechanic, Marble Crafting	Hotel Vater, small shops
4	M. Murad Brohi Village (Haji Abdul Rehman)	Fuel wood selling, livestock and agriculture labor in nearby town	Masonry, Driver	Electrician, Mechanic, Plumber	Private Employees, Government Employees, Jobs in KWSB
5	Maharaj Goth	Agriculture Labor, Livestock, Balloon selling, and selling of toys	Mason work, driving		Small shops
6	Patai Brohi Goth	Labor, Agriculture and Livestock	Driver	-	-
7	Allah Dino Goth	Livestock, hired labor in nearby areas, rain fed agriculture			Income from a rental crush plant on their land

7.3.4.2. Income level and vulnerability

The overall financial condition of the local communities in the area is highly vulnerable. Most of the people do not have a consistent income and most earn the minimum wage fixed by the Government. People usually depend on the daily wage income for labour work, which sometime varies from the expected average monthly income. They often have shortages of resources to cover minimum monthly expenses, which forces

household members to search for alternative livelihood resources. The inconsistent and mostly low-income sources create health issues, malnutrition, low education and low-quality standard of life. Based on the reported income level data (Table 26) as well as other indicators such as the distribution of housing standards and the livelihood profiling, two of the communities, namely Haji Ibrahim Goth and Mahraj Community, are the most vulnerable in terms of poverty level and income generation opportunities.

Table 26. Distribution of population by income level in affected settlements (%)

S#	Village Name	Low Income <10,000 Rs	Avg Income 10, 000 to 19,000 Rs.	Above Avg Income 20,000 to 30,000 Rs	Good Income >30,000 Rs.
1.	Haji Noor Mohd Goth	20%	60%	18%	2%
2.	Haji Ibrahim Goth (Deh Jam Chakra)	70%	26%	3%	1%
3.	Haji Gul Mohd Goth	10%	65%	20%	5%
4.	M. Murad Brohi Village (Haji Abdul Rehman)	10%	60%	20%	10%
5.	Maharaj Goth	75%	22%	2%	1%
6.	Patai Brohi Goth	40%	40%	15%	5%
7.	Allah Dino Goth	n.a	n.a	n.a	n.a

Generally, the population in the project area can be classified as vulnerable with children and women being more vulnerable than the general population. The socio-economic baseline indicates that a portion of the population lives in extreme poverty, without access to basic social services like health care and a safe water supply, dependent on fragile ecosystems for livelihoods and are annually subjected to natural calamities in the form of drought and flooding during the rainy season.

Women, children and the elderly can be considered more vulnerable than the general population due to the cultural barriers that prevent them from having full control over key decisions in their lives. Poor access to basic social services particularly health care, food and safe water also impacts them harder than other groups. Food insecurity during the lower income periods (e.g. during the dry season when there is less work in the agricultural sector) has a direct impact on the health of children, the elderly and women of childbearing age.

7.3.4.3. Women's role in income generation

Women in the local communities mostly do the daily house chores that include cleaning, child rearing, washing clothes and house management. However, some women in the local communities do handicraft work, tailoring, agriculture and livestock labor for income generation. The women in Haji Ibrahim Goth perform jobs as ragmen to share income and household expenditures. However, women's income is not separately counted as income sharing but as combined income to run household expenses. Other activities of women include agriculture labor in nearby villages and livestock within the community.

Table 27. Women's Role in income generation

S#	Village Name	Unskilled	Semi-Skilled	Skilled	Other
1.	Haji Noor Mohd Goth	-	-	-	Household Daily chores
2.	Haji Ibrahim Goth (Deh Jam Chakra)	Scavenger, Ragman, livestock and agriculture labor in the PAA and Karachi peri-urban areas.	-	-	Household Daily chores
3.	Haji Gul Mohd Goth	-	-	Handicraft, Tailor	Household Daily chores
4.	M. Murad Brohi Village (Haji Abdul Rehman)	-	-	-	Household Daily chores
5.	Maharaj Goth	Agriculture Labor, Livestock and balloon selling		Handicraft, Tailor	Household Daily chores
6.	Patai Brohi Goth	Livestock and Fuel Wood	-	-	Household Daily chores
7.	Allah Dino	-	-	Embroidery and stitching	Household Daily chores

7.3.4.4. Agricultural activities

Community-based agricultural activities, in the form of private gardens, are very rare along the water canal. PAP do not own land for agricultural purposes due to the high prices of the land in peri-urban areas. However, large extensions of cultivated land, outside the boundaries of the main settlements, have been observed in areas near the canal. These lands are commonly owned by influential families and individuals who do not reside in the nearby communities, but who lease or cede the use of the land to trusted community members for subsistence agriculture purposes.

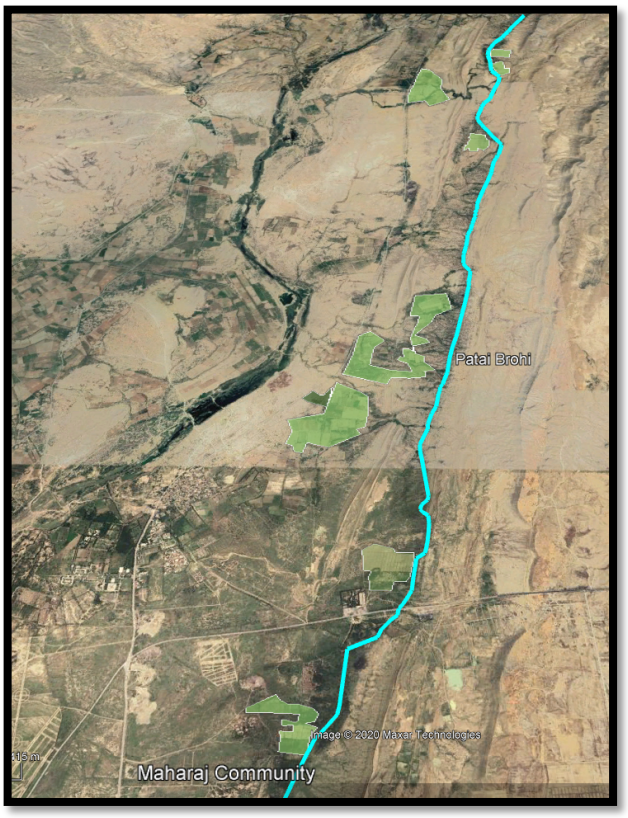
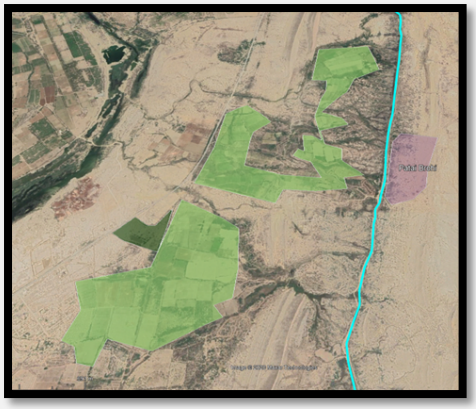


Figure 34. Overview of the location of the main agricultural land in PAA.

More detailed social mapping is included in Appendix F.

The following sections include some facts gathered during consultations in each settlement:

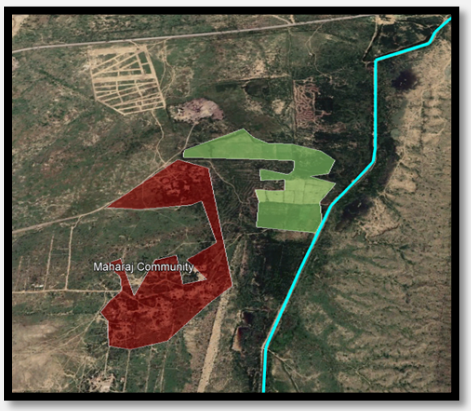
PATAI BROHI



- Around 13 acres of land have been identified by consulted community members to be owned by Mr. Amjad Khan, a businessman engaged in the marble industry who does not reside in the area and who performs agricultural activities as a supplementary activity. He normally grows guava, tomatoes, papaya and spinach. He has formally applied for access to irrigation water from a nearby scheme (a secondary irrigation system stemming from the Hub Canal). However, permission has not been granted by the authorities.

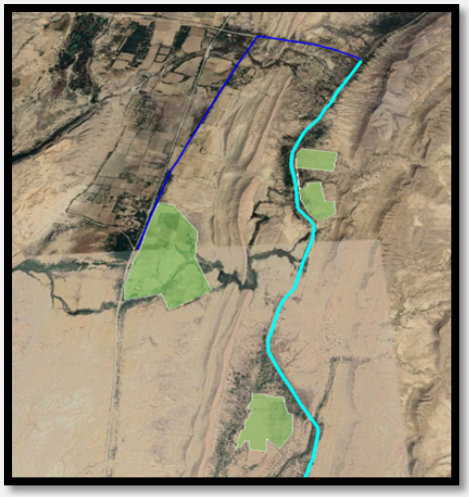
- The total estimated surface of the agricultural land located near Patai Brohi (as shown in the aerial photo above) amounts to 330 acres.
- The land is mostly rainfed during the rainy seasons and no wells have been perforated for irrigation purposes. The water is accumulated in ponds during the rainy season (rainfall runoff usually flows down from the hilly areas near the villages) and is used for irrigation for the winter crop cycle (dry season).
- The agriculture land belongs to well-off Mengal Tribes from Balochistan, who do not reside in the nearby settlements. The land is ceded for use to local villagers, who are trusted settlers from Balochistan. Villagers use the land without any payment or formal lease, based on mutual trust and kinship links with the owners.
- The community leader of Patahi Brohi also owns some land in the area and uses it for agricultural purposes (about 4 acres).
- Apart from agricultural purposes, the land is currently being converted into residential land, with several plots showing evidence of construction preparation works.
- Members of the community that were consulted believe that surface seepage water is not directly benefiting the local communities for agriculture purposes. Whether underground percolated water from the canal could be benefitting the land is unknown (but mostly discarded) by consulted sources.
- The main cultivated crops include: Cluster Beans (Gwar), Lentils (Moong) and Sesame Seed (Till), Chilli, Ridge Gourd (Toori), Bitter Gourd (Karela) and Bringle (Bangan), cotton.

MAHARAJ



- The surface of agricultural land near Maharaj community is estimated at 45 acres.
- According to the consulted villagers, the landowner is Yar Mohd Rindh (former member of the National Assembly). Villagers are allowed to cultivate without legal lease or payment. This information has been authenticated by KWSB.
- The land is mostly rainfed. The water is accumulated in ponds during the rainy season (1-2 meter dug ponds) and used for irrigation during the dry season.
- According to community members, most agricultural activities started last year, although some households have been using the land for the last 10 years.
- Crops include Chilli, Ridge Gourd (Toori), Bitter Gourd (Karela) and Bringle (Bangan) etc

CANAL UPPER SECTION



- About 120 acres of land located within 600m from the canal is irrigated by a secondary canal system, running in parallel to the main canal (shown in dark blue in the aerial photograph above).
- A cotton field in the south of the main area (35 acres) has been identified. However, no consultation regarding the current status of the land and irrigation sources could be performed at the time of the site visit (shown at the bottom of the aerial photograph above).
- Two additional smaller plotted areas have been identified at the east side of the canal. During the field visit, no signs of ongoing agricultural activities were identified

OTHER AREAS

- The community leader in Haji Noor Mohd Goth owns agriculture land (4 acres) in the surrounding area. He cultivates Kadoo, Toori, Carrot, Cucumber and Spinach with rainwater and uses it for self-consumption as well as for income generation.
- Haji Abdul-ur-Rehman from Murad Brohi Village has some agricultural plots in the surrounding areas which he uses for agriculture work. However, it is far from the canal and farmers are aware of the origin of the seepage water stemming from the canal. They cultivate it only for self-consumption. They grow cluster beans (gwar), lentils (moong) and sesame seed (till).

7.3.4.5. Livestock

Some households in the communities have livestock for both commercial and domestic use, however, the number of households engaged in this activity is limited due to unavailability of space and affordability. Only three communities, namely M. Murad Brohi Village (Haji Abdul Rehman), Alla Dino goth and Patai Brohi Goth, keep livestock in each household. Livestock graze in the nearby surrounding vegetated areas. Common livestock owned by the communities includes cows, goats and buffalo. As per discussions with community members, due to the recent rain[18] in the area, the livestock have been severely impacted, and the communities have faced major livestock losses during the months of July and August, 2020.

Table 28. Livestock with Communities

S #	Village Name	Number of HH Possessing Livestock	No of Livestock	Types of Livestock	Income generation	Domestic Use
1.	Haji Noor Mohd Goth	1 No. HH	15 Nos.	Cows and Goats	Yes	Yes

[18] Sindh was the hardest hit area by the monsoon rains of August 2020 in Pakistan, causing severe flooding, many casualties, destroying housing etc.

S #	Village Name	Number of HH Possessing Livestock	No of Livestock	Types of Livestock	Income generation	Domestic Use
2.	Haji Ibrahim Goth (Deh Jam Chakra)	20Nos. HH	80 Nos.	Cows, Buffalo and goats	Yes	Yes
3.	Haji Gul Mohd Goth	5 Nos. HH	300 Nos.	Cow	Yes	-
4.	M. Murad Brohi Village (Haji Abdul Rehman)	Every HH	4-5 Nos.	Goat and Cow (Avg 4:1)	-	Yes
5.	Maharaj Goth	5 HH	10 Nos.	Goats		Yes
6.	Patai Brohi Goth	Every HH	Avg 5 Nos.	Goats	Yes	Yes
7.	Allah Dino Goth	Most HH	3-4	Goats	Yes	Yes

7.3.4.6. Access to market

All communities living near the canal have easy access to markets. People usually have motor bikes, and some have private cars for transportation. The communities are not far from the main road connecting with Karachi City, especially Haji Noor Mohd Goth and Haji Gul Mohd Goth, which are located closest to the main access road of Karachi.

7.3.5. Access to water

Communities living in the PAA area are highly dependent on canal water. Canal water is used for drinking (both human and livestock), domestic use (washing and bathing), and utensil washing etc. In general, it was observed that the general public come to visit the canal for bathing and camping as a recreational activity. Mostly young men were seen swimming and having packed lunches. There are significant differences across settlements in the specific way in which canal water is accessed and used. The main issues for each of them can be summarized as follows:

- Haji Noor Mohd Goth uses bore water of 2 to 3 meter depth. According to the consulted community members, water quality is good and it is used both for drinking and domestic purposes (i.e washing clothes and pots, etc). The borehole is close to the canal (approximately 100 meters from the canal edge) and community leaders claim that it is directly benefiting from the canal water through seepage (see photo in Figure 29)

- Haji Ibrahim Goth (Deh Jam Chakra) community uses the canal water for domestic and drinking purposes. The canal water is transported by a water bowser to a water storage tank. During the site visit, it was observed that people from the communities are bathing and washing clothes in the canal.

- Haji Gul Mohd Goth obtains water from the pipelines of KW&SB. However, during shortages they collect water from the canal with jerry cans.

- Haji Abdul-ur-Rehman villagers take water from the canal for domestic purposes. Normally there are water tanks located inside the village and tankers fill them with water. Also, women fetch water from the tanks with mud pitchers and jerry cans and use it for their domestic work. They requested legal permission from KW&SB for a pipeline connection to their village, which is under consideration.

- An illegal underground pipeline connection from the canal has been observed in Maharaj Community. During the site visit, the team observed that the pipeline is partially exposed in some places (see photo in Figure 29).
- Patai Brohi Village obtains canal water using pumps as they have legal approval from KW&SB. Water is used for domestic and livestock purposes.
- In Allah Dino Goth the population is dependent on canal water (mostly drinking, washing, and other domestic purposes). Water is extracted through pipes as they are getting direct water from the canal without pumps and water is provided twice a week by KWSB.

Table 29. Use of Canal Water

S #	Village Name	Main Source of water for domestic use (Drinking & Cleaning other)	Main Source of Water for Agriculture use	Main Source of Water for Livestock use	Use of Canal Water for any purpose and mean of collection
1.	Haji Noor Mohd Goth	Bore water	Nil	Bore water	Nil
2.	Haji Ibrahim Goth (Deh Jam Chakra)	Canal Water	Nil	Canal Water	Tanker use to transport canal water to village for domestic use
3.	Haji Gul Mohd Goth	Govt. Pipeline Water	Nil	Govt. Pipeline Water	Nil
4.	M. Murad Brohi Village (Haji Abdul Rehman)	Canal Water	Nil	Canal Water	Washing Cloths and Drinking using jerry can
5.	Maharaj Goth	Canal Water	Nil	Canal Water	Washing Cloths and Drinking Using jerry can
6.	Patai Brohi Goth	Canal Water	Nil	Canal Water	Domestic use using pump
7.	Allah Dino Goth	Canal Water	Nil	Canal Water	Tanker use to transport canal water to village for domestic use.

Figure 35. Photographs of Community Access to Water

Bore hole at Haji Noor Mohd Goth

Illegal Pipeline in Maharaj Goth

7.3.6. Education

According to local authorities, school enrollment remains very low in most of the settlements within the PAA. Low income, affordability, low preference and unavailability of educational facilities in the area are the most common reasons given by interviewed informants for low levels of school enrolment in the area. Enrolment rates have been gradually decreasing in recent years. Community education facilities are summarized in Table 28. The following are some specific comments gathered during consultations in each settlement:

- The community Haji Gul Mohd Goth shows a more advanced development pattern and has a substantially higher education level, compared to the adjacent neighbour villages.
- In Haji Ibrahim Goth (Deh Jam Chakra), one community school is being run by the NGO AL-Khidmat, which provides meals to the children for the purpose of incentivizing interest for children to go to school. It is a Primary Level school, and it accommodates around 150 to 200 children.
- In Murad Brohi Village (Haji Abdul Rehman), a school building exists, but due to unavailability of teachers, it is not functional. The villagers themselves hire teachers for their children, but mostly they can't afford teacher remuneration.
- In Maharaj Community there are no schools within or near the village.
- In Patai Brohi Village there is a primary school where children of the community learn basic education. However, due to absenteeism of teachers in recent years the service has proven to be ineffective and unreliable.
- In Allah Dino Goth the population is mostly uneducated, with the exception of some younger members of the community: about 10 girls and 15 boys have primary education (3 boys are currently enrolled), and 3 boys have Intermediate education. No school is present within the village. Students need to go a fair distance to attend school and gain higher education.

At the time of the interviews, it was found that all institutions were closed due to precautionary measures related to COVID-19.

Table 30. Education in local communities

S #	Village Name	No of Primary Student (M/F)	No of Matric Student (M/F)	No of Intermediate Student (M/F)	No of University Student (M/F)	School / College or University Available
1.	Haji Noor Mohd Goth	7 Boys 5 Girls	2 Male	-	-	1 Km away School 1.5 Km away Hamdard University
2.	Haji Ibrahim Goth (Deh Jam Chakra)	Avg 80 Boys 50 Girls	10 Male	-	-	One school of NGO (Alkhidmat) inside village (see Figure 30)
3.	Haji Gul Mohd Goth	Avg 100 Boys 70 Girls	Avg 130 Male and 70 Female	45 Male	5 Male Graduates 1 Male Doctor 1 Male Engineer	4 Primary School (Boys & Girls), 1 Secondary School (Boys & Girls) and 1 University @ 1 km distance (Hamdard)
4.	M. Murad Brohi Village (Haji Abdul Rehman)	7 Boys and 3 Girls	5 Male under Matric 4 male Matric	-	1 Male Graduate	1 Primary School within village (see Figure 30)
5.	Maharaj Goth	2 Boys	-	2 Male	-	No any school within village or surrounding 2 km
6.	Patai Brohi Goth	12 Boys	1 Male	-	-	1 Primary school inside village
7.	Allah Dino Goth	10 Girls 15 Boys	3 Boys	3 Boys		No any school within village or surrounding 2 km

Figure 36. Photographs of some Community Education Facilities

Govt. Primary School at M. Murad Brohi Village

NGO School in Haji Ibrahim Goth

7.3.7. Health

The communities living in the area are close to the city and usually travel to Karachi in cases of medical emergency. One of the city's renowned hospitals, known as Hamdard Medical, which is also a research institution, is located near the PAA, however, this is a comparatively expensive facility compared to other private clinics or Government Hospitals. According to consulted sources, there are many medical clinics in the surrounding areas and some within village boundaries, which are well developed compared to other neighbouring villages. At the time of medical need, people rush to the private clinic in the city area which is around 3 to 5 km away, or usually go to the civil hospital Gadap for a health check-up, which is cheaper than other private medical clinics. An NGO (Alkhidmat) has developed a small one-room clinic in Haji Ibrahim Goth (Deh Jam Chakro) served by one doctor, hired by the NGO. The community have many health issues particularly respiratory and skin problems and other viral diseases due to solid waste scavenging and exposure to toxic fumes at the landfill site those engaged in the ragman profession, including children.

In Patai Brohi Village women´s health is particularly poor due to lack of awareness of some basic health issues. During the site visit it was observed that the community was not allowing the polio vaccination teams to vaccinate children, because of the myth that children will die when they get vaccinated. There is a general lack of awareness about vaccination in the area.

Table 31. Medical facilities in the area

S #	Village Name	No of Clinic within 2km	No of Hospital within 2 km
1.	Haji Noor Mohd Goth	Nil	1 Hospital (Hamdard)
2.	Haji Ibrahim Goth (Deh Jam Chakra)	1 Clinic of NGO (Alkhidmat) inside village	Nil
3.	Haji Gul Mohd Goth	4 Clinics inside village	1 Hospital (Hamdard)
4.	M. Murad Brohi Village (Haji Abdul Rehman)	Nil	Nil
5.	Maharaj Goth	Nil	Nil
6.	Patai Brohi Goth	NIl	Nil
7.	Allah Dino Goth	Nil	Nil

Clinic in Haji Ibrahim Goth

7.3.8. Social infrastructure and cultural heritage

There are only two types of structures that can be considered as culturally relevant within the communities: mosques and graveyards (listed in Table 32), although none of them have particularly significant artistic or heritage value. Each Muslim community has a mosque within their village.

Table 32. Culturally relevant structure

S.No	Location	Mosque	Graveyard	Temple	Other Culturally Relevant Buildings
1.	Haji Noor Mohd Goth	Yes	Yes	No	No
2.	Haji Ibrahim Goth (Deh Jam Chakra)	Yes	No	No	No
3.	Haji Gul Mohd Goth	Yes	No	No	No
4.	M. Murad Brohi Village (Haji Abdul Rehman)	Yes	No	No	No
5.	Maharaj Goth	No	No	No	No
6.	Patai Brohi Goth	Yes	Yes	No	No
7.	Allah Dino Goth	No	No	No	No
8.	Outside communities	No	25°03'01.6N 67°01'48.0E	No	No

Mosque in M.Murad Brohi Village (Haji Abdul Rehman)

There are no or limited basic facilities available in the villages of PAA, except for Haji Gul Mohd Goth where Government supplied electricity is available. Other communities use solar panels for electricity, although to a limited extent due to maintenance issues. Road and local transport are available only in Haji Noor Mohd and Haji Gul Mohd Goth.

Table 33. Basic Facilities / Amenities

S #	Village Name	Electricity	Gas	Landline Telephone	Cellular Signals	Sewerage System	Road	Local Transport
1.	Haji Noor Mohd Goth	Solar	No	No	Yes	No	Yes	Yes
2.	Haji Ibrahim Goth (Deh Jam Chakra)	Solar	No	No	Yes	No	No	No

S #	Village Name	Electricity	Gas	Landline Telephone	Cellular Signals	Sewerage System	Road	Local Transport
3.	Haji Gul Mohd Goth	Govt. K-Electric	Yes	No	Yes	No	Yes	Yes
4.	M. Murad Brohi Village (Haji Abdul Rehman)	Solar	No	No	Yes	No	No	No
5.	Maharaj Goth	Solar	No	No	Yes	No	No	No
6.	Patai Brohi Goth	Solar	No	No	Yes	No	No	No
7.	Allah Dino Goth	Solar	-	-	-	-	-	-

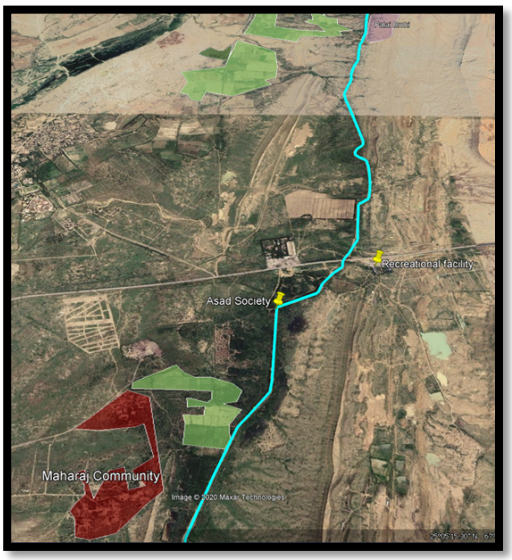
Two additional relevant infrastructure elements have been observed outside the community boundaries. An under-construction structure has been observed next to the Karachi Water Canal known as the Asad Society. The landowner explained that the structure is being constructed to develop a concrete form house and the area occupied is around 72 acres that has been registered at the land revenue department of Sindh, Pakistan. A commercial recreational facility made up or four concrete form houses has been observed near the Canal. The average rent for 24 hours booking is approximately 25,000 Rs during the summer season, and 10,000 Rs. during the winter season. During discussions with some local representatives of the area, it was explained that these form houses collect water from the canal for the swimming pools, gardening, cleaning & washing and other water needs of the recreational facility, without obtaining permission from regulatory authorities, however, staff at the form house denied this statement.

Under Development Structure at KWC		
S.No	Description	Coordinate
1.	Society Structure under development	25°04'31.6N, 67°02'07.2E

Recreational Activities at KWC			
S.No	Description	Coordinate	Remarks
1.	4 unit Farm house	25°04'45.23N, 67°02'34.27E	Established and functional

Figure 37. Asad Society

Asad Society



Location of Asad Society

7.3.9. Summary and Key Findings

- There are **seven human settlements** located in the PAA, all of them within a range of 600m distance from the canal, hosting a total population of **38.300 inhabitants** (approx.). All of them show a predominantly migrant profile from other parts of the country, having settled in the peri-urban area of Karachi in the last 20-30 years, except for Allah Dino Goth.
- Six out of the seven settlements show a highly **vulnerable profile** in terms of income generation opportunities and access to basic services, being Haji Gul Mohd Goth (the largest in population with around 30.000 inhabitants) the only one connected to public energy and water distribution networks. The remaining affected population (8,000 inhabitants) show significant rates of extreme poverty, informal livelihood sources, illiteracy and temporary (pacca) housing.
- Two of the settlements, namely Maharaj and Haji Ibrahim Goth, remain in **informal legal status**, without any official recognition by the authorities as population settlements. This condition is accompanied by the highest levels of vulnerability in the form of housing and livelihood conditions. In the case of Haji Ibrahim, livelihoods are tightly linked to the presence of a nearby landfill, as most of their members are engaged in **scavenging activities**.
- **Rainfed agricultural activities** are performed in some extensive areas near Maharaj, Patai Brohi and Allah Dino. Rain and mountain spring water is accumulated in dug ponds during the rainy season and later used for the winter cropping cycle. Agricultural land belongs to influential landlords who do not reside in the PAA. Local villagers work the land under informal agreements with the landlords. Only in very few cases villagers have acquired smaller agricultural plots.
- **Main livelihoods sources** in the PAA settlements include hired labour in nearby towns and agricultural areas, substance agriculture on leased land, livestock, rubbish picking (Haji Ibrahim Goth) and, to a lesser extent, small handcrafts. Formal employment opportunities are only found in Haji Gul Mohd Goth in the form of government and private sector (mostly in the marble industry) jobs.

- All but two settlements (Haji Noor Mohd Goth and Haji Gul Mohd Goth) are **highly dependent on canal water** for human and animal consumption as well as domestic uses. Different means of collection are used along the PAA, including distribution through tankers, direct collection with jerrycans, and summer pumps. One illegal piped connection has been identified in Maharaj Community.
- All but one settlement are dependent on **off-grid solar power,** whereas basic **social infrastructure** (health care and education) is totally missing in two of them (Allah Dino Goth and Maharaj Goth). Five settlements have at least one primary school within 1km of their boundaries and three of them have a clinic or hospital within a 2 km range

Table 34. Key social indicators for PAA settlements

INDICATOR	Haji Noor Mohd Goth	Haji Ibrahim Goth (Deh Jam Chakro)	Haji Gul Mohd Goth	M. Murad Brohi Village (Haji Abdul Rehman)	Maharaj Goth	Patai Brohi Goth	Allah Dino Goth
Location along canal course (distance from pumping station)	1km	1.6km	3km	4km	5.5km	11.5km	14km
Avg. distance to Canal (meters)	150m	300m	300m	600m	430m	150m	600m
Land rights	Permanent/ registered	Landless/ informal User	Permanent/ registered	Permanent/ registered	Landless/ informal user	Permanent/r egistered	Permanent/ registered
Settled in the area (years)	25	20	25	25	20	25	100
Population	300	7,000	30,000	500	150	290	96
Migrated from	Quetta, Upper Punjab and some from rural areas of Sindh	Thatta district Sindh	Quetta, Upper Punjab and some from rural areas of Sindh	Balochistan	Upper side of the Sindh province called Kashmore.	Khuzdar & Punjgor of Balochistan Province.	Balochistan
Percentage of pacca housing	75%	5%	90%	50%	0%	85%	Majority of Pacca and a few semi-katcha
Main source of livelihood	Labor, stone crushing	Scavenger, ragman, livestock and agriculture, labour in nearby town	Labor work, , livestock and agriculture labor in nearby town	Fuel wood selling, livestock and agriculture labour in nearby town	Agriculture labour, livestock, balloon selling, and selling of toys	Labor, agriculture and Livestock	Livestock, hired labor in nearby areas, rainfed agriculture
Percentage of low income households (<10,000 Rs)	20%	70%	10%	10%	75%	40%	n.a
Role of women in income generating activities	None	Scavenger, Ragman, livestock and agriculture labour in nearby town	Handicraft, Tailor	None	Agriculture Labour, Livestock and balloon selling, Handicraft, Tailor	Livestock and Fuel Wood	Embroidery and stitching
School / College or University Available	1 Km away School 1.5 Km away Hamdard University	One school of NGO (Alkhidmat) inside village	4 Primary School, 1 Secondary School 1 University (Hamdard)	1 Primary School within village	No school within village or surrounding 2 km	1 Primary school inside village	No school within village or surrounding 2 km

INDICATOR	Haji Noor Mohd Goth	Haji Ibrahim Goth (Deh Jam Chakro)	Haji Gul Mohd Goth	M. Murad Brohi Village (Haji Abdul Rehman)	Maharaj Goth	Patai Brohi Goth	Allah Dino Goth
Clinics and hospitals within 2kms	1 Hospital (Hamdard)	1 Clinic NGO (Alkhidmat) inside village	4 Clinics inside village, 1 Hospital	None	None	None	None
Energy access	Solar	Solar	Grid connection	Solar	Solar	Solar	Solar
Main Source of water for drinking & cleaning	Bore water	Canal Water	Govt. Pipeline Water	Canal Water	Canal Water	Canal Water	Canal Water
Main Source of Water for Agriculture	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed
Main Source of Water for Livestock use	Bore water (possibly filled through canal infiltration)	Canal Water	Govt. Pipeline Water	Canal Water	Canal Water	Canal Water	Canal Water
Use of Canal Water for any purpose and means of collection	Nil	Washing Cloths and Drinking using jerry can	Nil	Tanker use to transport canal water to village for domestic use	Washing Clothes and Drinking Using jerry can	Domestic use using pumps	Pipes from the canal (provided by KWSB)
Culturally relevant infrastructure	Mosque, graveyard	Mosque	Mosque	Mosque	None	Mosque, graveyard	None

8. Stakeholder Mapping and Consultations

8.1. Stakeholder mapping

Stakeholders are the individuals and organizations who either (a) stand to be affected by the project or (b) could influence on the project's success. They may be net beneficiaries or negatively affected individuals, included or excluded from decision-making, service users, or project participants. Stakeholder mapping is the identification of a project's key stakeholders, an assessment of their interests in the project and the ways in which these interests may affect a project. The main purpose of carrying out a stakeholder's analysis is to help identify:

- individuals or organizations to be engaged in consultation (these stakeholders may change or some may be added during project design and implementation).
- roles they should play and at which stage.
- the terms of relationships to be established.
- the terms and extend of information disclosure.

The following is a complete list of all stakeholders identified and consulted during the E&S scoping exercise:

Table 35. List of stakeholders

Institution/Department	Administrative level
Deputy Commissioner Office (Revenue office West)	West Karachi District
Agriculture Department (Malir)	Malir, Sindh (District Office)
Irrigation Department	Karachi, Sindh
Land Utilization Department	Sindh (Provincial Office)
Ex-Union Counselor – Sub Division Mangopir	Shah Mureed Subdivision (Taluka)
KS&WB	Circle-II (Malir & West District)
KS&WB	Gaddap Town (Malir)
KS&WB	Shah Mureed & Manghopir Sub-division
Land Utilization Officer	Sindh
Deputy Commissioner Office Malir	Shah Mureed Subdivision (Taluka)
Mukhtiarkar Office West	Manghopir Subdivision (Taluka)
Assistant Commissioner Office West	West, Karachi, Sindh
Assistant Commissioner Office West	Manghopir Subdivision (Taluka)
Social Welfare Department	Karachi, Sindh
Assistant Director Sindh Solid Waste Management)	Sindh, Province
Javed Ahmed Mahar, Conservator Wildlife Department	Government of Sindh, Karachi.
Village representatives	• Haji Noor Mohd Goth • Haji Ibrahim Goth (Deh Jam Chakra) • Haji Gul Mohd Goth • M. Murad Brohi Village (Haji Abdul Rehman) • Maharaj Goth • Patai Brohi Goth

HANDs (NGO)

Project Affected People

The matrix presented in Table 36 is used to develop the stakeholder map. The groups/entities positioned in Box A and Box B are the most important stakeholders and their interests should be considered during all phases of the project. It is also very important to build relationships with the most influential stakeholders in Box C, to keep them informed along the process. The persons/groups/institutions positioned in Box D are not key stakeholders and their participation and information can remain as minimal.

Table 36. Stakeholder map

		Degree of Influence	
		High Influence	Low Influence
Degree of Importance	High Importance	**Box A** • KWSB • Sindh Wildlife Department • Sindh Forest Department • Sindh Environment Protection Agency Stakeholders who stand to lose or gain significantly from the project AND whose actions can influence the project's ability to meet its objectives. The project needs to ensure that their interests are fully represented in the process. Overall impact of the project will require good relationships to be developed with these stakeholders.	**Box B** • PAP • Village representatives Stakeholders who stand to lose or gain significantly from the project BUT whose actions cannot influence the project's ability to meet its objectives. The project needs to ensure that their interests are fully represented in the process.
	Low Importance	**Box C** • Land utilization department (district and province level) • Irrigation department (district level) • Agricultural department (district level) • Revenue department (district level) Stakeholders whose actions can influence the project's ability to meet its objectives BUT who do not stand to lose or gain much from the project. They may be a source of risk; and you will need to explore means of monitoring and managing that risk.	**Box D** • HANDS (NGO) • Social Welfare Department Stakeholders who do not stand to lose or gain much from the project AND whose actions cannot influence the project's ability to meet its objectives. They may require limited monitoring or informing of progress but are of low priority. They are unlikely to be the subject of project activities or involved in project management.

The above analysis concludes that the stakeholders falling in Box A are the most relevant for the success of the project. These include the KWSB as the Executing Agency and main beneficiary of the project.

The PAP are the main stakeholders in terms of possible social and environmental impacts, and as such are of high importance however, their influence on decision making may be limited (their views are typically conveyed through consultations with, and the involvement of, their community or group representatives). They should be actively engaged during the consultation process. If their grievances are not taken adequately into account and lead to protests, the Project proponent's reputation and project success can be at risk.

Government agencies included in Box C can be influential in the process, particularly in terms of administrative procedures required for the project implementation phase and the management of mitigation measures, such as possible supplementary irrigation measures, formalization of settlements, etc.). Institutions listed in Box D have been engaged for the purpose of information, data collection and knowledge of the legal/administrative requirements, but whose participation in decision making will be very limited.

8.2. Initial community consultation held during site visit.

Consultations were carried out by the local Social Expert with the local communities during the field visit. The Social expert was accompanied by KWSB staff who provided clear information about the Project (location, extension, purpose, the main actors involved, the role of IFC, and purpose as consultants). Visual aids such as printed mapping was used during the consultations.

The team acquired information about the population in each village, including household structure, ethnicity, main sources of livelihood, household income, agriculture, livestock, land ownership, energy source used for cooking, education, hospitals and heath care infrastructure, culturally relevant structures, water use from the canal, facilities available in the villages, access to the markets, the role of community leaders, reasons for migration to the area, vulnerability status, indigenous people and gender role in income generation.

The local communities were optimistic regarding development in the area, however some of the local residents raised concerns about the water supply issue in the event of restrictions on water they use for domestic purposes. People also asked about employment and other small business opportunities that would be created by the Project during construction. People did not raise any apprehensions or concerns regarding impacts due to Project construction activities as they understand that the construction impacts are short term.

Table 37 Participants in community consultations during site visit

Number of representatives[19]	Name of Village
15 representatives	Patai Goth
8 representatives	Haji Noor Mohd Sindhi Goth
10 representatives	Haji Ibrahim Goth
5 representatives	Haji Abdul-ur-Rehman Goth
6 representatives	Haji Gul Mohd Goth
4 representatives	Sardar Yar Mohd Rind (Maharaj Goth)
5 representatives	Allah Dino

[19] All representatives identified themselves as member of the corresponding local council governing in each community.

8.3. Institutional consultations

Institutional consultations were carried out in early October 2020 with Government and Non-Government Organization to obtain information about the use of Canal Water, any legal or other implications that apply on the locals to utilize the canal water and the real time information about it. Table 38 provides a list of consulted persons and corresponding institution. The following sections provide a summary of the main findings and information collected during the consultations.

Table 38 Institutional consultations

S#	Name of the Person / Designation	Name of Organization/ Department	Aministrative level
1.	Deputy Commissioner Office	Revenue Office West	West Karachi District
2.	Additional Director	Agriculture Department (Malir)	Malir, Sindh (District Office)
3.	Executive Engineer	Irrigation Department	Karachi, Sindh
4.	Deputy Director	Land Utilization Department	Sindh (Provincial Office)
5.	Ex-Union Counselor	– Sub Division Manghopit	Shah Mureed Subdivision (Taluka)
6.	Superintendent Engineer (Bulk Water Supply Circle-BWSC)	KS&WB	Circle-II (Malir & West District)
7.	Asst Engineer	KS&WB	Gaddap Town (Malir)
8.	Environmental Engineer	KS&WB	Shah Mureed & Manghopir Sub-division
9.	Section Officer	Land Utilization Officer	Sindh
10.	Mukhtiarkar Shah Mureed	Deputy Commissioner Office Malir	Shah Mureed Subdivision (Taluka)
11.	Javaid Ahmed / Tapedar Manghopir	Mukhtiarkar Office West	Manghopir Subdivision (Taluka)
12.	Asst . Commissioner West	Assistant Commissioner Office West	West, Karachi, Sindh
13.	Tapedar sub-division Manghopir	Assistant Commissioner Office West	Manghopir Subdivision (Taluka)
14.	Deputy Director	Social Welfare Department	Karachi, Sindh
15.	Coordinator	HANDs (NGO)	Malir, Karachi, Sindh
16.	Manager Women Development	HANDs (NGO)	West, Karachi, Sindh
17.	Assistant Director	Sindh Solid Waste Mangement	Sindh Province
18.	Javed Ahmed Mahar	Conservator Wildlife Department	Government of Sindh, Karachi.

In general terms, the consulted institutions welcomed the project and offered their assistance along the process in order to collect all necessary data and clarify any relevant legal aspects. The consultations aimed, firstly, at gathering an initial overview over the human and economic landscape of the affected area, collecting different perceptions and qualitative descriptions of the settlements and their activities. In this respect the Revenue Department offered a description of the human landscape in the affected area, distinguishing between formal and informal settlements, although not supported with specific data or maps. Official data on land plots and maps are either obsolete or simply not available, according to the informants. Some basic characterization of the communities in terms of livelihoods was also provided by the Revenue Department, claiming that agricultural activities are rare in the area due to the high prices of the land. This aspect was confirmed by the agricultural department, which claims that official allotment of agricultural land is granted only when linked to an irrigation scheme and/or the provision of proper infrastructure, which is not the case for most of the affected communities in the area. Some exceptions can be found however, as some smallholding farmers residing in the area, own up to 10-15 acres of land in some cases.

HANDS, a non-governmental organization, also contributed to the characterization of the area, stressing the basic level of development of the communities in terms to income and access to basic services and the need for the project to provide opportunities to the affected communities. It should be noted however, that, although generally showing a good knowledge and understanding of the area, the characterization by the consulted source has been provided in very general terms without any support in the form of data, maps or figures.

The degree of dependence on the canal water and the legal regime of usage was specifically addressed during consultations. In this regard, KWSB claims that they are aware of the informal uses of the canal water. According to the source, the use of Hub Canal water is tolerated for drinking purposes, however, there is no notification or program to stop the use of water for local communities for drinking purpose. KWSB added that communities are not allowed to use canal water for agriculture or other activities but informally, seepage water from aqueducts and the canal benefits the communities to some extent (an aspect that could not be confirmed on the ground or in consultation with the communities, who claim that seepage water is not being used for agricultural fields).

From the legal and regulatory perspective, the consulted sources helped identify some of the relevant laws and rules applicable to the project (see Section 1), including the Land Acquisition Act 1894. They also informed about the administrative procedure to acquire legal status as a formal settlement and the different categories of land classification.

8.4. Additional consultations and site visits

8.4.1. Additional institutional consultations on agricultural issues

In the face of some contradicting evidence and perception on the use of canal water for agricultural purposes, an additional consultation with relevant stakeholder was held on October 20th 2020. The consulted institutional representatives included Mr. Shahid Saleem (Additional Agriculture Director), Tufail Skeikh (KWSB), Rahim Palijo (ExN KWSB), Murad Brohi (Local Ex-UC Counselor) and local community leaders. They

were consulted for further investigation on the irrigation water source as agricultural land use. The main conclusions of the consultation can be summarized as follows:

- The Hub Canal water is not used for any agriculture activities, either directly or indirectly, using well water or any other means. The team of KWSB patrols along the canal to look over any activity to get illegal connection for agriculture or other activities. The use of canal water is prohibited to use for agriculture or other activities until it is permitted by the Government. Despite that, it was acknowledged that some illegal connections were taken by the local communities without Government approval for drinking and domestic purpose.
- Rainwater is used for agriculture purposes. According to local leaders of communities, the water is accumulated in dug ponds during the rainy season, rainfall runoff flows across the hilly areas near the villages. However, in recent times they are converting land into plots for residential purposes. Land near the canal is expensive and usually people use the land for residential use (in plotting) but not for extensive agriculture use.
- The area where seepage is found is not benefiting the local communities for agriculture. There were only wild bushes and natural vegetation rather than agriculture activity in these locations.
- The farmers do not make agriculture activities consistently but on typically following seasonal rains.
- Bore water is used by some communities for drinking purposes. The agriculture which is irrigated using tube well water is not located near the canal but some distance away from the canal. The tube well depth is around 200 to 300 ft deep whereas wells are 40 to 50 ft deep reported Mr. Shahid Saleem, Additional Agriculture Director.

8.4.2. Additional site visit on agricultural issues

On October 26th, 2020, an additional site visit was performed in order to collect further information on agricultural activities near the canal and to inspect their possible dependence on seepage water. Photographic documentation and consultation with local farmers were collected, showing evidence of the rainwater collection ponds. No direct evidence (at surface level) was collected on the dependence of agricultural activities on seepage water from the canal.

8.4.3. Second community consultation (December 2020)

Due to revisions in the project designs, by which a new pipeline may be installed to replace a section of the canal or the entire canal, instead of the rehabilitation of the existing canal, a second consultation process was launched on December 21st – 23rd in accordance with the provisions of IFC's PS1. This substantial change in project design is expected to result in important consequences for both formal and informal users of the infrastructure, which up to that moment were not fully informed about new access regime to the canal water. The construction of the pipeline will result in a total restriction of any use of the water by the surrounding communities.

The objectives of this new round of consultations can be summarized as follows:

1. Inform affected communities of the new design plans and explanation of the total restriction to direct access to the water through private means (either formal or informal).
2. Discussion with affected communities of mitigation measures, and, in particular, on the proposal of a community water access initiative through selected watering points and licensed tankers for the affordable provision of water.
3. Discussion with KWSB on the design and implementation of the mitigation measures.
4. Consultation with affected communities on the installation of a PV station for the WTP.
5. Collection of baseline information from the settlement not previously identified (Goth Allah Dino).

In light of these specifications, the following issues were addressed with the community members:

i. What is the **degree of dependence** of the community on water from the canal? What percentage (approx.) of the total water consumed in the community comes from the canal?
ii. Considering the dependence of the community on water from the canal, how do community leaders **assess the impact** of the project on livelihoods and economic activities?
iii. Is there any **alternative source of water** for the community which could be further used or escalated as a substitute of water canal?
iv. What is the **average quantity of water** used by a household in one day (including human consumption, economic activities, cleaning, cooking, livestock, etc.)? How much from this water comes from the canal?
v. Do community members **pay** for directly or indirectly accessing water from the canal or any other source (tankers, pumps, connections, wells, etc.)
vi. Please explain that if the community lacks sufficient alternative water resources to cover the loss of access to the canal, some **possible solution** could be explored to guarantee water needs.
vii. In case that the demand of water needs to be covered with additional resources, what would be the **preferred solution**? Please suggest options to the consulted leaders:
    a) Digging a community well, to be managed by the community.
    b) Direct provision of water to households through tankers for an affordable fee. Tankers would collect water from the canal and distribute it to the community according to their needs.
    c) Granting direct access to the pipeline water through metered watering points for an affordable fee. Water would be directly collected by community members at a designated watering point near the pipeline.
viii. Do community members normally commute to areas at the other side of the canal? Which points or areas do they use for **crossing** the canal (under aqueduct, bridge, etc.)?
ix. Would community members be **willing to pay** for accessing alternative sources of water if the fee is reasonable and affordable? What would a reasonable price be for a gallon of water according to the socioeconomic conditions of the community?
x. Please, explain that the most feasible solution at the moment is option c), although all alternatives will be contemplated. Proceed to explain the characteristics of the system (see next section for details)

xi. In case option c) is finally implemented, does the settlement have proper road **infrastructure** for tankers to access the community? what would need to be done to make the settlement more accessible for tankers?

xii. Have there been any **drowning or fatalities** in the canal in recent times involving community members? How many in the last year? Does the canal imply other risks for the community (e.g., animal drowning)?

During the consultations, the community representatives showed a collaborative attitude and explicitly expressed their willingness to welcome the project. Nonetheless, the implications of the new designs raised some concerns among the consulted representatives, particularly regarding their high dependence on canal water. Specific data on water needs and dependence of the canal were collected during the interviews. Discussions were also held regarding different alternative options for mitigation strategies, among which the construction of community wells was not particularly welcomed, due to the poor quality of underground water in the area. If this is found to be a feasible solution, it was suggested that wells could only partially cover the needs of the community (cleaning and domestic use) and that an alternative option should be given for drinking water. The direct provision of water from the canal was mostly welcome by the representatives, although some different perspectives were shared regarding the specific mode of implementation (including distribution through water tankers and direct collection from watering points). In most of the cases, the communities expressed their unwillingness to obtain water for a fee, even if it is below market prices, alleging their lack of resources and vulnerable livelihood.

The following sections, together with other data and information sources consulted (maps, legislative documentation, official data, etc.), provide further details and findings of the consultation, including baseline socioeconomic conditions of the affected communities and the expected impacts of the project.

9. Potential Impacts & Recommended Mitigation Measures

9.1. Approach and Impact Assessment Methodology

The identification of key project risks and potential impacts should include impacts that may occur during the various phases of the project. The assessment of preliminary impacts for this project will used a simplified matrix method which considers the following parameters: whether impacts are direct or indirect, their duration, and their corresponding project phase. A preliminary determination of the **Magnitude** of the key impacts of the project, based on the parameters above and others which consider spatial extent, reversibility of the potential impacts, and irreplaceability of identified resources or values.

The probability of occurrence of each impact and the Significance of the impacts are not evaluated at the Scoping stage or in this report. but are described briefly in this section for completeness, as they form an important part of the Impact Assessment process, and because they will need to be assessed during the ESIA. A preliminary cumulative impacts assessment is also included in this Scoping Report.

To identify potential impacts (both positive and negative) it is important that the nature of the proposed project is well understood so that the impacts associated with the project can be assessed. The process of identification and assessment of impacts typically includes:

- Determining the current environmental conditions (natural and social environment) in sufficient detail so that there is a baseline against which impacts can be identified and measured.
- Determining future changes to the environment that will occur if the activity does not proceed.
- Develop an understanding of the activity in sufficient detail to understand its consequences; and
- The identification of significant impacts which are likely to occur if the activity is undertaken.

A simple, clearly defined method is used in order to accurately determine the significance of the predicted impact on, or benefit to, the surrounding natural and/or social environment. The following methodology or a similar methodology should be applied to predict the impacts during the ESIA: process:

- Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
- Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.
- Cumulative impacts are those that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present, or reasonably foreseeable future activities. The cumulative impacts will be assessed by identifying other applicable projects, such as construction and upgrade of electricity generation, and transmission or distribution facilities

in the local area (i.e. within 20 km of the proposed project) that have been approved or is currently underway.

- Nature of impact - the type of effect that a proposed activity will have on the environment and should include "what will be affected and how?"

Impacts are described by their intensity, irreplaceability, spatial extent and duration, reversibility, and their probability of occurrence as described in the following tables and sections. During the ESIA phase, scores would be attributed to each of the descriptors or factors listed in the tables in order to determine Magnitude and Significance according to the following equations:

- The **Magnitude** of an impact can be described as the anticipated severity of the impact and based on:

Magnitude = Intensity + Extent + Duration

- The **Significance** of an impact determines whether the impact will cause a notable impact on the environment and can be based on:

Significance = Magnitude of Impact x Probability.

These concepts are described in the following Tables. Some impact methodologies attribute scores to ratings, such as those in the following tables and determine Magnitude and Significance per equations mentioned above.

Potential Intensity Description (negative)	Rating
Potential to severely impact Human Health (morbidity/mortality); or to lead to Loss of species (fauna and/or flora)	Very High/Fatal Flaw
Potential to reduce faunal/flora population or to lead to severe reduction/alteration of natural process, loss of livelihoods or sever impact on quality of life, individual economic loss	High
Potential to reduce environmental quality – air, soil, water. Potential Loss of habitat, loss of heritage, reduced amenity	Medium
Nuisance	Medium-Low

Spatial Extent Description
Site specific (Project footprint + 200 m radius)
Local (<10 km from site)
Regional (within 100 km of site)
National
International/Global (e.g. Greenhouse Gas emissions or migrant birds).

Duration Description
Temporary (less than 2 years) or duration of the construction period. This impact is fully reversible. *E.g. the construction noise temporary impact*
Short term (2 to 5 years). This impact is reversible.
Medium term (5 to 15 years). The impact is reversible with the implementation of appropriate mitigation and management actions.
Long term (> 15 years but where the impact will cease after the operational life of the activity). The impact is reversible with the implementation of appropriate mitigation and management actions.
Permanent (mitigation will not occur in such a way or in such a time span that the impact can be considered transient). This impact is irreversible. *E.g. The loss of a palaeontological resource on site caused by construction activities is permanent and would be irreversible.*

Probability
Improbable (little or no chance of occurring <10%)
Low Probability (10 - 25% chance of occurring)
Probable (25 - 50% chance of occurring)
Highly probable (50 – 90% chance of occurring)
Definite (>90% chance of occurring).

The Irreplaceability of resource loss caused by impacts can be described as follows:

- High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment. For example, if the project will destroy unique wetland systems, these may be irreplaceable);
- Moderate irreplaceability of resources;
- Low irreplaceability of resources; or
- Resources are replaceable (the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment).

The **Reversibility** of impacts can be described as follows:

- High reversibility of impacts (impact is highly reversible for example, the nuisance factor caused by noise impacts associated with the operational phase of an exporting terminal can be considered to be highly reversible at the end of the project life);
- Moderate reversibility of impacts;
- Low reversibility of impacts; or

- Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment. The impact is permanent. For example, the loss of a palaeontological resource on the site caused by building foundations could be non-reversible).

For the purposes of this Scoping assessment, a **simplified Scoping Matrix** to determine **Preliminary Magnitude** of the impacts has been developed. It allows for transparency of results and considers the following:

- whether the impact is Direct or Indirect
- the duration of the Impact over time
- in which phase(s) of the project the impact will be expressed
- the preliminary Magnitude of the Impact, Before Mitigation and After Mitigation.
- whether the impact is negative or positive.

The preliminary Magnitude of the potential impacts will be presented using the following descriptors and ranking:

■ ■ ■ = high
■ ■ = moderate
■ = low
○ = no impact
+ = locally positive
+ + = regionally positive

Table 39 Evaluation matrix of preliminary key impacts of the project

Impact during	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
Construction	■ ■ ■ = high ■ ■ = moderate ■ = low ○ = no impact + = locally positive + + = regionally positive	■ ■ ■ = high ■ ■ = moderate ■ = low ○ = no impact + = locally positive + + = regionally positive	Short term Mid term Long term	Direct Indirect
Operation	■ ■ ■ = high ■ ■ = moderate ■ = low ○ = no impact + = locally positive ++=regionally positive	■ ■ ■ = high ■ ■ = moderate ■ = low ○ = no impact + = locally positive + + = regionally positive	Short term Mid term Long term	Direct Indirect

This method allows the identification of the most important and impacts and for which impact mitigation measures should be applied in order to reduce the negative effects of the project on the natural and social environments.

9.2. Preliminary Impacts and Mitigation Measures – Natural Environment

9.2.1. Air Quality

9.2.1.1. Impact description

Fugitive dust emissions during construction

Site preparation and construction activities (removal of vegetation, site grading and compaction, demolition of structures, excavation/trenching, and vehicular traffic) will cause temporary impacts, throughout the duration of the construction phase, on air quality, as a result of dust emissions which can be a significant nuisance and the source of repetitive grievances from the nearby communities.

In addition, dust emissions may have significant adverse impacts including reduced visibility, soiling of buildings and materials, reduced growth and production in vegetation and nearby cropland and may affect sensitive areas and aesthetics. Fugitive dust can also adversely affect human health.

Vehicle and Machinery exhaust, CO_2 Emissions during construction

During the construction phase, the project will generate CO_2 emissions and other emissions from heavy equipment and vehicles as well as from generators used for auxiliary power.

9.2.1.2. Proposed mitigation

- Regular spraying of construction areas and roads with spray trucks to minimise dust emissions and community grievances as well as impacts on nearby crops. Alternatives include windbreaks, gravel roads, reduced vehicle speed, dust control stabilizers on road surfaces.
- Have construction laydown areas where heavy vehicles are kept, located away from the communities and minimise traffic through communities and residential areas.
- Regular washdown of vehicles and construction equipment, in a designated area equipped with drainage and settling basins.
- Monitor particulate matter (TPM, PM10 and PM2.5) at various locations over the duration of the construction phase to ensure levels meet the WHO Air Quality Guidelines [20] included in IFC General EHS Guidelines (2007). Include background measurements during the ESIA stage, prior to construction to determine the background air quality during both the wet season and dry season.
- Cover dedicated separated excavated topsoil, subsoil and muck piles to avoid dust generation, erosion and sediment transport.
- Regular vehicle maintenance
- Minimise vehicle idling and trip optimization.
- Worker EHS awareness training.

[20] World Health Organization (WHO). Air Quality Guidelines Global Update, 2005.
PM 24-hour value is the 99th percentile.

- A grievance mechanism that allows to address grievances from communities promptly.

9.2.1.3. Preliminary impact assessment

Table 40 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct
During operation	○ = no impact		Long term	

9.2.2. Noise

9.2.2.1. Impact description

The nearby communities are within one kilometre from the canal, and the construction activities for this project, including demolition, excavation/trenching, the establishment of a construction laydown area, worker's camp (if applicable), heavy vehicle traffic, worker transportation (if applicable), construction of the solar PV plant and WTP rehabilitation can all be sources of noise and of significant grievances from community members.

During construction, people may also be concerned about vibrations that may cause building damage.

During the operations phase, the WTP is not expected to generate greater noise levels than in the past and the small solar PV facility is not expected to generate nuisance noise.

9.2.2.1. Proposed mitigation

- Follow Sindh Environmental Quality Standards for Noise and IFC's noise level guidelines (General EHS Guidelines, 2007), whichever is most stringent, respecting zoning and time of day restrictions. Avoid night shifts because of the proximity of the communities and sensitive receptors in the surrounding areas.

	Noise Level Guidelines (IFC General EHS Guidelines One Hour LAeq (dBA))		Sindh Environmental Quality Standards for Noise One Hour LAeq (dBA)	
Receptor	Daytime 07:00-22:00	Nighttime 22:00-7:00	Daytime 06:00-22:00	Nighttime 22:00-6:00
Residential Areas	55	45	55	45
Commercial Areas	70	70	65	55
Industrial Areas	70	70	75	65

Silence Zones*	-	-	50	45

Note: * Silence Zones: 100 m around hospitals, education centres and courts.

- Have construction laydowns away from communities, where heavy vehicles are kept, to minimise traffic through the villages and to minimise community noise.
- Minimise vehicle idling, trip optimization.
- Worker EHS awareness training.
- Grievance Mechanism that addresses grievances from community promptly.
- Consider noise barriers around construction sites if noise is a problem and a constant source of community grievances. Topographic features in the landscape can also be effective to buffer noise levels as are berms and embankments. These are also useful for visual amenity impacts.
- During operations of the solar PV station, consider noise barriers around the sub-station transformer if sensitive receptors are located near this noise emitting source. Topographic features in the landscape can also be effective to buffer noise levels.
- If grievances arise due to noise during construction or operations, monitor noise levels for compliance with standards and implement measures as above.

9.2.2.2. Preliminary impact assessment

Table 41 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct
During operation	■ ■ = moderate	■ = low to ○ = no impact	Long term	Direct

9.2.3. Surface Water / Water Bodies

9.2.3.1. Impact description

Construction activities may adversely impact surface water bodies due to the following:

- construction activities such as aqueduct rehabilitation, trenching/excavations and vehicular traffic along the canal may impact streams (seasonal and permanent) flowing under the aqueducts, as well as wetlands and ponds created by rainwater and/or seepage by altering natural drainage patterns. This impact can be accentuated if sufficient space for pipeline construction is not available within the service road right-of-way along the canal and areas outside the right of way need to be

used for excavation, trenching and for depositing the excavated soil piles and any demolition waste from canal sections and aqueduct rehabilitation.

- use of water for dust suppression during dry season (See Section 9.2.1).

During operation:

- It is likely that the canal rehabilitation will reduce the amount of surface water in the seasonal and permanent streams that flow under the aqueducts and towards the west of the canal and the Hub River, it is possible that the project will reduce the water that accumulates in nearby ponds and limits the amount of water that reaches the wetland areas along the west side of the canal. The extent of this impact (extent to which current seepage rates contribute to surface water bodies) will need to be assessed during the ESIA stage.
- it is likely that the seepage contributing to wetlands, ponds, streams, and associated vegetation may contribute to wildlife habitat and water for agricultural purposes. Dependence of ecosystems and ecosystem services on seepage water will need to be assessed further during the ESIA.
- Cleaning of the solar PV panels will require a total of 70 m^3/month for nine months if dry-cleaning methods are not used, e.g., approximately 630 m^3/year. Water used for panel cleaning must meet quality standards of the panel manufacturer.

9.2.3.2. Proposed mitigation

- During Construction: Identify a set-back distance from waterbodies such as ponds and wetlands and use markers or barrier tape to minimise disturbance to these area during construction.
- divert flow from excavation/trenching areas using temporary channels or culverts and rehabilitate streambed with similar substrate and characteristics over the buried pipeline or use culverts.
- Following construction, revegetate the disturbed areas with local plant species (buried pipeline, unused topsoil and soil piles with native grass and other flora species (no alien or invasive species).
- Following construction, restore any riparian vegetation and vegetated areas that were damaged or removed during construction to prevent erosion and sediment transport into surface water bodies.
- For operational impacts: the ESIA will need to assess (i) the degree of dependence of surface water bodies with seepage and (ii) the values associated with the surface water bodies (such as habitat for biodiversity, source of water used for agricultural purposes etc.).
- During operations: monthly monitoring of surface water bodies (flows and/or water levels where and if appropriate) to measure response to the lack of seepage and any associated impacts.
- See biodiversity and ecosystem services impacts for mitigation measures associated with impacts to surface water.
- Surface water monitoring during operations.

- Worker EHS Awareness training.
- See Section 9.2.1.2. for ways to minimise the use of water for dust suppression during the dry season.
- Cleaning schedule optimization can minimize the annual volume of water used for PV panel cleaning.
- Dry cleaning methods should be considered to minimize any pressure on freshwater sources. Dry cleaning methods include semi-automated options consisting of truck/tractor configurations with customized cleaning equipment or fully automated rigs which run along the panels as a track and clean the panels with spinning brushes, micro-fiber cloth wipers, a combination of brush and vacuum cleaner etc. and are widely used in arid countries.

9.2.3.3. Preliminary impact assessment

Table 42 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct
During operation	■ ■ ■ = high	■ ■ = moderate To ■ = low	Long term/permanent	Direct and indirect

9.2.4. Groundwater (Quantity)

9.2.4.1. Impact description

Construction activities may adversely impact groundwater from the following:

- alteration in local drainage patterns during construction, trenching/excavation may adversely impact groundwater flow to local bore wells and dug-out wells.
- during operation, it is possible that the absence of canal seepage results in a decrease in groundwater flow to local boreholes/wells.

Operations may alter the soil moisture and groundwater adjacent to the canal. Detailed studies of the impact of seepage on soil moisture and groundwater will need to be included in the ESIA.

9.2.4.2. Proposed mitigation

- An inventory of nearby wells should be undertaken during the ESIA phase to be able to monitor and compare with any changes in well water levels during the construction phase and following construction to monitor impact of rehabilitation works. If wells are likely to dry up as a result of the project, alternate means of water supply will need to be evaluated during the ESIA stage to compensate well owners.

- During the ESIA stage determine the dependence on seepage water of water wells located downstream from the canal (to the west).
- Any anticipated long-term effects on wells in the vicinity of the project will need to be compensated, by providing water to the well owners (refer to report for options for providing water to water users).
- Monitoring of groundwater levels in nearby wells during the wet and dry seasons during operations (over a period of one to two years or as determined in the ESIA).

9.2.4.3. Preliminary impact assessment

Table 43 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct
During operation	■ ■ = moderate	■ = low	Long-term/permanent	Direct

9.2.5. Surface and Ground Water Quality

9.2.5.1. Impact description

Construction activities may adversely impact surface and groundwater quality from the following:

- run-off from construction sites may contain petroleum hydrocarbons, grease, lubricants, solvents, and other waste materials.
- wastewater and sanitary water from construction camps and/or worker facilities.
- during construction, exposed soils, from trenching, excavation, clearing and other earthwork may cause sediment transport into surface water bodies during the rainy season.
- construction activities may adversely impact groundwater quality in nearby wells if wells do not have wellhead protection from surface water contaminants.
- during operation, runoff from precipitation may cause erosion of areas that have not been revegetated and may cause erosion of the PV plant foundations.

During operation, wastewater and sanitary wastewater from the facilities may lead to surface water contamination if effluents are not treated adequately.

9.2.5.2. Proposed mitigation

- During Construction: Stormwater drainage mechanism with sedimentation basins need to be designed and constructed to settle solids from runoff should take into account runoff from contributing catchments and include adequately sized culvert and ditches.

- During Construction: Stormwater drainage should be designed such that runoff from the construction site does not discharge directly to any surface water body, dry ditch, channel, stream, pond, or wetland area.
- Cover dedicated separate excavated topsoil, subsoil and muck piles (from trenching excavation) to avoid dust generation, erosion and sediment transport into water bodies.
- Minimize any vegetation removal prior to heavy rainfall periods to avoid exposed soil erosion.
- Stormwater drainage systems should be regularly cleared of debris (during construction and operations)
- Silt barriers and check dams should be used around construction activities near water bodies to prevent sediment transport into watercourses.
- An inventory of nearby wells and groundwater quality testing to determine background groundwater quality should be undertaken during the ESIA phase to be able to monitor and compare with any changes in well water quality (or perceived changes in well water quality) in neighbouring wells.
- During construction and operation: wastewater and sanitary wastewater should not be discharged to a surface waterbody without being treated to meet local effluent quality guidelines and IFC's General EHS Guidelines' Indicative Values for Treated Sanitary Sewage Discharges (2007). Septic tanks can be used.
- Following construction revegetate disturbed and exposed areas native grasses, shrubs, and flora to prevent erosion (no alien or invasive species).
- Spill Prevention Plan, secondary containment around all hazardous substances and petroleum hydrocarbon tanks and containers
- Waste management plan
- Hazardous Materials handling Procedures
- Emergency Response Plan - construction
- Have spill kits available on site in high risk areas
- Worker EHS Awareness Training

9.2.5.3. Preliminary impact assessment

Table 44 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect

During construction	■ ■ = moderate	■ = low	Short term	Direct
During operation	■ ■ = moderate	○ = no impact		

9.2.6. Soil Moisture

9.2.6.1. Impact description

The project will likely cause a decrease in soil moisture along both sides of the canal and downgradient towards the Hub River from (i) the elimination of seepage from cracks in aqueducts that contribute to surface water bodies that in turn contribute to water percolating into the soil and soil moisture content and (ii) from the elimination of direct subsurface seepage from canal cracks into the underlying soil. Moisture and groundwater will flow (slowly) downgradient towards the Hub River.

Over the years, soil moisture (in addition to surface water) has contributed to the vegetation growth in the PAA that is less affected by the annual dry seasons and droughts, providing wildlife habitat, grazing areas and fodder for livestock year-round. Without mitigation, these habitats will revert back to dryer bush land/dry desert habitats with scarcer vegetation with seasonal streams, ponds and wetlands during the rainy season.

9.2.6.2. Proposed mitigation

- The ESIA will need to assess (i) the degree of influence of seepage on soil moisture and (ii) the degree of dependence of the biodiversity habitats, cropland, and grazing land within the PAA on soil moisture to determine whether any compensation would be required for impacts on cropland or grazing areas.
- If determined necessary on the ESIA, quarterly monitoring of soil moisture in conjunction with monthly surface and groundwater monitoring during operations for an initial period of 1 or 2 years or as prescribed following ESIA studies.

9.2.6.3. Preliminary impact assessment

Table 45 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ = low to ○ = no impact	■ = low to ○ = no impact	Not significant	Very localized
During operation	■ ■ ■ = high	■ ■ = moderate	Long term / permanent	Direct and indirect

9.2.7. Soil Structure, Characteristics and Quality

9.2.7.1. Impact description

Earth movement machinery, heavy construction equipment, vehicular traffic, soil, muck, and aggregate piles etc. can cause changes in soil structure and characteristics due to compaction and lead to decreased soil

quality and productivity. Construction sites are also at risk of soil contamination. In addition, trench excavation and pipeline installation may have impacts on surrounding soil structure, however, studies on pipeline projects indicate soil structure and characteristics generally recover on average after 6 years.

The canal rehabilitation section of the project will use the Hub Canal service road as the main access road and working strip for the canal rehabilitation activities. The pipeline alignment over the first 6.2 km will be to the west of the canal, within the canal ROW and service road alignment. The pipeline working strip will be within the service road alignment and/or canal ROW and may require minimal vegetation clearing but is generally flat and follows the canal infrastructure and service road elevation. The pipeline is located closer to and within the peri-urban areas closer to Karachi. Once the pipeline crosses over to the east side of the canal, the working strip will be within the service road alignment located on that side of the canal and remain within the canal ROW and will avoid populated and agricultural areas located on the west side of the canal.

Trench excavation will require excavated soil management activities. It will be necessary to separate topsoil from subsoil, keeping them in separate piles and plan their re-use. Because most of the excavation will mostly be carried out within the service road allowance, there will be less quantities of topsoil.

9.2.7.2. Proposed mitigation

- Excavated soils management: topsoil and subsoils shall be separated and kept separately in dedicated covered piles.
- Topsoil stored in piles for long periods of time will need to be raked and aerated to avoid compaction.
- Construction staging and planning within the canal ROW will minimise vegetation clearing and footprint of working areas to minimise soil compaction.
- Working strips will be restored to their initial conditions and levelled, any affected areas not being used as service roads after construction will be revegetated using stored topsoil and local species.
- Excess soil, muck and demolition wastes shall be re-used to infill the disused canal section. Only “clean fill” shall be used to infilling purposes.
- Contaminated soil by accidental spills during construction activities should not be mixed with other soil piles and should be kept separately and set aside for remediation.
- Waste and hazardous waste handling, storage and transportation will be done in such a manner as to not cause contamination of soil, surface water or groundwater.
- Spill Prevention Plan, secondary containment around all hazardous substances and petroleum hydrocarbon tanks and containers
- Waste management plan
- Hazardous Materials handling Procedures
- Emergency Response Plan - construction

- Have spill kits available on site in high-risk areas.
- Worker EHS Awareness Training

9.2.7.3. Preliminary impact assessment

Table 46 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	During construction and some years afterwards	Localized along service road and pipeline corridor within the ROW
During operation	■ = low to ○ = no impact	■ = low to ○ = no impact	Not significant	Not significant

9.2.8. Erosion and Sediment Transport

9.2.8.1. Impact description

The areas prone to erosion that may be impacted (e.g., exacerbate erosive processes) are:

- temporary streamflow channels under aqueducts.
- exposed soils and soil piles due to trenching, excavation ad other groundworks.

9.2.8.2. Proposed mitigation

- Use appropriate setbacks from water bodies and use markers or barrier tape to minimise disturbance of water bodies.
- Use silt screens and check dams where necessary.
- Implement a temporary stormwater management early in the construction phase.
- Stormwater management system for the operations phase, including adequately sized culverts for drainage ditches and stream crossings.
- During site preparation, earth movement, excavation and grading activities, maintain topsoil, subsoil and muck in separate covered piles to be re-used to cover exposed areas once pipeline installation and PV plant components are completed.
- During construction, if possible, and operation, revegetate affected areas including under the PV modules and re-establish any riparian vegetation along streams that may have been damaged with native grasses and other native flora. For the PV plant component, revegetate with short native grasses to prevent erosion and avoid excessive growth (which can present bushfire risks).

- Worker EHS Awareness Training

9.2.8.3. Preliminary impact assessment

Table 47 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct/Indirect
During operation	■ = low	■ = low to ○ = no impact	Long term	

9.2.9. Soil Contamination & Pollution

9.2.9.1. Impact description

Soil contamination is a risk at all construction sites and industrial facilities where hazardous substances are handled and stored. Exposure to hazardous substances in the workplace puts workers at risk. Hazardous substance spills at the project site could adversely impact soils, surface water, community groundwater/well water, community health and biodiversity.

9.2.9.2. Proposed mitigation

- Waste management plan that includes solid waste, liquid effluents and hazardous waste for both construction and operations phases.
- Spill prevention plan that includes secondary containment for all hazardous substances and petroleum hydrocarbon tanks and containers for both construction and operations phases.
- Spill kits located where necessary (e.g., near any surface water bodies) for both construction and operations phases.
- Hazardous substance handling and storage procedures.
- EHS Training and awareness training for all workers.
- Emergency Preparedness and Response Plan for accidents and environmental incidents.

9.2.9.3. Preliminary impact assessment

Table 48 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct/Indirect
During operation	■ = low	■ = low to ○ = no impact	Long term	

9.2.10. Vegetation/flora

9.2.10.1. Impact description

Construction activities along the canal that may impact vegetated areas/flora include:

- excavations and trenching (for the pipeline),
- areas to deposit excavated soil piles and demolition wastes from canal sections and aqueducts,
- the opening of new access roads, permanent and/or temporary,
- temporary construction work camps and offices,
- construction laydown areas (for temporary stockpiling of equipment and materials),
- During construction, flora will be affected by dust especially during the dry season.
- impacts to the Guggar/Gugel plant identified during the biodiversity surveys (*Commiphora wightii*, a critically endangered species (CR))

If insufficient space is available within the right of way of the service road for these construction activities, vegetation may be impacted by these activities.

During operations, the lack of seepage will (i) decrease the amount of water in surface water bodies (wetlands, ponds and streams) which supports riparian vegetation/habitat for terrestrial fauna and birds (ii) decrease the soil moisture content which will affect vegetation growth patterns and in turn impact wildlife habitat. Dependence of ecosystems (and ecosystem services) on seepage water will need to be assessed further during the ESIA.

9.2.10.2. Proposed mitigation

During Construction

- Use appropriate setbacks from vegetated areas and water bodies by using markers or barrier tape to minimise disturbance and creeping of construction areas into neighbouring green space.
- Select the location of construction camps and laydown areas with the aim of avoiding the clearing of vegetation, by using available modified and peri-urban areas.
- Avoid locating new access roads and locating laydown areas near riparian vegetation and water bodies (even if seasonal).
- Identify the location of the Guggar/Gugel plant identified during the biodiversity surveys (*Commiphora wightii*, a critically endangered species (CR)) and use taped barriers or other barriers to establish a set-back around it to avoid any impacts during construction (refer to Figure 24 in Section 7.2.7.3 for location of sighting of Guggar/Gugel plant)

- Have biologists on site during construction to identify any EN or CR species (and other individual Guggar/Gugel plants), if damage is unavoidable due to project activities, attempt to transplant ahead of project activities, if possible.
- Regular spraying of construction areas and roads with spray trucks to minimise dust emissions (See section 9.2.1 for more related mitigation measures under Air Quality).

During Operations

- To mitigate impacts during operations: the ESIA will need to assess (i) the degree of dependence of vegetation patterns in the PAA with seepage and (ii) impacts of a change in vegetation pattern on ecosystem services and wildlife habitat.
- *Commiphora wightii*, the critically endangered species (CR) found in the PAA during the site visits is a species that prefers drier conditions. The ESIA will require a Biodiversity Action Plan (BAP) to address impacts, mitigation and compensation of impacts to this species. The BAP should also include *Manis crassicaudata* (Indian pangolin). The Sindh Wildlife and Forestry Departments should be consulted during the preparation of the BAP and other entities such as IUCN, and Conservation NGOs to develop mitigation and compensation measures.

9.2.10.3. Preliminary impact assessment

Table 49 Evaluation matrix of preliminary impacts on vegetation patterns

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct/Indirect
During operation	■ ■ ■ = high	■ ■ = moderate	Long term / permanent	Direct and indirect

note: * the impact of elimination of seepage on vegetation around the canal will be studied in more depth during the ESIA stage of the project.

Table 50 Evaluation matrix of preliminary impacts on Commiphora wightii (CR)

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct/Indirect
During operation	■ = low	○ = no impact to + = locally positive	Long term	Direct and indirect

note: * the “do nothing” option for this CR species implies it remains at risk unless mitigation includes a management plan to increase population size in the PAA.

9.2.11. Fauna

9.2.11.1. Impact description

Construction activities may impact wildlife and wildlife habitat due to direct impacts of project footprint, noise, dust emissions and traffic, as well as impede connectivity (e.g., rehabilitation of aqueducts are likely to prevent terrestrial fauna from crossing the canal under the aqueduct overpasses and may also disrupt connectivity for aquatic fauna in the streams that flow under the aqueducts).

Construction activities may also impact the following EN species observed or known to frequent the PAA: *Manis crassicaudata* or Indian pangolin (EN), *Aquila nipalensis* or Steppe Eagle (EN), *Falco cherrug* or Saker Falcon (EN) and other raptors in the PAA (note the location of raptor roosting sites observed during the scoping site visits in Figure 24 and section 7.2.7.4).

During operations, the lack of seepage will (i) decrease the amount of water in surface water bodies (wetlands, ponds, and streams) which provides habitat to aquatic fauna and supports riparian vegetation/habitat for terrestrial fauna and birds (ii) decrease the soil moisture content which will affect vegetation growth patterns and in turn impact wildlife habitat. Dependence of ecosystems (and ecosystem services) on seepage water will need to be assessed further during the ESIA.

9.2.11.2. Proposed mitigation

- Use appropriate setbacks from vegetated areas and water bodies by using markers or barrier tape to minimise disturbance and creeping of construction areas into neighbouring green space/wildlife habitat.
- Select the location of construction camps and laydown areas with the aim of avoiding the clearing of vegetation, by using available modified and peri-urban areas.
- Maintain connectivity for wildlife under aqueducts or over canal at regular intervals.
- Avoid impacts to the following protected species: Steppe eagle and the Saker falcon (and other raptors in the area). The ESIA/ESMP should develop mitigation measures specific for these species. Have biologists on site during construction to carry out capture and relocation of fauna, as required.
- Avoid impacts to Indian Pangolin. The ESIA/ESMP should develop a mitigation plan specific for this species. Have biologists on site during construction to carry out capture and relocation of fauna, as required.
- Avoid impacts to amphibian and aquatic fauna: Have biologists on site during construction to carry out capture and relocation of aquatic fauna and amphibians prior to interrupting flow in or seepage to any streams or water bodies.
- To mitigate impacts of operations: the ESIA will need to assess the degree of dependence of wildlife and wildlife habitat on seepage.

9.2.11.3. Preliminary impact assessment

Table 51 Evaluation matrix of preliminary impacts on fauna

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct/Indirect
During operation	■ ■ = moderate	■ = low	Long term / permanent	Direct/Indirect

9.2.12. Ecosystem Services

9.2.12.1. Impact description

Provisioning Services:

- The project will have a long-term **net positive effect** towards meeting the shortfall in water supply to the City of Karachi, however the water supply may be temporarily interrupted during the rehabilitation of the first 11 km of canal. The pipeline can be built without interrupting flow in the canal.
- The project will adversely impact communities that rely on canal water for human and animal consumption: impacts include lack of access of communities to water for their own consumption and for their livestock as well as impacts to vegetation growth patterns in the PAA which in turn influence availability of grazing areas and fodder for livestock.

Regulating Services:

- During operations, the project may impact the source of water to communities and crops during prolonged periods of drought.

Cultural Services:

- The section of canal that will be replaced by a buried pipeline will impact the availability of recreational spaces used for camping, picnics, walking and leisure activities (as well as bathing, washing clothes and dishes).

Supporting Services:

- The project may impact supporting services of water that contribute to the creation of ponds, wetlands and streams and supports vegetated areas and percolation through soil and groundwater and provide for subsistence agriculture and vegetation for grazing/fodder. Impacts may include a decrease in employment opportunities on larger cropland areas if cropland is supported by seepage water (surface water or soil moisture/groundwater). The extent of dependence of supporting services will need to be assessed during the ESIA.

9.2.12.2. Proposed mitigation

- The alternative of canal rehabilitation over the first 11 km and pipeline over the remaining section of the canal minimises disruption of water to the City of Karachi compared to the base case alternative of rehabilitation of the canal over its entire length, but the impact will still be moderate and will require providing the city with fresh water from other sources.
- Mitigation measures for some ecosystem services are included in the natural physical environment impact sections (surface water, soil moisture, groundwater), flora and fauna impact sections and social impact sections (grazing land/fodder for livestock). The full ecosystem services impact assessment will be carried out during the ESIA and will assess the level of dependence on seepage of ecosystems and ecosystem services in the PAA.
- For the reach that will be replaced with a pipeline, rehabilitate the service road or ROW (or the empty unused canal itself, if deemed safe) into an area that can be used by community members for recreational purposes (camping, picnics, walking and leisure activities).

9.2.12.3. Preliminary impact assessment

Table 52 Evaluation matrix of preliminary impacts on the PAA ecosystem services

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ ■ = high	■ ■ = moderate	Short term	Direct
During operation	■ ■ ■ = high	■ = low	Long term / permanent	Direct / Indirect

Table 53 Evaluation matrix of preliminary impacts on the City of Karachi water supply

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct
During operation	○ = no impact	+ + = regionally positive	Long term	Direct

9.2.13. Waste Management

9.2.13.1. Impact description

The construction phase will generate solid and non-hazardous waste, hazardous waste and wastewater effluents. Solid waste will include inert demolition waste from aqueduct structures and canal sections that need to be rehabilitated. During operations, the new PV plant will produce solid non-hazardous waste such as refuse generated by workers, scrap metal and domestic waste, as well as hazardous waste. Hazardous

wastes may include spent solvents, oily rags, empty paint cans, broken PV panels, defective or broken electrical materials, empty containers.

It is expected that the waste generated by the WTP and pumping station will not change significantly, including the generation of sludge by the WTP, however this should be assessed further during the ESIA and detailed design and feasibility studies for the WTP.

9.2.13.2. Proposed mitigation

- A Waste Management Plan solid, liquid and hazardous waste streams based on a hierarchy that considers prevention, recycling and reuse, treatment and disposal should be adopted.
- The closest waste management facility to the project site is the Jam Chakro landfill site which accepts municipal solid waste, hazardous waste, and has recycling facilities for plastics, paper/cardboard, scrap metal and composting facilities.
- Segregate waste at the source and store in designated areas at construction laydown areas.
- Broken PV panels must be segregated and collected as waste of electric and electronic equipment (WEEE) paying particular attention to avoid dispersion in the environment of any fragments.
- Waste should be removed at regular intervals and not allowed to accumulate.
- Wastewater effluent treatment (see Water Quality)

9.2.13.3. Preliminary impact assessment

Table 54 Evaluation matrix of preliminary impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct/Indirect
During operation	■ = low	■ = low to ○ = no impact	Long term	Direct

9.3. Key Risks and Mitigation Measures – Social Environment

9.3.1. Access to water by affected communities.

9.3.1.1. Risk description

As depicted in the baseline analysis, a large share of the affected population is highly dependent on canal water for human and animal consumption as well as other domestic uses. Out of the seven identified settlements, five are directly dependent on canal water, which implies a total population of about 8,000 inhabitants. It should be noted that out of this directly affected population, a large majority (7,150) are settled in informal villages without any legal recognition as a residential area by the competent authorities (Haji

Ibrahim Goth and Maharaj Goth). Communities without legal recognition may not be eligible for services such as water distribution systems, sewage/wastewater treatment, electrical distribution and basic infrastructure etc. and therefore be more vulnerable to the effects of restricting access to canal and canal water. In the face of the proposed project description, through which the open canal infrastructure will be substituted by a water pipeline along the entire section, the affected communities will be deprived of water for all basic uses. It should be noted that when asked about the reasons for having settled in the area, some of the consulted community leaders stressed the importance of the canal as a factor, some of them even alleging shortage of rainfall as a reason to leave their territories of origin and settle in Karachi conurbation. The livelihood disruption of full restriction to canal water may be extremely detrimental to the affected communities, as not only human consumption will be severely impacted, but also livestock activities will be rendered unfeasible without water sources for animal consumption or grazing areas/fodder. In the absence of any mitigation measures, the likelihood of (non-land related) economic displacement as a consequence of shortage of water will be very high[21].

The remaining two settlements, which are not directly served by the canal, are also expected to be impacted by the project, particularly in the case of Noor Mohd Sindhi Goth, where the borehole that serves the community is believed to be benefited from the canal water through underground infiltration. Nevertheless, this aspect will need to be further assessed and confirmed during ESIA stage. In the case of Gul Mohd Goth, the impact of the project is expected to be minimal, as they make use of water from the canal only in cases of shortage in the public network system[22].

When asked about available alternative sources of water for the community in the face of water canal restrictions, only in few cases the villages count with other options for water collection, which in most cases are either not apt for human consumption (boreholes) or imply unaffordable costs to the community (water tankers). The following table summarizes the community leader´s perceptions on alternative sources of water:

Table 55. Community leaders' perceptions on availability of alternative water sources[23]

Community	Alternative sources of water
Haji Ibrahim Goth	Bore water is brackish up to 300 ft deep or more. There is no alternative solution except the tanker water which currently cost is Rs.3000 / 1000 gallon or using brackish water that creates health issues. Lack of water storage facilities at homes is also a problem for the feasibility of distribution through tankers
Maharaj Goth	They use bore water when there is shortage of water through canal, however it is brackish at 300 ft deep. There is no alternative source for drinking purpose.
Patai Brohi	Digging wells may serve the purpose but it is very brackish water

[21] The option of migration as a consequence of the limitation of access to canal water has been explicitly mentioned by community leaders in Haji Ibrahim

[22] The frequency and duration of such shortages are unknown and will need to be further investigated in ESIA stage in over to quantify the specific impact over this community

[23] Perceptions refer to current available sources to the community.

Allah Dino	Paid tanker water is the only available alternative at the moment
Gul Mohd Goth	Not directly impacted. The community receives water supply line provided by Government.
Noor Mohd Sindhi Goth	This community gets water from a bore well next to the canal. Community leaders believe that the well is fed from the canal through infiltration. There are no alternative water resources except tanker water. The cost of water would currently be around Rs.6000 for 3000 Gallon. The bore water is brackish in the area up to 180 feet depth or more.
M. Murad Brohi Village	No alternative source of water

9.3.1.2. Proposed mitigation

In the face of the severe impacts expected from the total limitation of access to canal water for the communities, it is proposed that a Community Water Access System is developed by KWSB in order to compensate for the loss of access that the construction of the pipeline will imply to nearby communities.

IFC Performance Standard 1 (GN19)

In the event of impacts by project activities other than land acquisition or restriction of access to land use, the client's social and environmental risks and impacts identification process under Performance Standard 1 should address how these risks and impacts will be avoided, minimized, mitigated, or compensated for by the client. Examples include the loss of access to state-owned sub-surface minerals by artisanal miners, and/or pollution **or project-related disruption of access to water on land not acquired by the project** or whose use is not restricted by the project. While Performance Standard 5 will not apply to these situations, the client should nonetheless consider appropriate mitigation measures for the affected people under Performance Standard 1.

At the moment, the most feasible option[24] for the provision of alternative water sources to the communities would have the following characteristics:

i. Installation of a number of **watering points** along the canal/pipeline. A preliminary suggestion would consist of installing one specific watering point for each of the affected communities.
ii. Watering points can be provided with a **meter for monitoring** of the water demand by each community so that future needs can be properly assessed.
iii. Different **modalities of water distribution**, to be alternatively or simultaneously implemented, are suggested. The exact modality of distribution will need to be further investigated through a participatory process during the ESIA stage[25]:
    a) Since some of the settlements are not legally recognized, the provision of water can be performed through **licensed tankers** that would distribute the water among affected

[24] During consultation with communities, the construction of community borewells was also considered as a possible mitigation measure. Initially, this measure was conceived to be implemented jointly with canal watering points in order to reduce the water stress from the canal. However, given the alleged poor water quality of underground water and the limited demand of water required to cover community needs, this option has been discarded for the Community Water Access System

[25] When asked in consultations about the multiple options for community water delivery KWSB expressed its willingness to adapt to the community needs although it expressed a preference over direct collection by the communities at the designated watering points, instead of the use of tankers.

households. In this case, KWSB can collect fees for the licenses, whereas private providers would charge a price to the final users. Final prices will need to be established by KWSB taking into consideration the vulnerability conditions of the final users in order to guarantee affordability.

b) Alternatively (or simultaneously) to this option, communities can **directly access** the water points for collection. A system of affordable fees or free distribution with possible limited quotas shall be considered.

c) Finally, KWSB might consider **the direct and free of charge distribution of water through hired tankers**.

iv. The total **demand for water** will need to be established at ESIA stage. A preliminary assessment through consultation with community leaders has been performed during scoping stage, yielding a total potential demand of 0.10 MGD. The following table summarizes the estimated calculations.

Table 56. Estimated water demand for the proposed Community Water Access System

Community	Daily Water demand[26] litres/per HH/per day	Number of HH	Average demand (l)
Haji Ibrahim Goth	250 to 300	1,200	330,000
Maharaj Goth	500 to 700	22	13,200
Patai Brohi	600 to 700	40	26,000
Allah Dino	800	20	16,000
Gul Mohd Goth	500-600	5,000	n.a.
Noor Mohd Sindhi Goth	500 to 700	45	27,000[27]
Haji Abdul Rehman Goth	800 to 1000	65	58,500
TOTAL DEMAND (MGD[28])	N/A	6392	0.1034 MGD

v. **Affordability** issues will need to be assessed during ESIA studies. Two possible scenarios are contemplated:

a) If the willingness-to-pay for water is sufficient among the communities to sustain market conditions, KWSB can charge a fixed fee to private tanker owners, who in turn would provide water distribution services for a final price. The final price will need to be regulated and negotiated with affected communities during ESIA stage.

b) If willingness to pay for water is not sufficient to sustain market conditions, water will need to be distributed free of charge or for a reduced price among the communities, by KWSB, either

[26] Estimations provided in consultation with community leaders.

[27] Canal water needs to be confirmed subject to the degree of dependence of borehole on canal water filtration.

[28] Million (Imperial) Gallons Day

directly or through hired service providers. Fixed monthly water consumption quotas would need to be established and negotiated with the communities.

A preliminary assessment of the preferred mitigation options by PAA, as well as their willingness to pay for water services has been performed in consultation with local leaders for each settlement. The interviewed representatives were offered the three following options:

a) Digging a community well, to be managed by the community.
b) Direct provision of water to households through tankers for an affordable fee.
c) Granting direct access to the pipeline water through metered watering points for an affordable fee. Water would be directly collected by community members at a designated watering point near the pipeline.

Further collection of data and investigation will need to be performed during ESIA stage to confirm the results. In general terms, communities would welcome the installation of bore wells in their communities as partial solution to meet non-drinking needs, due to the poor quality of the underground water. The distribution of water through tankers is also welcomed although all but one community rejected the possibility of paying a few for the services. The lack of water storage facilities in dwellings is another feasibility issue raised by the consulted informants. Direct collection at the watering points is also generally accepted by the communities, except in the case of Maharaj, where the lack of transportation means has been highlighted as a possible barrier. The following table provides further details of the preliminary investigation.

Table 57. Willingness to pay for water services in project affected communities.

Community	Do community members pay for directly or indirectly access to water from the canal or any other source (*tankers, pumps, connections, wells, etc.)*	Preferred mitigation solution	Willingness-to-pay
Haji Ibrahim Goth	No	a) They would welcome the construction of boreholes, however, bore water is very contaminated and brackish. Besides, a high number of wells will be required given the population size. b) Direct provision of water to household through tankers is acceptable, but without fee. The tanker will need to serve many families as not every household has water storage capacity. Therefore, frequent tanker trips will be required to meet the needs of the community. c) Collecting of water from the metered points can be managed but fees cannot be afforded.	Not willing to pay
Maharaj Goth	No	a) This option is welcome, but only for non-drinking uses. b) They welcome this option, but they cannot afford fees c) Both collection of water and affordability are the concerns of community as they do not have transportation means and water storages.	Not willing to pay

Community	Do community members pay for directly or indirectly access to water from the canal or any other source (*tankers, pumps, connections, wells, etc.)*	Preferred mitigation solution	Willingness-to-pay
Patai Brohi	No	a) Acceptable, but water is brackish and can be used only for cleaning or other activities, but not for drinking purpose. b) Acceptable, but free of charge. People cannot afford payment. c) Acceptable. The collection of water can be managed but affordability is the main concern.	Not willing to pay
Allah Dino	No	a) No. (It is very brackish) b) Yes, but without fee, as fees are not affordable c) Yes, but without fee. They can manage the collection of water	Not willing to pay
Gul Mohd Goth	They have proper water billing from the Government. Which is an average 200-300 Rs./ month	N/a	N/a
Noor Mohd Sindhi Goth	No	a) Community well is feasible and agreed by the community. But they said, the ground water is brackish and cannot be used for drinking or other house chores. b) Direct Provision of water to household through tankers is acceptable, but without fee. They said, people are poor and mostly unskilled workers who cannot afford purchasing water even on affordable rates. b) Collecting of water from the metered points can be managed but fees cannot be afforded.	Not willing to pay
M. Murad Brohi Village	They don't pay directly to KWSB but on collection of water. They have the water tanker available and collect water from canal. The fuelling & maintenance on average Rs. 500 / 1200 Gallon	a) No. The ground water is brackish. b) Yes. Rs. 500 / 1200 Gallon water c) Yes. Collection of water is not an issue but should come under affordable rate Rs. 500/1200 Gallon. The metering point should be near to them.	Rs. 500 / 1200 Gallon water

vi. **Transportation infrastructure.** In the event that water tankers are opted for to supply water to the communities, proper road access will need to be ensured prior to the implementation of the system. In consultation with community leaders, it was determined that in most cases (except Maharaj and Abdul Rehman) the road infrastructure will most likely need upgraded to accommodate the traffic of tankers, although this will depend on the exact location of watering points. This aspect will need to be further investigated at ESIA stage.

vii. **Timing and transitional support during construction.** The system must be put in place prior to the operation of the new facility. During the construction stage, a transitional system must be provided to guarantee the communities´ water needs before the watering points can be operated. Direct distribution through tankers or the definition of safe collection points along the canal, which will need

to be clearly identified and secured, are the most recommendable approaches. These two approaches can be used alternatively or in combination.

viii. **Responsibilities.** Based on these findings, the proposed Community Water Access System will be further developed during the ESIA stage and implemented by KWSB, which will be the responsible agency in the management and administration of the system including the following aspects:

- Determination of water fees, if applicable
- Concession and administration of tanker licenses, if applicable
- Establishment of water consumption quotas if applicable
- Monitoring of water demand and supervision of watering point meters
- Concession of administrative permits for access to watering points
- Stakeholder engagement and community consultation along the process and the implementation of the system
- Any other managerial, administrative and/or legal aspect needed for the correct implementation of the system.

All physical investments needed for the implementation of the system (watering points, meters, supplementary transport infrastructure, etc.) will need to be designed and installed by the Project Developer. The details of such requirements will be provided in the corresponding Terms of Reference.

ix. **Legal aspects**. The design of the Community Water Access System will need to take into consideration the legal entitlements needed for the provision of services, and in particular with regards to the informal settlements (Maharaj and Haji Ibrahim Goth) which have not received legal recognition as residential areas. Should the provision of direct services (permissions over water points, direct distribution of water etc,) require the legal recognition as formal settlement, KWSB shall assist the communities in coordination with the Revenue Department and the competent authorities in order to obtain such declarations, prior to the implementation of the System. Shall the option of water distribution through licensed tankers be preferred, the requirement of formal registration might be omitted.

9.3.1.3. Preliminary impact assessment

The restriction of water access to the affected communities is categorized as a direct, negative and long-term impact, as the canal has been confirmed as the main source of water for all purposes for most of the villagers. The impact will manifest from the start of the works, during construction stage, and will expand along the entire lifecycle of the project, likely resulting in the unfeasibility of livelihoods and possibly forcing the migration of the PAP if no action is undertaken to mitigate the effects. Therefore, the magnitude of the impact prior to mitigation measures has been categorized as high. The above-described mitigation measure is expected to substantially counterbalance the project impact through reliable and sufficient provision of water, although some residual negative impacts may still affect the communities after its implementation.

These may come in the form of higher travel times to collect water, depending on the exact location of watering points or the distribution arrangements, as well as the impossibility of direct use of the canal for leisure, bathing and other direct uses that will be unfeasible after the installation of the water pipeline.

Table 58. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ ■ = high	■ = low	Long term	Direct
During operation	■ ■ ■ = high	■ = low	Long term	Direct

9.3.2. Dependence of agricultural land on seepage water

9.3.2.1. Risk description

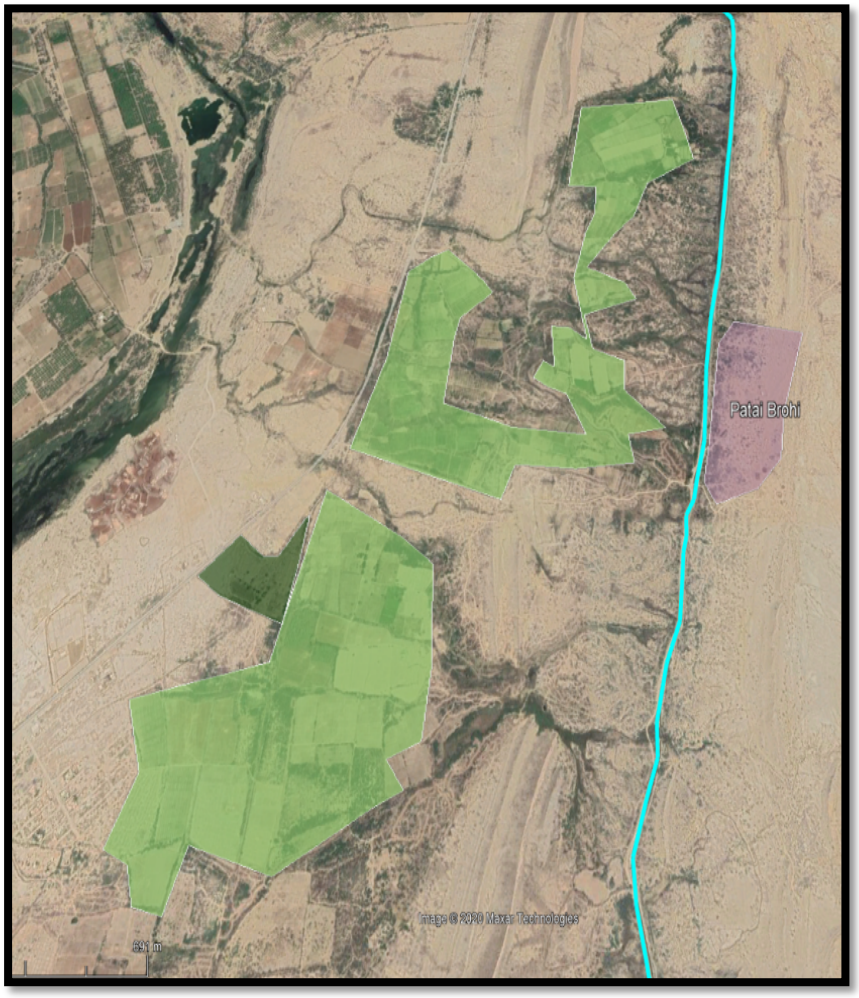
As detailed in the project description section, the decay of the Hub Canal infrastructure has resulted in multiple fractures and deterioration of materials along its course and the subsequent seepage of water in numerous points. At the same time, the accumulation of water losses along the years has generated a complex system of surface (and possibly underground) streams that, not only have contributed to the growth of wild vegetation and ecosystems but could also be indirectly benefiting nearby agricultural lands. The most evident indication of this effect has been found through the analysis of aerial images, which seem to portray a clear spatial correlation between water currents generated from the canal, and the location of agricultural fields. The correlation is particularly clear in the case the agricultural fields in Patai Brohi Area. The analysis of aerial images and the corresponding GIS mapping, together with consultations with local farmers and community leaders yielded the following observations:

1) There is a clear pattern of spatial correlation between the presence of agricultural fields and the wild vegetation generated by water currents stemming from the canal.
2) The surface water currents that benefit the wild vegetation are in some cases fed also by natural spring water from the mountains located to the west side of the canal (for example around aqueducts 9 and 10). In these points, water dripping from the decaying aqueducts seems to enhance the existing streams flowing from the mountains.
3) In some other areas, and in particular the wild vegetation situated between aqueducts 9 and 10, the surface flows seem to be a direct effect of seepage water from the canal, without influence from natural stream water. This situation is also observed in the agricultural fields within the area of influence of Maharaj Community.
4) When asked about the sources of irrigation for the agricultural fields in the area, consulted farmers claimed that the land is rainfed during the rainy season, without any other additional irrigation sources (wells, secondary canals, etc.). The water is accumulated in ponds for later use for irrigation purposes during the dry season. Farmers are aware of seepage water, but they disagree with the idea that the land´s productivity could be positively influenced by it.

Figure 38. Water ponds for agricultural purposes near Patai Brohi

In the face of these observations and in the absence of detailed agronomic, hydrological, and/or hydrogeological studies, there are reasons to believe that seepage water could be helping soil moisture and feeding the underlying aquifers, hence contributing to the generation of vegetation growth and the enhancement of land productivity. Further studies will need to investigate this hypothesis in greater depth during the ESIA stage in order to quantify the effect and possible losses due to the rehabilitation of the infrastructure. Although non-negligible, it is reasonable to think that the expected contribution of seepage might not be a crucial factor for the feasibility of the affected agricultural activities. This is based on the fact that direct and accumulated rainfall water is the main source of irrigation water according to the consulted farmers.

Aduequct - 9
Aduequct - 10
Patai Brohi
HUB RIVER
HUB DAM ROAD
LEGEND
Gate Valve
Bridge
Culvert
Hydrants
Tracks
Contours
Water Pipe
ROW
Aqueducts
Karachi Water Canal
Major Streams
Lasbela Canal
Cultivation
Vegetation
Pondings
Settlements
Mountain Ranges
Receational Establishment
Health and Human Services
Open/Barren Land
Religious Institutions
300 150 0 300 Meters
TYPSA
Halcrow Pakistan (Pvt) Ltd


Patai Brohi

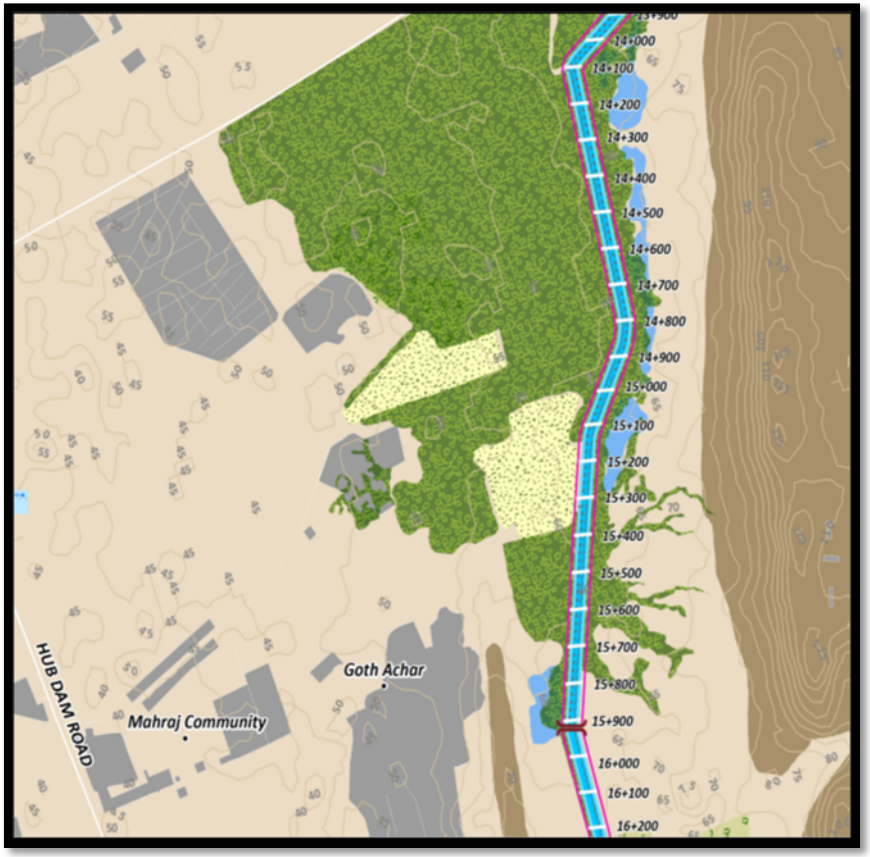


Figure 40. Aerial and GIS mapping showing spatial correlation between agricultural fields and seepage flows stemming from the canal around the Patai Brohi settlement

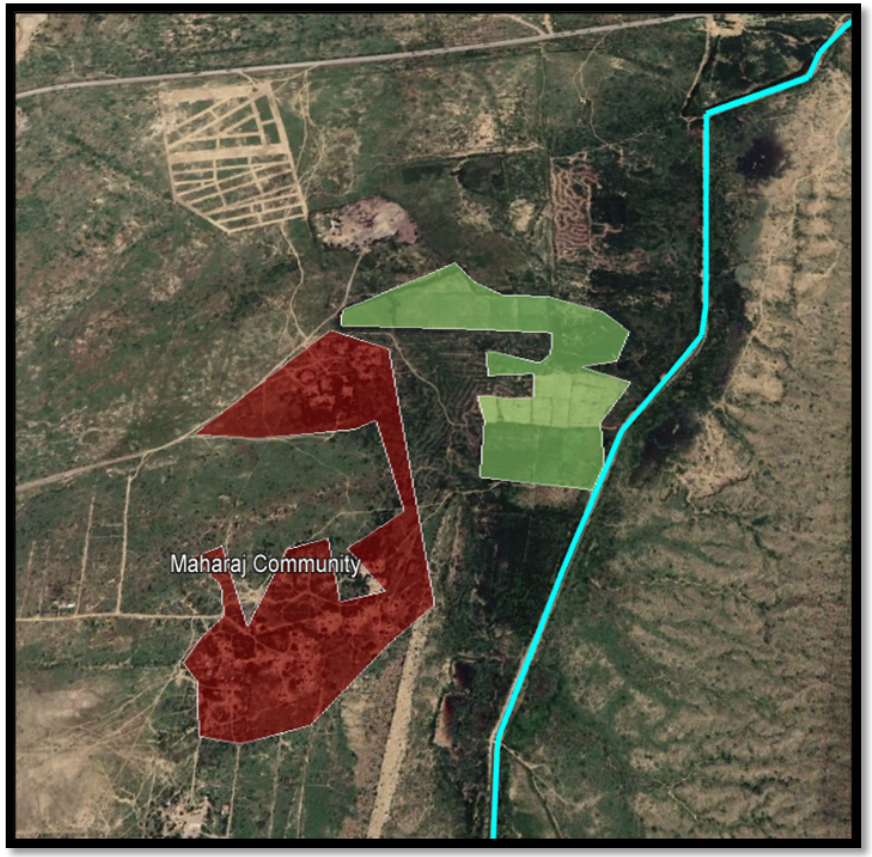


Figure 39. Aerial and GIS mapping showing spatial correlation between agricultural fields and water stemming from canal seepage around Maharaj Community.

9.3.2.2. Proposed mitigation

Mitigation measures for possible agricultural losses include the following different components:

- **Detailed ESIA studies**. The first recommended action consists of the performance of detailed studies during the ESIA stage in order to determine the actual effects of seepage water on soil moisture and vegetation growth in the area, including both natural ecosystems and agricultural land. In the event that such effects are quantified to be substantial, proper mitigation and/or compensation measures will need to be deployed in order to minimize negative impacts in terms of livelihoods.
- The release of ecological flows from the canal for agriculture are not feasible. Engagement with the irrigation department will be required to determine mitigation and compensation measures of any impacts on agricultural activities and livelihoods.
- **Monitoring** of impacts of reduced water availability to agricultural land in the project area, including reduced surface water flows and soil moisture (return to seasonal water availability) to determine long-term impacts, mitigation and compensation measures.

9.3.2.3. Preliminary impact assessment

The possible effects over land productivity as the consequence of the cessation of seepage are classified as an indirect negative impact. It is expected to manifest during operation, probably requiring at least a full cropping cycle to be perceivable, hence no immediate impact should be expected during the construction phase. The magnitude and likelihood of the effects are yet to be determined in ESIA studies but the collected information, in the form of aerial imagery and consultations seem to discard a critical level, hence the preliminary assessment has been established as low-to-moderate.

Table 59. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	○ = no impact			
During operation	■ = low to ■ ■ = moderate	■ = low	Long-term	Indirect

9.3.3. Impacts over land and assets along the Canal's corridor.

The works described for the rehabilitation of the Hub Canal will imply the deployment of heavy construction and transportation machinery, as well as the stacking of large quantities of materials, hence requiring the temporary occupation of significant portions of land at both sides of the existing infrastructure. According to information received from KWSB, the property rights over the Canal infrastructure include the acquisition of

a right of way of 100ft (30.5m) at both sides of the canal[29]. After visual inspection and aerial imaging analysis, it has been estimated that such corridor will be, in general terms, sufficient for accommodating all necessary construction elements, without the need for temporal or permanent acquisition of additional land. Nevertheless, it should be noted that some particular sections of the corridor show a narrower pattern, with some fenced private properties and land plots located within the theoretical 30.5m right of way, but not affecting the canal road. These narrow areas, however, are observed only at one bank of the canal, leaving the opposite side of the corridor available for construction works. The planning of construction works shall pay particular attention to the following identified narrower areas in order to avoid damages over vegetation, fences and private property.

Table 60. Location and description of narrower sections of Hub Canal corridor

Approx. central coordinates	Length	Canal Bank	Available corridor width	Description
25° 1'49.00"N 67° 1'29.02"E	280m	East	13m	Trees and vegetation fencing allotted land (unknown land use)
25° 3'19.97"N 67° 1'45.92"E	420m	East	6-7m	Trees and vegetation fencing allotted land (unknown land use). Small structure located at 28m from the canal
25° 3'57.48"N 67° 1'55.77"E	160m	West	10m	Trees and vegetation fencing allotted land (agricultural land use)
25° 4'35.79"N 67° 2'16.04"E	500m	West	8-10m	Trees and vegetation fencing allotted land (unknown land use)
25° 5'5.76"N 67° 2'32.18"E	200m	West	10m	Trees and vegetation fencing allotted land (agricultural land use). Structure located within 30m from canal

Regarding the presence of residential structures or any other formal or informal element requiring physical resettlement, the surveys and imagery analysis performed in the corridor confirm the absence of any significant encroachment that may impede the construction works. As presented in previous sections, informal residential settlements are all concentrated around two well bounded communities, namely Maharaj and Haji Ibrahim, both of them located at more than 300m from the canal edge. Any other permanent or semi-permanent elements such as vendors' stalls, workshops, storage facilities, etc. have not been observed.

9.3.3.1. Proposed mitigation

The triggering of PS5 standards is not expected for the required works, and hence no particular provisions for land acquisition and resettlement will be required for the project. Nevertheless, the Project Developer shall provide feasible solutions for the avoidance of damages in areas where the right of way corridor might be compromised by the presence of fenced private property.

[29] At the moment of preparation of this report, official confirmation of the right of way through the corresponding legal documentation was still pending.

9.3.3.2. Preliminary impact assessment

This is classified as a low direct impact to manifest in the short run during construction stage. Mitigation measures in the form of feasible solutions to accommodate the works in narrower sections of the corridor are expected to completely mitigate any risks.

Table 61. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ = low	○ = no impact	Short term	Direct
During operation	○ = no impact	○ = no impact		

9.3.4. Community/Public Safety and risk of drowning

9.3.4.1. Risk description

As described in the social baseline section, direct use of the water for domestic and recreational purposes is common along the Hub Canal. This practice is not absent from risks for the villagers, since in some sections of the canal the velocity of the water flow can be sufficiently high to be incompatible with human swimming. As a consequence, between 10 and 15 human fatalities are estimated to occur every year according to consulted community leaders. This figure, however, should be taken with caution, as no official data about the accidents could be gathered during field work. KWSB does not keep records of drownings or any other incidents with the local communities, and hence no specific information on the specific circumstances or demographics of the victims are available. Nevertheless, based on ground observation, it is reasonable to think that vulnerable groups such as women and children, who are more commonly engaged in domestic and leisure activities in the canal, are likely the most affected population segments. Although less frequent, livestock losses also take place as a consequence of accidental falls into the canal.

The substitution of the existing canal infrastructure by a water pipeline will unequivocally imply the complete mitigation of any drowning hazard to the community in the fast flowing section of the canal, since the infrastructure to be installed will impede any direct contact with the water. The new infrastructure is not expected to imply any additional direct or indirect health hazard for the PAP during its operation stage. However, the risk of drowning will still be possible during construction, at least for the period of time in which the water supply is still conducted through the existing infrastructure and before the transfer of the flow to the pipeline. During operation there remains a low risk in the upper canal section.

9.3.4.2. Proposed mitigation

As a positive effect regarding drowning risk is expected, however the project should consider measures to enhance and promote public safety around the open canal section, such as fencing, security, awareness campaigns, signage etc.

During construction, proper signalling and fencing of the areas under construction should be put in place, with particular emphasis on the limitation of access to water and the areas where heavy machinery will be located. Exceptions to access restrictions for transitional water provision to the communities must be clearly identified, with signage and secured at all times.

9.3.4.3. Preliminary impact assessment

The magnitude of the impact during operation of the project is categorized as locally positive and direct, manifesting its positive effects along the entire lifecycle of the infrastructure (potentially saving from 10 to 15 lives every year of operation). During construction, however, drowning hazards will be possible in the absence of specific mitigation measures, and hence it has been categorized as moderate. Community safety measures, as above described, are expected to lower the magnitude of the impact, being in any case a short-term risk during construction stage.

Table 62. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■■ = moderate	■ = low	Short term	Direct
During operation	■ = low	+ = locally positive	Long term	Direct

9.3.5. Impact over community mobility and crossing paths during construction.

9.3.5.1. Risk description

The proposed rehabilitation works along the canal will imply the deployment of heavy machinery, transportation vehicles and the stacking of construction materials along the acquired corridor, which can potentially impose mobility restrictions for the inhabitants of affected settlements. During consultation with community leaders, specific information on mobility needs around the canal, including the auxiliary transport infrastructure (bridges and roads along the canal corridor) has been specifically investigated.

Community	Possible mobility restrictions and alternative routes during construction works	Do community members normally commute to areas at the other side of the canal? Which points or areas do the use for crossing the canal (under aqueduct, bridge, etc)
Haji Ibrahim Goth	They have an alternative route from backside of the village that they use to access the main city. However, the blockage of access will trouble them temporarily as they also use the access road along the canal.	They don't usually commute to the other side of the canal. However, if required, they use the main road for getting into the other side of canal. (They are 1Km from the main road.
Maharaj Goth	The disturbance of access along the canal will temporarily trouble them, as they use a small patch of access road around 300m	They don't normally commute to the other side of canal. However, if required, the go through bypass road

Community	Possible mobility restrictions and alternative routes during construction works	Do community members normally commute to areas at the other side of the canal? Which points or areas do the use for crossing the canal (under aqueduct, bridge, etc)
Patai Brohi	They use the canal access road reaching to the main city area and markets. Due to blockage of access, the travelling will be restricted. There is no alternative access.	People normally use bridge to commute other side of canal, where agricultural plots are located
Allah Dino	They don't usually use the access road of canal. They have a paved road passing nearby village that commute to main city.	The community does not normally commute to other side of canal. Closest crossing point over canal is 3km away (under aqueduct)
Gul Mohd Goth	No particular issues as they usually don't use the canal access road. This community is connected with the main roads and they don't usually commute to the canal area.	They don't normally commute to the other side of canal. If required, they use aqueduct
Noor Mohd Sindhi Goth	The community is very close to the canal. People use the canal road for daily commute. They have an alternative road from backside, but it is in poor condition and access becomes difficult during rainy season. They don't use aqueducts as they are very close to the main road (500 m approximate) away. For short term construction work, the community agreed to the expected impacts but requested to make the access feasible where necessary	They don't usually commute to the other side of the canal. However, if required, they use the main road for getting into the other side of canal. (They are 500 m near to main road.)
M. Murad Brohi Village	This is one of the main concerns for the community as they mainly use the aqueduct and canal road to reach the city and other important areas. The restriction of access will be detrimental. It is proposed to minimize the access blockage under the aqueduct nearest to settlement (11). Manage the activities in step by step and keep a partial access row open either along the canal road or under the aqueduct.	Yes. They normally commute to the other side of the canal as the other side is the main city access and markets. They use the crossing under aqueduct 11.

9.3.5.2. Proposed mitigation

As part of the Community Health and Safety Plan, the Project Developer will need to provide detailed and regular information to local leaders and villagers who may need to cross through the Project Area for livelihood purposes, as well as the alternative walking paths around the site. The exact location of fences that may limit local mobility as well as the alternative routes will need to be mapped and disclosed to PAP in all settlements. All information activities on the specific alternative routes will need to be disclosed and documented in the corresponding Stakeholder Engagement Plan. In particular, the following measures will need to be addressed in order to mitigate mobility restrictions in the most affected settlements:

- Murad Brohi Village: minimization of the access blockage under the aqueduct nearest to settlement (Aqueduct 11). Sequencing of activities on a step-by-step basis in order to keep a partial access row open either along the canal road or under the aqueduct.

- Noor Mohd Sindhi Goth. Conditioning of alternative path connecting the settlement with the main road.
- Patai Brohi. Provision of an alternative route to villagers through the main road at west side of the canal, including a safe crossing point through the canal. If necessary, given the expected increase of distances due to temporal diversion, collective transportation means shall be considered.

During the operation stage, access to the road along the canal or an alternative path must be granted to the communities. The detailed design and feasibility studies and ESIA will need to consider feasible solutions that allow for the restriction of access to the pipeline while preserving the mobility of the most isolated settlements (particularly Maharaj and Patai Brohi). Safe corridors, able to support at least light vehicles, should be provided to preserve the current routes used to connect the villages with the main city.

9.3.5.3. Preliminary impact assessment

The impacts over community mobility are classified as direct effect of the project, as it will imply the blockage of some important paths and roads that connect the villages with important destination areas. The most severe impacts are expected during construction, which can be substantially mitigated through definition of alternative paths and safe corridors across the works areas, although some marginal disturbance will be unavoidable. During operation, some long-term impacts over mobility might occur depending on the restrictions imposed by the Project Developer on the canal road infrastructure. The provision of safe corridors along the canal should fully mitigate this possible impact.

Table 63. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■■ = moderate	■ = low	Short term	Direct
During operation	■ = low	○ = no impact	Long term	Direct

9.3.6. Substitution of KWSB workers

9.3.6.1. Risk description

The participation of a private Project Developer in the rehabilitation and operation of an existing infrastructure like the Hub Canal, will inevitably imply an important shift in the staff involved in the management of the service. The installation of new equipment and technologies will require the involvement of personnel and skills that in many cases will be exclusive to the Project Developer´s knowhow. Therefore, part of the personnel currently involved in the project under the management of KWSB will be substituted by the labour force of the Project Developer, potentially causing the loss of jobs and the subsequent social impacts for the affected workers.

As mentioned in Section 3.5.5 KWSB has 105 employees working at the Karachi Water Canal Facilities, including the canal, pumping station, rising mains and water filtration plant. They are responsible for the daily operations and maintenance tasks. The list comprises 97 people plus 8 security personnel.

It is estimated that the private sector will employ less personnel to carry out the O&M tasks, and the estimation of the future operation stage workforce is presented below:

Table 64. Future Operation Phase Workforce

Workforce	No. of staff
	no.
Plant manager	1
Chief operation engineer	1
Personnel manager	1
Accountant administrative	1
Administration assistant	1
Shift supervision	1
Chief maintenance engineer	1
Chief maintenance engineer electrical	1
Maintenance operator mechanical	2
Maintenance operator electrical	2
Lab chief	1
Lab operator	2
Technicians	4
Safety officer	1
Workshop manager	1
Workshop mechanic	2
Store manager	1
Secretary	1
Laborer	6
Cleaner	5
Driver	4
Security guard	10
Subtotal labor	**50**

Out of these 50 positions, it is estimated that only 10 could be filled by current KSWB staff.

9.3.6.2. Proposed mitigation

In a preliminary agreement between IFC and KWSB, the risk of retrenchment of workers has been addressed through two different measures to be implemented during the transition in the management of the infrastructure. Out of the total KWSB´s labour force potentially affected, some of the positions have been identified as transferable (i.e. approximately 10 of the current 105 employees), which through the proper training skills recycling, could remain involved in the project under the management of the Project Developer.

Secondly, the remaining KWSB´s staff currently involved in the Hub Canal will be transferred to other nearby projects or facilities in order to avoid the retrenchment of workers.

In the absence of a proper transitional plan for the recycling of positions and the transfer to other projects, for the remining employees, some could be subject to retrenchment and subsequent social impacts, which could potentially generate some opposition to the project. The transitional plan for that staff will need to be fully compliant with PS2, specifically the following paragraphs:

- Paragraph 18. Prior to implementing any collective dismissals,10 the client will carry out an analysis of alternatives to retrenchment.11 If the analysis does not identify viable alternatives to retrenchment, a retrenchment plan will be developed and implemented to reduce the adverse impacts of retrenchment on workers. The retrenchment plan will be based on the principle of non-discrimination and will reflect the client's consultation with workers, their organizations, and, where appropriate, the government, and comply with collective bargaining agreements if they exist. The client will comply with all legal and contractual requirements related to notification of public authorities, and provision of information to, and consultation with workers and their organizations.

- Paragraph 19. The client should ensure that all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner. All outstanding back pay and social security benefits and pension contributions and benefits will be paid (i) on or before termination of the working relationship to the workers, (ii) where appropriate, for the benefit of the workers, or (iii) payment will be made in accordance with a timeline agreed through a collective agreement. Where payments are made for the benefit of workers, workers will be provided with evidence of such payments.

9.3.6.3. Preliminary impact assessment

This impact, which is expected to be manifested only in the operation stage, has been classified as long term and moderate. The implementation of the above-described measures will substantially lower its effects, although some minimal disturbance regarding the relocation of workers will be unavoidable.

Table 65. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	○ = no impact	○ = no impact		
During operation	■■ = moderate	■ = low	Long term	Direct

9.3.7. Land related impacts of proposed PV Plant

9.3.7.1. Risk Description

The project will include as one of its sub-components the rehabilitation works and improvement of the Water Treatment Plant, including the installation of an autonomous power supply system in the form of a solar PV

plant of up to 4.5 MW. This new infrastructure will be located at the east flank of the Water Treatment Plant, occupying an estimated area of 14.4 Ha of government owned land (KWSB). Therefore, no land acquisition process will be necessary prior to the commencement of the works. The land has been visually inspected during field work in search of any human activity or assets that may trigger the application of IFC standards on physical or economic displacement, as the area remains unfenced and easily accessible from nearby settlements. At the moment of the visit, no signs of relevant formal or informal activity were observed. Furthermore, representatives of the closest community in the area, named Ghulam Mohd Goth were also consulted in order to confirm these observations. According to this source, community members do not use the land for any livestock or agriculture purpose and informal use of the land was discarded by the community representatives.

9.3.7.2. Proposed mitigation

No mitigation measure needed.

9.3.7.3. Preliminary impact assessment

No land related impacts are expected from this project sub-component.

Table 66. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	○ = no impact	○ = no impact		
During operation	○ = no impact	○ = no impact		

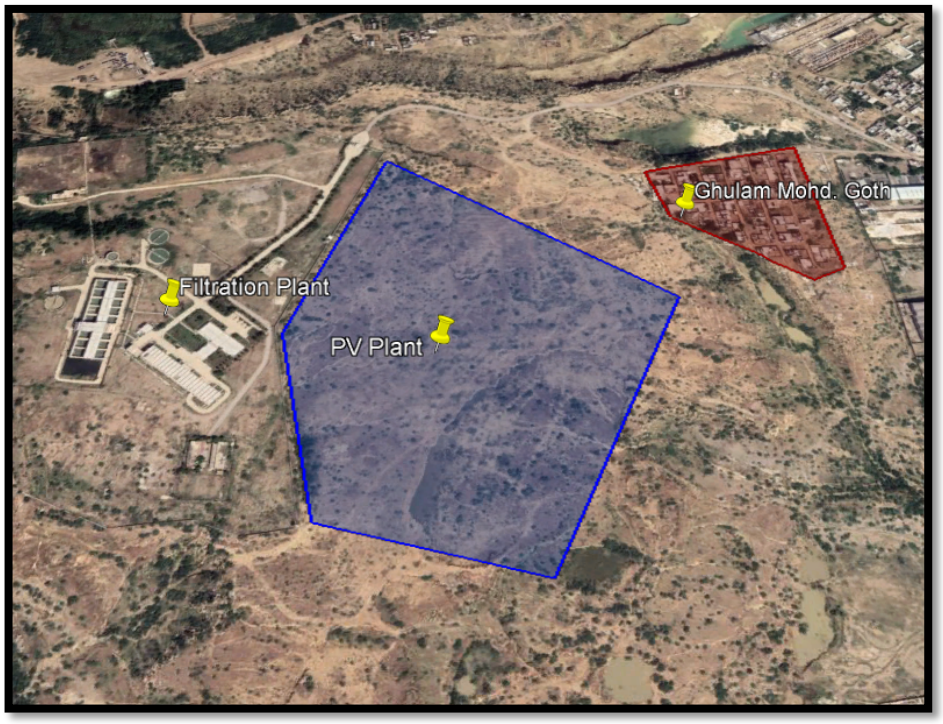


Figure 41. Aerial view of the proposed PV plant and Ghulam Mond Goth

9.3.8. Job opportunities

9.3.8.1. Risk description

The Hub Canal rehabilitation works, and the proposed improvements are expected to employ approximately 400 people between technicians and low-skilled workers. The workforce to be employed during construction and operation are expected to be comprised of a mix of Pakistani nationals working for the Project Developer, in addition to personnel hired through local subcontractors that will be providing a range of supporting services, including security, supplies, transportation, accommodation, etc. As the project transitions from construction into operation, there will be a shift in the size and skills of the labour force required. Consequently, it will be necessary to develop the skills of local people during construction so that suitable individuals are able to take up the long-term positions during operations. Given the low level of education and skills in the nearby settlements, these will most likely be bounded to basic seasonal maintenance activities (e.g., ground clearing, etc). Additionally, the Project is expected to positively influence the local and regional economy during construction from the direct procurement and supply of materials and services from companies based in the local and regional area. Experience from similar projects has indicated that, whilst local employment is a temporary positive impact, significant adverse impacts can occur if the local recruitment process is not adequately managed, risking into poor acceptance of the project by local communities and possible grievances.

9.3.8.2. Proposed mitigation

The project developer shall implement a local hiring plan in consultation with PAP, local leaders and district representatives, and in a way that meets long term operational needs of the Project as well as the short-term construction needs. The plan shall take into account the relatively low skill base of the local population, as

described in the social baseline information. The local hiring plan must be developed in accordance with national labour law and in alignment with International Labour Organisation (ILO) core labour conventions as required by the international standards. Additionally, during the ESIA stage, the Project Developer shall investigate possibilities for local sourcing and procurement opportunities to promote sustainable local business development, as well possible capacity building actions to enable them to meet standards for procurement. The Project Developer will work with local vocational training schools to develop curricula which will qualify local students to better meet the needs of the project. All capacity building actions shall be gathered in a Community Investment Plan to be developed during the ESIA stage.

9.3.8.3. Preliminary impact assessment

Subject to the implementation of fully fledged local hiring program, the project is expected to generate locally positive impacts in terms of employment opportunities. These will be mostly short-term opportunities during construction work in the form of direct jobs generated in low skilled activities. In the longer run, opportunities during operation will be more limited and will require further engagement through the development of skills.

Table 67. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	+ = locally positive	+ = locally positive	Short term	Direct
During operation	○ = no impact	+ = locally positive	Long term	Direct

9.3.9. Presence of workers, interaction with PAP and COVID-19

9.3.9.1. Risk description

Community health and safety may be at risk from worker migration and the presence of workers in the PAA, resulting in a potential change in the disease profile of the local population. Although the likelihood of severe impacts is low, a more robust social baseline study during the full ESIA stage, will expand on communicable disease morbidity, crime incidence, gender-based violence (GBV) and risks of sexual exploitation of local women and children considering their level of vulnerability.

Particular attention should be paid to the COVID-19 risks, as, in the context of Pakistan, communicable respiratory diseases will likely be the most significant concern for potential interactions between the workforce and community members. Local workers may be exposed to potential COVID-19 risks where they are employed on the workers' camp. In turn this could result in further spread of COVID-19 back to the local community. A detailed assessment will be undertaken once the Project Developer has been appointed and their plans can be examined in detail. On the other hand, there is a potential capacity saturation of the provision of local health services and facilities for construction workers. If a workforce camp is proposed, it will be designed in accordance with IFC guidance and will include provision for required services.

9.3.9.2. Proposed mitigation

A more thorough process to prevent and minimize exposure to COVID-19 risks will be included in the **Full ESIA**. While the full details of the workers' camp have not been provided yet, the mitigation measures to avoid and reduce risk exposure will be implemented, as detailed in the Interim Advice for IFC Clients on Preventing and Managing Health Risks of COVID-19 in the Workplace (IFC, 2020). The ESIA will also consider the potential impact on local hospitals and medical facilities in the event of an outbreak of Covid-19 at the worker's accommodation. There is no information regarding workers' accommodation or whether a worker's camp will be required at this time. If the project requires construction camps which include workers accommodation, the "Worker's Accommodation Processes and Standards": guidance note by IFC and EBRD should be followed.

The Project Developer shall prepare and implement a **Community Health and Safety Plan** in which the following aspects will need to be detailed.

- Description of further restrictions of the movement and interaction of workers with local communities outside the site, as well as additional COVID-19 prevention measures within the workers' camp.
- Awareness training on communicable disease prevention, gender-based violence (GBV), sexual exploitation and harassment awareness. Provide this training on an ongoing basis to promote gender equality and prevent any form of gender-based violence.
- Health screening conducted among employees and contractors before contracting workers and on a periodic basis throughout their employment/contract.
- Identification of opportunities to support local public health campaigns that focus on prevention of communicable diseases.
- Development of a Worker Code of Conduct.
- Zero-alcohol tolerance policy, including current intoxication, for workers during working hours.
- Random alcohol testing is conducted for workers entering and leaving the site.
- System of penalties for anyone found with alcohol on site.
- Ensure that Project security is aware of the Project's goals to establish good relationships with local stakeholders; the grievance mechanism for communities to voice concerns; and receives human rights and cultural sensitivity training to ensure the respect and protection of the local community.
- Minimise risks to the community from project security. As per PS4, the project will be guided by the principles of proportionality and good international practice (such as the "United Nation's (UN) Code of Conduct for Law Enforcement Officials", and the "UN Basic Principles on the Use of Force and Firearms by Law Enforcement Officials", "The Voluntary Principles on Security and Human Rights", the "UN Guiding Principles on Business and Human Rights") in relation to hiring, rules of conduct, training, equipping, and monitoring of such workers, and by applicable law. The Project proponent will make reasonable inquiries to ensure that those providing security are not implicated in past abuses; will train them adequately in the use of force (and where applicable, firearms), and

appropriate conduct toward workers and Affected Communities; and require them to act within the applicable law. The client will not sanction any use of force except when used for preventive and defensive purposes in proportion to the nature and extent of the threat. The client will provide a grievance mechanism for Affected Communities to express concerns about the security arrangements and acts of security personnel.

- Liaise with local health professionals to identify ways in which the Project can provide sustainable investments in the health care facilities used by their workers.
- Ensure that within the Worker Code of conduct it is made clear that workers and employees should not use any community boreholes or water from nearby bodies. Ensure a system of penalties is put in place for non-compliance.

Additionally, the Project Developer shall prepare an **Occupational Health, Industrial Safety and Accidents Prevention Program for Workers** with appropriate accident prevention program, reporting and periodic review (summary of relevant measures) including provision of routine training and testing, and proper safety equipment such as hearing protection, hardhats, steel-toed shoes, safety railings, fall arrestors, sensors for notification on reaching of warning and action limits for exposure to hazardous gases and liquids or impending catastrophic failures (as applicable). The program shall also address Worker Accommodation. Rules including Mitigation for COVID-19 related risks and no GBV and/or sexual exploitation by workers shall be also included.

9.3.9.3. Preliminary impact assessment

The potential risks above described are classified as indirect moderate impacts which, although predominantly revealed during the construction stage, might extend its effects in the long run in the form of possible health issues or disabilities. The magnitude of the impact can be substantially reduced to a minimal residual risk through proper management of community and workers´ safety programs, including the set of measures described above. Operational and maintenance activities of the infrastructure will not imply labour intensive or hazardous tasks and therefore are not expected to deploy substantial risks for the communities.

Table 68. Evaluation matrix of impacts

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■■ = moderate	■ = low	Long-term	Indirect
During operation	○ = no impact	○ = no impact		

9.3.10. Water Supply to City of Karachi

9.3.10.1. Impact description

- Construction activities will temporarily interrupt water supply to the WFP. KWSB will need to consider alternative sources of water during the period when the canal will be shut down for rehabilitation.

- During operations, the rehabilitation of the canal and WTP components will ensure a greater amount of water reaches the WTP and the City of Karachi and will improve water quality being supplied from the WFP to the City of Karachi

9.3.10.2. Proposed mitigation

- The WFP will need to ensure water quality meets WHO standards and Sindh Water Quality Standards (depending on the parameters, whichever is strictest – refer to Table 8 in Section 7.1.8 for a comparison of the standards).
- Construction staging such that water supply interruption is minimised (the preferred alternative of pipeline + canal rehabilitation described in this report decreases the overall down time of the conveyance system compared to full rehabilitation of canal only).

9.3.10.3. Preliminary impact assessment

Table 69 Evaluation matrix of preliminary impacts on the City of Karachi water supply

Impact on	Magnitude of impact before mitigation	Magnitude of impact after mitigation	Duration of impact	Direct/indirect
During construction	■ ■ = moderate	■ = low	Short term	Direct
During operation	○ = no impact	+ + = regionally positive	Long term	Direct

9.4. Potential Decommissioning Impacts

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. Rehabilitation will ensure that the total area is restored to a natural landscape and draining surfaces, covered with suitable topsoil and native vegetation species. The following activities are associated with the decommissioning phase:

- Existing buildings and structures are demolished, rubble removed and the areas levelled;
- Remaining exposed excavated areas filled and levelled;
- Land and permanent waste piles prepared for re-vegetation, where suitable.

Possible sources of fugitive dust emission during the closure and post-closure phase include:

- Smoothing of stockpiles by bulldozer;
- Grading of sites;
- Transport and dumping of overburden for filling;
- Infrastructure demolition;
- Infrastructure rubble piles;
- Transport and dumping of building rubble;
- Transport and dumping of topsoil; and
- Preparation of soil for re-vegetation – ploughing and addition of fertiliser, compost etc.

Exposed soil is often prone to erosion by water. The erodibility of soil depends on the amount of rainfall and its intensity, soil type and structure, slope of the terrain and the amount of vegetation cover.

Decommissioning generates a number of different waste streams from construction materials, concrete, scrap metal, electrical waste to PV panels. For the solar PV facility which has a life of approximately 25 years, PV panel end-of-life management is an important issue facing many older PV facilities and increased deployment around the world is generating the need for end-of-life solutions for PV panels.

Today's typical c-Si PV panels contain about 76% glass (panel surface), 10% polymer (encapsulant and backsheet foil), 8% aluminium (mostly the frame), 5% silicon (solar cells), 1% copper (interconnectors) and less than 0.1% silver (contact lines) and other metals (mostly tin and lead). More than 90% of their mass is composed of glass, polymer and aluminium, which can be classified as non-hazardous waste. However, smaller constituents of c-Si panels can present recycling difficulties since they contain silicon, silver and traces of elements such as tin and lead, accounting for around 4% of the mass.

There are currently very few jurisdictions around the world for solar PV hazardous waste facilities or treatment, storage and disposal facilities (TSDF). This is expected to change over the life of the project, as it is changing in other jurisdictions.

The proponent should prepare a Decommissioning Plan two to three years prior to decommissioning that includes demolition and dismantling waste from the facilities and infrastructure components. It should include value chain opportunities from reuse.

9.5. Potential Cumulative Impacts

Potential cumulative impacts as defined in PS1 are those that "(...) that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned, or reasonably defined developments at the time the risks and impact identification process is conducted."

The potential cumulative impacts assessment carried out as part of the ESIA should consider the following:

- Any other public works or infrastructure projects in the Project area of influence that will coincide in time with the construction activities of the project. These may include water supply infrastructure, new road construction or road rehabilitation etc.
- Cumulative impacts of solar PV waste from other facilities with end of life in the next 25-30 years.

The following other projects have been identified in the local area that could potentially create cumulative impacts:

- The Sindh Resilience Project[30] (SRP): The SRP is a World Bank funded project with the objective of mitigating flood and drought risks in selected areas and strengthen Sindh's capacity to manage

[30] https://projects.worldbank.org/en/projects-operations/project-detail/P155350

natural disasters and public health emergencies. The project entails the construction of a number of small recharge dams that would accumulate rainfall during the wet season. A series of 13 dams were proposed under the SRP in the Kirthar Protected Area Complex, 3 of which would be located in the Hub Dam Wildlife Sanctuary, located on streams up at higher elevations on the hills to the east of the Hub Canal. These dams may impact discharge patterns in the streams that flow under the canal aqueducts. (the SRP targeted a total of 14 dams and 10 have already been built by November 2020). Consultation with the Government of Sindh on the future location of the remaining dams and their implementation schedule should take place during the ESIA stage.

- World Bank supported projects related to waste management in Sindh, which includes improvements to the Jan Chakro landfill site.

10. Summary of Proposed Mitigation Measures

A summary table of the key issues/risks/impacts and proposed mitigation measures is provided in Appendix C.

The estimated cost of the environmental and social mitigation measures described in this report has been estimated to be approximately 3% of the Project´s CAPEX, approximately 1.56 million USD.

Mitigation measures during the operation phase will be further defined and costed in the ESIA and in the Biodiversity Action Plan.

11. Summary and Conclusions

11.1. Main Environmental Findings

The state of disrepair of the canal has caused leakage and seepage of water from the conveyance infrastructure (aqueducts and canal) into the surrounding environment. The extent of the contribution of seepage to surface water bodies, groundwater and soil moisture will need to be determined during the ESIA stage, however, the studies carried out during the Scoping stage indicate that seepage may be contributing to soil moisture, and to the development of vegetated areas, particularly on the west side of the canal in the direction of the Hub River Valley. Historical satellite imagery since the construction of the canal indicates that the surface area and density of vegetation has increased during recent years due to cracks and deterioration of the infrastructure.

Most of the canal, from the Hub Dam all the way to the Northern By-pass road is located within a protected area, the Hub Dam Wildlife Sanctuary which is part of the larger Kirthar Protected Areas Complex (KPAC). At the time the wildlife sanctuary was established in 1974 it was considered an important area for birds and migratory birds, but due to its proximity to the Karachi Metropolitan area and its industrial zone, the area has lost some of its ecological significance. The Northern By-pass road with heavy traffic linking Sindh with Balochistan Province has further deteriorated its importance. The Hub Dam and reservoir (a Ramsar site) was built in 1984 on the Hub River on the arid plains north of Karachi.

The following habitats are found within the project's area of influence and can be classified as modified habitat according to PS6: seasonal agricultural fields, settlements and other built environments. The following habitats could also be classified as modified habitat since its current extension and conditions are subject to human activity and largely dependent on man-made infrastructure such as the water canal and seepage water: Riverbed (riparian) vegetation including areas influenced by seepage, and Bushland/Rangeland. Natural habitats existing in the project's area of influence are limited to "Dry / desert with scarce vegetation including hills/cliffs". In some areas, under natural regional climatic conditions, less human intervention, and no seepage from the canal, it would still be possible to have some of the "Riverbed (riparian) vegetation" and "Bushland/Rangeland" which could be classified as natural habitat. Critical habitat as defined in PS6 was found in the project area of influence: one critically endangered tree was found within the PAA, a *Commiphora wightii* (Guggar/Gugal/ Mukul tree) and observations or known presence of the Indian pangolin (EN), the

Steppe eagle (EN) and the Saker Falcon (EN) were also recorded in the PAA. A Biodiversity Action Plan for *Commiphora wightii* and the Indian pangolin will be required.

It is expected that the project will have short term impacts during the construction phase but also long-term impacts due to the cessation of seepage and leakage of water from the canal. These impacts would affect current year-round soil moisture levels, surface water bodies (including small wetlands, ponds, and streams) that maintain the existing vegetation and habitat patterns and support ecosystem services. The extent of this impact on the natural environment, as well as on ecosystem services will need to be assessed further during the ESIA stage of the project.

11.2. Main Social Findings

From a social perspective, the **receiving environment** of the project presents a complex and diverse setting of seven small population settlements, all of them showing some degree of dependence over the infrastructure elements to be rehabilitated, and in particular in terms of use of canal water. All of the affected villages are located within a range of 600m or less from the closest canal section, hosting populations ranging from 100 to 30,000 inhabitants. Nevertheless, the directly affected population (i.e., showing a critical degree of dependence over the canal) has been estimated to be at around 8,000 (residing in six of the seven identified settlements). A high degree of vulnerability is observed within the PAP, including housing conditions, livelihood resources and access to basic services. This is particularly the case for two of the villages (Maharaj and Haji Ibrahim Goth) where no formal legal recognition of the settlement has been granted. Livelihoods are of a non-land-based nature, mostly comprised of subsistence livestock, hired labour and, in the case of the largest informal settlement, rubbish picking activities. Agricultural activities are present in the area, although most of the land is not owned by the local villager. It is believed that the seepage generated as a consequence of infrastructure decay could be benefiting soil moisture and agricultural yield in the nearby land plots worked by the local farmers.

Regarding the **expected impacts**, both formal and informal settlements are dependent on canal water for basic consumption and domestic needs, with little or no alternative sources to cover the demand in case of full restriction to the canal, which will be the likely case after the finalization of the rehabilitation works. This, together with the potential dependence of nearby agricultural lands on seepage water, could imply a critically negative impact to the inhabitants of six out of the seven affected settlements, likely prompting them to migrate to other areas in case an alternative water source is not provided as part of the mitigation measures. Direct land impacts are not expected as consequence of the rehabilitation works due to the fact that the property rights of the infrastructure include an acquired right of way that can sufficiently accommodate the works without affecting any human settlement. Any permanent assets, in the form of residential structures or businesses have not been identified within this corridor. However, important mobility restrictions may occur during construction and operation of the project, as some of the communities are highly dependent on the road infrastructure adjacent to the canal. One of the most positive aspects of the project is expected in terms of drowning hazards, since the substitution of the canal by a water pipeline and/or the subsequent fencing of the infrastructure will avoid up to 10-15 annual fatalities registered every year. Another positive aspect of the project may come in the form of job opportunities for the local villagers, particularly during construction stage, which will need to be accurately assessed and adapted to the set of skills available in the area. Due to the proximity of human settlements and the magnitude of the civil works involved, general hazards

associated to the presence of heavy machinery, workers and construction materials may also imply health and safety risks for community members.

In order to **mitigate** these risks, a set of measures with different distribution of responsibilities between the public and private sector are suggested, which will need to be further developed and detailed during ESIA stage. The central piece of social interventions corresponds to the design and implementation of a Community Water Access System to replace the direct dependence of affected settlements on water from the Hub Canal. A menu of different options, which can be alternatively selected or implemented in combination, have been described. These include the installation of watering points in strategically placed locations along the canal/pipeline, the distribution of water through licensed tankers and/or the direct collection of water at the mentioned watering points. The exact modality in the provision of the services will need to be designed under the principles of affordability, accessibility, and proportionality, including sufficient transitional support. It should be noted that the total water demand by the affected villagers is estimated at 0.1 MGD. The dependence of vegetation and agricultural lands on seepage water might be mitigated through the installation of gates/valves located in strategic points along the canal that can be used for periodic controlled water discharges. Although the exact water needs to sustain ecosystems and land productivity are yet to be determined in ESIA stage, it is recommended that the infrastructure design includes such elements. A proper monitoring system will need to be designed and implemented for the efficient function of the mechanism. Other relevant mitigation measures include the definition of alternative routing and local mobility plans for the affected settlements during construction, the preparation of a Community Health and Safety Plan to address common hazards of the civil works and interactions with workers and the definition of feasible solutions to accommodate construction works in identified narrower areas of the right of way along the canal.

11.3. Recommendations for Future Studies

Recommendations for future studies are being prepared separately in the form of Terms of Reference (TORs).

- Project detailed ESIA
- Stakeholder Engagement Plan
- Biodiversity Action Plan
- Hydrological studies to determine the availability of water in the Hub Dam Reservoir which includes potential impact of climate change.

11.4. Recommendations to enhance Project Outcomes

A long-term Bulk Water Supply Agreement will be signed by a private sector developer to operate the conveyance and water treatment systems described in this report and supply water to the City of Karachi. The agreement will need to take into consideration the following:

- the water needs of the communities in the PAA as described in this report: these will be quantified in the ESIA and the mechanisms to deliver water to communities will be described in the detailed design and feasibility studies and summarised in the ESIA. This information will include the location

of watering points and the amount of water required at each point. Different modalities of water distribution to communities are described in Section 9.3.1.2, and the selected mechanisms will need to be determined based on a participatory process which includes the communities.

- the Bulk Water Supply Agreement will need to envisage periods of no flow in the canal (according to historical data this has occurred 10% of the time over the past 20 years): how will water be delivered to the PAA communities during these periods. The agreement should envisage a simple system of water allocation or delivery to communities that is equitable and transparent during dryer periods when limited amounts of water are available.

- the Bulk Water Supply Agreement should specify the environmental and social standards that the operation of the system should adhere to, such as the IFC Performance Standards and specific water quality standards (WHO Drinking Water standards, Sindh standards etc.) In addition, it is recommended that the financing arrangements for the project include a Common Terms Agreement (CTA) which covenants the E&S standards to be followed and the mitigation measures described in the Project specific ESIA and ESMP and BAP over the term of the loan.

- the Bulk Water Supply Agreement could include minimum local content and employment requirements to contribute to local economic development and build capacity in the communities of the PAA (this also contributes to project acceptance).

The canal currently supplies approximately 25% of Karachi's water supply. Future population growth and requirements for irrigated cropland will add to the current water demand and stress in the region. Future water supply solutions will need to include large scale desalination plants in coastal areas.

Appendix G includes a Table of government and other stakeholders, and their roles and responsibilities for E&S matters pertaining to the Project. The table identifies the different stakeholders, their function and their role in the Project, when their participation/engagement is required, and their capacity to carry out these activities (if known) and additional requirements (if needed to increase capacity).

12. References

Begum, A. et al., 2013. WATER BIRDS DIVERSITY AND CONSERVATION AT HUB DAM LASBELLA, KARACHI, PAKISTAN. African Journal of Science and Research ,2013, 2(3): 22-26 ISSN: 2306-5877 Available Online: http://ajsr.rstpublishers.com/

BirdLife International (2020) Important Bird Areas factsheet: Kirthar National Park (including Hub Dam). Downloaded from http://www.birdlife.org on 17/12/2020.

EBRD, Workers' accommodation: processes and standards, A guidance note by IFC and the EBRD, August 2009.

Galib, & Hussain, S. & Khan, Zaheer & Damhoureyeh, Said & Zehra, A. & Fatima, F. & Hussain, Babar & Siddiqui, Saima & Shakeel, D. & Tabassum, F. & Samreen, N. & Khan, Alishba & Jabeen, T. & Hashimi, M. & Hasnain, S. (2013). An Overview of Occurrence, Distribution, and Status of the Birds of Khirthar Protected Area Complex (KPAC), Sindh. Canadian Journal of Pure and Applied Sciences. 7. 2515-2532.

Khan, MZ. et al., 2013. Current habitat, Distribution and Status of the Mammals of Khirthar Protected Area Complex. Canadian Journal of Pure and Applied Sciences. 7(2).

Kanwal, J. 2018. Review of the distribution, status and conservation of the wildlife of Sindh. Canadian Journal of Pure and Applied Sciences Vol. 12, No. 2, pp. 4519-4533, June 2018.

University of Melbourne, 2000. Khirthar National Park, Baseline Environmental Study. The University of Melbourne, Australia. (unpublished).

Waseem, A.K. 2015.Distribution, status and current state of habitat of Hog deer (*Axis porcinus*) in Indus eco-region. Pakistan Wildlife Foundation.

Appendices

Appendix A – Gap Analysis Regulatory Framework and IFC Performance Standards

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
IFC Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts			
ESIA (requirement to conduct a process of environmental and social assessment which identifies E&S risks and impacts, alternatives analyses, cumulative impacts	Sindh Environmental Protection Act, 2014 requires an EIA or IEE.		The project must meet both the local regulatory framework and the ESIA requirements according to PS1.
ESMS appropriate to nature and scale of project, overarching policy.	The EIA or IEE must be accompanied by an Environmental Management plan which includes provisions for monitoring, reporting and auditing	ESMS and overarching policy not required under local legislation.	The project must meet both the local regulatory framework and the ESIA requirements according to PS1.
Stakeholder engagement (ongoing process that involves: stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and ongoing reporting & communication).	EIA/IEE requires effective public consultation, the EIA needs to be accessible to public and Government Agencies for comment (a notice must be published to this effect)	No provision for Ongoing consultation once project is approved and constructed	The project must meet both the local regulatory framework and the ESIA requirements according to PS1.
[20-21] Emergency Preparedness and Response (EPR)	Sindh Environmental Protection Act, 2014, Hazardous Substances Rules, 2014 stipulates that the EIA shall include a Safety Plan		Follow IFC PSs
[22-24] Monitoring and Review	The EIA or IEE must be accompanied by an Environmental Management plan which includes provisions for monitoring, reporting and auditing		The project must meet both the local regulatory framework and the ESIA requirements according to PS1.
[29] Disclosure	EIA needs to be disclosed and accessible to public and Government Agencies for comment (a notice must be published to this effect)		The project must meet both the local regulatory framework and the ESIA requirements according to PS1.
[34-35] External Communications and Grievance Mechanisms	GM not mentioned in legislation	Not regulated in Sindh legislation	Follow IFC PSs
[36] Ongoing Reporting to Affected Communities	Not considered	Ongoing Reporting not considered	Follow IFC PSs

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
Performance Standard 2: Labour and Working Conditions Vs Pakistan National Labour legislation comprising: • **The West Pakistan Shops and Establishments Ordinance 1969** • **The Employment of Children Act 1991** • **The Bonded Labour System Abolition Act 1992.** • **THE SINDH TERMS OF EMPLOYMENT (STANDING ORDERS) ACT, 2015** • **Industrial and commercial employment (standing orders) ordinance, 1968** • **The Factories Act 1934** • **Workers' Welfare Fund Ordinance, 1971**			
[10] Respect of applicable collective agreement.	Constitution and labour law provide for freedom of association and allow workers and employers to join and form unions. (Section 3 of Industrial Relations Act 2012). Constitution also supports freedom of association, subject to any reasonable restrictions imposed by law in the interest of sovereignty or integrity of Pakistan, public order or morality (art. 17).		[10] The project must respect the applicable collective agreement.
[11] Identification of migrant workers and provision of equivalent working conditions to non-migrant	There is no explanation found in laws about migrant workers	Migrants worker right not regulated in National Law	In the unlikely event of migrant worker joining works, all labour rights and conditions will apply in equal terms to the national workers

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[12] When accommodation services are needed, a quality policy and management should be implemented. • **The accommodation services will be provided in a manner consistent with the principles of non-discrimination and equal opportunity** • **Provision of basic serves during accommodation.** **Workers' accommodation arrangements should not restrict workers' freedom of movement or of association.**	The Workers' Welfare Fund Ordinance, 1971 was promulgated for the establishment of a Workers' Welfare Fund (the "Fund") for providing residential accommodation and other facilities for workers and for matters connected therewith. THE SINDH TERMS OF EMPLOYMENT (STANDING ORDERS) ACT, 2015 describe the accommodation standard and arrangements for workers.	No legal obligation to provide specific policy on accommodation	Policy, rules and description of access to basic services and conditions of accommodation to be disclosed to workers by the project development prior to the commencement of the works
[13] In countries where national law recognizes workers' rights to form and to join workers' organizations of their choosing without interference and to bargain collectively, the client will comply with national law. The client should not seek to influence or control these mechanisms	THE SINDH INDUSTRIAL RELATIONS ACT, 2013. Section 3 (i). workers without distinction whatsoever, shall have the right to establish and subject to the rules of the organization concerned, join trade union and associations of their own choice without previous authorization:	No gaps identified	Project developer will abstain from influencing legally recognized worker´s associations and/or unions
[15] Employment relationship based on the principle of equal opportunity and fair treatment. No discrimination with respect to any aspects of the employment relationship (recruitment and hiring, compensation working conditions, etc.). The client will take measures to prevent and address harassment, intimidation, and/or exploitation, especially in regard to women.	No employer or trade union of employers and no person acting on behalf of either shall– (c) discriminate against any person in regard to any employment, promotion, condition of employment or working condition on the ground that such persons, or is not, a member or office-bearer of a trade union (Art 17, THE SINDH INDUSTRIAL RELATIONS ACT, 2013.)	No gaps identified	Project developer to describe in the EMSP the policies and measures to prevent and address harassment, intimidation, and/or exploitation, especially in regard to women

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[16] In countries where national law provides for non-discrimination in employment, the client will comply with national law	The Constitution of Pakistan has a wide range of provisions in regards to labour rights as Articles 11, 17, 18, 25 and 37(e) prohibit all forms of bonded labour, child labour, allow freedom of association, grant rights to unionise, provide citizen with the right to enter any lawful profession or trade without any discrimination and secure humane and reasonable working conditions	No gaps identified	Compliance with national law
[17] Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job will not be deemed as discrimination, provided they are consistent with national law.	No specific provision	Not regulated in National law	PS2 to be followed
[18] Prior to implementing any collective dismissals, the client will carry out an analysis of alternatives to retrenchment.	Where any workman is retrenched or discharged by a contractor or employer engaged in the constructions industry due to completion, cessation, discontinuance of work, he shall be given preference for employment in any other similar work undertaken by the contractor or employer within a period of one year from the date of such retrenchment or discharge.(industrial and commercial employment (standing ordinance, 1968))	Alternative to retrenchment not contemplated in the law, except o the possibility of preferential hiring in any other similar work within the next year	Analysis of alternatives to retrenchment to be contemplated prior to collective retrenchment by the project developer
[19] The client should ensure that all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner	The employer shall send a notice by registered post to the retrenched workmen belonging to the category concerned to offer themselves for re-employment and that notice shall be sent to the last known addresses of the retrenched workmen.(industrial and commercial employment (standing orders) ordinance, 1968)	No gaps identified	Notification of dismissal and severance payment in accordance with national law

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[20] The client will provide a grievance mechanism for workers (and their organizations, where they exist) to raise workplace concerns	In case of disputes concerning workers, the Industrial Relations Act, 2012, provides for a detailed procedure for internal redressal of individual grievances. Under the Act, a worker can file a written notice with his employer within 90 days of the day on which the cause of the grievance arises. If the aggrieved worker is dissatisfied with the decision, the worker can take the matter to the collective bargaining agent or the NIRC as the case may be.	No gap identified	Grievance redress mechanism in accordance with national law and applicable collective agreement. If no collective agreement is applicable, the project developer will define in the ESMP the proper redress procedure in case of lack of agreement in first stage
[21] The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. The client will identify the presence of all persons under the age of 18. Where national laws have provisions for the employment of minors, the client will follow those laws applicable to the client. Children under the age of 18 will not be employed in hazardous work. All work of persons under the age of 18 will be subject to an appropriate risk assessment and regular monitoring of health, working conditions, and hours of work.	A number of laws contain provisions prohibiting child labour, or regulating the working conditions of child and adolescent workers. The most important laws are:	No gap identified	Workers under 18 to be identified and notified in the corresponding ESMP monitoring reports. No hazardous works will be allowed for workers under 18.
[22] The client will not employ forced labor, which consists of any work or service not voluntarily performed that is exacted from an individual under threat of force or penalty	Article 11 of the Constitution deals specifically with forced labor. It says: "Slavery is non-existent and forbidden and no law shall permit or facilitate its introduction into Pakistan in any form. All forms of forced labour and traffic in human beings are prohibited"	No gap identified	National law to be applied

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[23] The client will provide a safe and healthy work environment, taking into account inherent risks in its particular sector and specific classes of hazards in the client's work areas, including physical, chemical, biological, and radiological hazards, and specific threats to women	Chapter 3 of Factories Act makes it obligatory on the employer to provide for safe and healthy working environment to the workers. (Section 13-33Q)	No gaps identified	National regulations on health and safety to be applied
[24-26] The client will take reasonable efforts to ascertain that the third parties who engage contracted workers are reputable and legitimate enterprises and have an appropriate ESMS consistent with the these PS. The client will establish policies and procedures for managing and monitoring the performance of such third party employers in relation to the requirements of this Performance Standard. The client will ensure that workers contracted by third parties have access to a grievance mechanism	No specific provisions of third party or subcontractor liabilities regarding labour conditions	Not regulated in national legislation	Provision in paragraph 24 and 26 of PS2 to be applied. The project developer will establish policies and procedures for managing and monitoring the performance of subcontractors in relation to the requirements of PS2
[27-30].If child labor, forced labor or safety risks or cases are identified in the supply chain, the client will take appropriate steps to remedy them. Where remedy is not possible, the client will shift the project's primary supply chain over time to suppliers that can demonstrate that they are complying with this Performance Standard	No specific provisions of third party or subcontractor liabilities regarding labour conditions	Not regulated in national legislation	Provision in paragraph 27-30 of PS2 to be applied. The project developer will take appropriate steps to remedy child labor, forced labor or safety risks or cases are identified in the supply chain the requirements of PS8

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
Performance Standard 3: Resource Efficiency and Pollution Prevention			
Resource Efficiency - GHG **[7-8] The client will consider alternatives and implement technically and financially feasible and cost-effective options to reduce project-related GHG emissions during the design and operation of the project.** **For projects that are expected to or currently produce > 25,000 tonnes of CO2-eq annually: quantification of direct emissions from the facilities owned or controlled within the physical project boundary, and indirect emissions associated with the off-site production of energy used by the project.**	National Climate Change Policy and National Disaster Risk Reduction Policy, 2012 and Framework for Implementation of the Climate Change Policy (2014-2030)		The project will not emit > 25,000 tonnes CO2/year, the solar PV plant will provide a low carbon electricity generation source to offset's the WTP's electricity usage.
Resource Efficiency - Water **[9] Adopt measures that avoid or reduce water usage so that the project's water consumption does not have significant adverse impacts on others. These measures include, but are not limited to, the use of additional technically feasible water conservation measures within the client's operations, the use of alternative water supplies, water consumption offsets to reduce total demand for water resources to within the available supply, and evaluation of alternative project locations.**	The National Climate Change Policy mentions water as one of the national adaptation priorities.		The project objective is to reduce water losses in the Karachi Water canal, in line with [9]

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[10-11] Pollution Prevention **The client will avoid the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release.**	Sindh Environmental Protection Act, 2014, Hazardous Substances Rules, 2014. SEQS 2016 (Sindh Environmental Industrial Waste Water, Effluent, Domestic, Sewerage, Industrial Air Emission and Ambient Airs, Noise for Vehicles, Air Emissions for Vehicles and Drinking Water Quality Standards)	National legislation not as detailed: • Wastewater effluent: IFC General EHS Guidelines are more stringent for BOD, COD, TSS, TDS • Noise standards: Sindh standards more stringent for commercial zones, less stringent for industrial zones during the day • Ambient air quality: IFC General EHS Guidelines more stringent than SEQS 2016	Follow IFC General EHS Guidelines and PSs when more stringent and Sindh regulations when more stringent (e.g. see report for noise standards).
[12-13] Wastes and Hazardous Materials Handling **Avoid the generation of hazardous and non-hazardous waste materials. Where waste generation cannot be avoided, reduce the generation of waste, and recover and reuse waste in a manner that is safe for human health and the environment. Where waste cannot be recovered or reused, the client will treat, destroy, or dispose of it in an environmentally sound manner that includes the appropriate control of emissions and residues resulting from the handling and processing of the waste material.**	Sindh Environmental Protection Act, 2014, Hazardous Substances Rules, 2014, stipulates that the EIA shall include a waste management plan and a safety plan. Includes provision for transportation of hazardous substances.	National legislation not as detailed	Follow IFC General EHS Guidelines and PSs and National legislation

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[14-17] Pesticide Use and Management **The client will not purchase, store, use, manufacture, or trade in products that fall in WHO Recommended Classification of Pesticides by Hazard Class Ia (extremely hazardous); or Ib (highly hazardous). The client will not purchase, store, use, manufacture or trade in Class II (moderately hazardous) pesticides, unless the project has appropriate controls on manufacture, procurement, or distribution and/or use of these chemicals. These chemicals should not be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly.**	Sindh Environmental Protection Act, 2014, Hazardous Substances Rules, 2014	National legislation not as detailed	Follow IFC General EHS Guidelines and PSs and National legislation
Performance Standard 4: Community Health, Safety, and Security vs Pakistan´s legislation on safety and health, comprising: • **Hazardous Occupations Rules, 1963 (Chapter 3)** • **Factories Act, 1934**			
[5] Community Health and Safety. **The client will evaluate the risks and impacts to the health and safety of the Affected Communities during the project life cycle and will establish preventive and control measures consistent with good international industry practice (GIIP), such as in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) or other internationally recognized sources. The client will identify risks and impacts and propose mitigation measures that are commensurate with their nature and magnitude. These measures will favour the avoidance of risks and impacts over minimization.**	There is no independent legislation on occupational safety and health issues in Pakistan. The main law, which governs these issues, is the Chapter 3 of Factories Act, 1934. All the provinces, under this act, have devised Factories Rules. Khyber Pakhtunkhwa and Sindh have enacted the Factories legislation in 2013 and 2016 respectively. The Hazardous Occupations Rules, 1963 under the authority of Factories Act is another relevant legislation. These rules not only specify some hazardous occupations (working with Lead; Aerated Waters; Rubber; Chromium; Cellulose Solution Spraying; Sand Blasting; Sodium and Potassium-Bichromates; Petrol Gas Generating Plant) but also authorize the Chief	National legislation on occupational health and safety do not contemplate specific provisions for affected communities, solely focusing on worker´s protection	In the absence of applicable national legislation PS4 provisions will be applicable.

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[6] Infrastructure and Equipment Design and Safety	Inspector of Factories to declare any other process hazardous as		
[7] Hazardous Materials Management and Safety			
[8] Ecosystem Services			
[9] Community Exposure to Disease.			
[10] Emergency Preparedness and Response			
[12-14] Security personnel			
Performance Standard 5: Land Acquisition and Involuntary Resettlement vs Land Acquisition Act of 1894			
Where livelihoods of displaced persons are land-based, or where land is collectively owned, the client will, where feasible, offer the displaced land-based compensation.	No legal provisions on land-based compensation	No legal provisions on land-based compensation	Permanent physical displacement not expected in the project
The client will take possession of acquired land and related assets only after compensation has been made available and, where applicable, resettlement sites and moving allowances have been provided to the displaced persons in addition to compensation	No legal provisions on the need to disburse compensation prior to commencement of the works	There is no mechanism to ensure payment is made before displacement	All compensations to be disbursed prior acquisition of land or related affected assets in accordance with PS5
The client will also provide opportunities to displaced communities and persons to derive appropriate development benefits from the project	No specific provisions in national law	No specific provisions in national law	Development opportunities and social investment to mitigate impacts and enhance livelihoods to be described in the Project developer´s ESMP
The client will engage with Affected Communities, including host communities, through the process of stakeholder engagement. Decision making processes related to resettlement and livelihood restoration should include options and alternatives, where applicable.	No equivalent requirements other than consultations being a key requirement of Pakistan Environmental Protection Act (PEPA)		Stakeholder Engagement Plan (SEP) to be prepared and implemented by Project developer

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
The consultation process should ensure that women's perspectives are obtained, and their interests factored into all aspects of resettlement planning and implementation	No legal provisions on gender issues during land acquisition process	No legal provisions on gender issues during land acquisition process	SEP to contain specific measures to ensure that women´s perspectives are obtained, and their interests factored
Disclosure of relevant information and participation of Affected Communities and persons will continue during the planning, implementation, monitoring, and evaluation of compensation payments, livelihood restoration activities, and resettlement to achieve outcomes that are consistent with the objectives of this Performance Standard.	The decisions regarding land acquisition and the amounts of compensation to be paid are published in the official Gazette and notified in accessible places so that the people affected are well informed.	Disclosure not contemplated beyond decisions on land acquisition	SEP to include a disclosure policy of all aspects related to the planning, implementation, monitoring, and evaluation of compensation payments, livelihood restoration activities, and resettlement
The client will establish a grievance mechanism as early as possible in the project development phase. This will allow the client to receive and address specific concerns about compensation and relocation raised by displaced persons or members of host communities in a timely fashion, including a recourse mechanism designed to resolve disputes in an impartial manner.	No equivalent provisions found in national law	No convenient grievance redress mechanism except recourse of appeal to formal administrative jurisdiction or the court of law	Project developer to establish a grievance redress mechanism in the ESMP regarding any aspect of the livelihood restoration and compensation measures, including a recourse mechanism designed to resolve disputes in an impartial manner.
Where involuntary resettlement is unavoidable, (…), a census will be carried out to collect appropriate socioeconomic baseline data to identify the persons who will be displaced by the project, determine who will be eligible for compensation and assistance, and discourage ineligible persons	No equivalent requirements (though the Pakistan Environmental Protection Act (PEPA) 1997 does require screening of social impacts that also include resettlement impacts)	Census not regulated in the law	Physical displacement not expected in the project. In case of temporary resettlement, a census will be deployed in the corresponding Resettlement and Livelihood Restoration Action Plan, to be prepared by the project developer

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
In the absence of host government procedures, the client will establish a cut-off date for eligibility. Information regarding the cut-off date will be well documented and disseminated throughout the project area.	No equivalent provisions found in national law	No equivalent provisions found in national law	Physical displacement not expected in the project. In case of temporary resettlement, a cut-off date will be defined in the corresponding Resettlement and Livelihood Restoration Action Plan, to be prepared by the project developer
Displaced persons may be classified as persons (i) **who have formal legal rights to the land or assets they occupy or use;** (ii) **who do not have formal legal rights to land or assets, but have a claim to land that is recognized or recognizable under national law;** (iii) **who have no recognizable legal right or claim to the land or assets they occupy or use.** **The census will establish the status of the displaced persons**	Only titled landowners or customary rights holders are recognized for compensation. Only registered landowners, sharecroppers and leaseholders are eligible for compensation of crop losses.	PAP with no recognizable legal right or claim to the land not entitled to compensation	Informal occupants of the land to be entitled for compensation for loss of assets or access to natural resources in the terms of PS5. Entitlements to be detailed in the ESMP and Resettlement and Livelihood Restoration program
In the case of physical displacement, the client will develop a Resettlement Action Plan (RAP) that covers, at a minimum, the applicable requirements of this Performance Standard regardless of the number of people affected	Negotiated purchase, no RAP required. Procedures available through instructions and agreement signed.	RAP not required in national law	In case of economic displacement of PAP, the Project Developer will prepare a Livelihood Restoration Action Plan
In the case of physically displaced persons with formal legal rights or claims over the land legally recognized, the client will offer the choice of replacement property of equal or higher value, security of tenure, equivalent or better characteristics, and advantages of location or cash compensation where appropriate. Compensation in kind should be considered in lieu of cash.	No legal provisions on land-based compensation	No legal provisions on land-based compensation	Permanent physical displacement not expected in the project

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
In the case of physically displaced persons without any legal recognizable right or claim over the land, the client will offer them a choice of options for adequate housing with security of tenure (…)., The client will compensate for the loss of assets other than land, such as dwellings and other improvements to the land, at full replacement cost (…). The client will provide relocation assistance sufficient for them to restore their standard of living at an adequate alternative site	Land valuation is based on the median registered land transfer rate over the 3 years prior to Section 4 of the LAA being invoked. A 15% 'compulsory acquisition surcharge' is paid over and above the assessed compensation. However, recent practice is that prices based on the average over the last one year prior to acquisition commencing is applied. Provinces have also issued instructions for assessing compensation to ensure displaced persons receive compensation at market price. The valuation of structures is based on official rates, with depreciation deducted from gross value of the structure and also 15% of the value of salvaged materials. The valuation of structures is based on official rates, with depreciation deducted from gross value of the structure and also 15% of the value of salvaged materials.	Transaction costs not included in compensation of assets and land	Specific assessment to determine full replacement costs to be carried in RAP for affected assets and land
Transitional support should be provided as necessary to all economically displaced persons, based on a reasonable estimate of the time required to restore their income-earning capacity, production levels, and standards of living	No equivalent provisions in national law	There is no provision for income and livelihood rehabilitation measures. There are also no special allowances for vulnerable groups. There are no requirements to assess opportunities for benefit sharing. Untitled PAPs are not entitled to rehabilitation support.	Entitlement to transitional support to be defined as necessary to all economically displaced persons ipersonsin the Livelihood Restoration Action Plan or RAP to be prepared by the project developer

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
If land acquisition or restrictions on land use result in economic displacement, defined as loss of assets and/or means of livelihood, regardless of whether or not the affected people are physically displaced (…), the following compensations will take place: • **Affected business owners will be compensated for the cost of re-establishing commercial activities elsewhere, for lost net income during the period of transition, and for the costs of the transfer and reinstallation of the plant, machinery, or other equipment.** • **In cases affecting persons with legal rights or claims to land, replacement property (e.g., agricultural or commercial sites) of equal or greater value will be provided, or, where appropriate, cash compensation at full replacement cost.** **Economically displaced persons who are without legally recognizable claims to land will be compensated for lost assets other than land (such as crops, irrigation infrastructure, etc.), at full replacement cost.**	No specific equivalent provisions on economic displacement	There is no provision for income and livelihood rehabilitation measures. There are also no special allowances for vulnerable groups. There are no requirements to assess opportunities for benefit sharing. Untitled PAPs are not entitled to rehabilitation support.	Entitlements to compensations due to economic displacement to be defined as necessary to all economically displaced persons in the Livelihood Restoration Action Plan or RAP to be prepared by the project developer
In the case of physically displaced persons without any legal recognizable right or claim over the land, the client will offer them a choice of options for adequate housing with security of tenure (…).,The client will compensate for the loss of assets other than land, such as dwellings and other improvements to the land, at full replacement cost (…).The client will provide relocation assistance sufficient for them to restore their standard of living at an adequate alternative site	Only titled landowners or customary rights holders are recognized for compensation	There is no provision for income and livelihood rehabilitation measures for economic displaced people. There are also no special allowances for vulnerable groups. There are no requirements to assess opportunities for benefit sharing. Untitled PAPs are not entitled to rehabilitation support.	Entitlements to compensations due to economic displacement to be defined as necessary to all economically displaced persons n the Livelihood Restoration Action Plan or RAP to be prepared by the project developer

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
In addition to compensation for lost assets, if any, economically displaced persons whose livelihoods or income levels are adversely affected will also be provided opportunities to improve, or at least restore, their means of income-earning capacity, production levels, and standards of living: • **For persons whose livelihoods are land-based, replacement land that has a combination of productive potential, locational advantages, and other factors at least equivalent to that being lost should be offered as a matter of priority.** • **For persons whose livelihoods are natural resource-based and where project-related restrictions on access envisaged in paragraph 5 apply, implementation of measures will be made to either allow continued access to affected resources or provide access to alternative resources with equivalent livelihood-earning potential and accessibility Where appropriate, benefits and compensation associated with natural resource usage may be collective in nature rather than directly oriented towards individuals or households.** • **If circumstances prevent the client from providing land or similar resources as described above, alternative income earning opportunities may be provided, such as credit facilities, training, cash, or employment opportunities. Cash compensation alone, however, is frequently insufficient to restore livelihoods.**	No equivalent provisions in national legislation		In the context of the project, restrictions to access to water will need to be specifically addressed by the Project Developer, for PAP regardless of their rights or legal claims over the land. The ESMP and Livelihood Restoration Plan will detail the measures to be implemented in accordance with the risks and mitigation measures identified in this E&S scoping exercise

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources			
[5] The risks and impacts identification process as set out in PS1 should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. **This process will consider relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution**	Sindh Environmental Protection Act, 2014 considers project-related impacts on biodiversity. Ecosystem services not considered in national legislation	Ecosystem services not considered in national legislation	PS6 and National legislation
[7] When avoidance of impacts is not possible, measures to minimize impacts and restore biodiversity and ecosystem services should be implemented. Given the complexity in predicting project impacts on biodiversity and ecosystem services over the long term, the client should adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.	Sindh Environmental Protection Act, 2014. Adaptive management not explicitly considered.	Adaptive management not explicitly considered.	PS6 and National legislation
[9-19] Protection and Conservation of Biodiversity **Characterisation of Habitat**	Sindh Wildlife Protection Act and amendments lists 326 bird species, 107 species of crawling animals, and 82 species of other classifications. Does not include a characterisation of Habitat as per PS6.	No Characterisation of Habitat as per PS6	National legislation and PS6

IFC performance Standard (A)	Regulatory Framework Pakistan (B)	Gaps between (A) and (B)	Project Policy
[20] Legally Protected and Internationally Recognized Areas	Sindh Wildlife Protection Act and amendments includes protected areas, some of which are KBAs and IBAs.		National legislation and PS6
[21-23] Invasive Alien Species	Sindh Wildlife Protection Act and amendments.		National legislation and PS6
[24-25] Management of Ecosystem Services	Nor considered	Ecosystem services not considered in national legislation	PS6
Performance Standard 7: Indigenous Peoples (Not triggered)			
Performance Standard 8: Cultural Heritage Vs Pakistan Legislation on Cultural Heritage			
PS8 requires the client to: (i) protect cultural heritage from the adverse impacts of project activities and support its preservation	ANCIENT MONUMENTS ACT 1904 EXPORT CONTROL ACT 1947 ANTIQUITIES ACT 1968, 1975 SINDH BUILDING CONTROL ORDINANCE 1979 SINDH WAQF PROPERTIES ORDINANCE 1979 NATIONAL CHARTER FOR CONSERVATION NAD PRESERVATION OF CULTURAL SINDH CULTURAL HERITAGE (PRESERVATION) ACT 1997 NATION FUND FOR CULTURAL HERITAGE ACT 1994, 1996, 1997, 2002 KARACHI BUILDING & TOWN PLANNNING REGULATIONS 2002, 2005	National legislation of cultural heritage is compliant with PS8 requirements	The ESIA will need to identify sites of cultural heritage and assess their value or importance at the community, provincial and national levels according to PS8

Appendix B – Guideline questions for discussion with local leaders

Question	Comments
BASELINE QUESTIONS (please emphasize that this set of questions is aimed at understanding and characterizing the community for our study)	
Please briefly explain how the Union (or community leaders) is organized and their main functions? how do they coordinate with the district? Is there any other local authority (religious for example) also taking part in public decisions?	
How many people/households are comprised in this community? Is there any official demographic registry? What´s the average number (approx..) number of household members?	• If any registry, let´s try to get at least some summary statistics of population. • During your visit also take account on the basic characteristics of the settlement: construction standards, building patterns (just a descriptive account
Are there any relevant migration flows (in or out) affecting the community? Are there newcomer settlers in the community or is it mostly historical settlers? Do community members commute to other villages or districts for work reasons?	
What are the main livelihood sources in the community?	Ask for approximate percentages and list those that are different from agriculture
Is there any relevant ethnic minority or migrant population present in the community?	Please indicate the specific tribal group if applicable and describe degree of vulnerability
What´s the roles of women within the household? Do the take part in agricultural activities? Do they perform any particular job or craft? Is there any women association or representative in the community for women issues? Do women normally hold land lease tittles?	If there are any women representatives present at the meeting, let´s briefly discuss their main issues
What is the main religion professed in the community (Sunni Islam)? Are there any religious minorities in the community (Shia Islam, Christian, etc.)?	Please look for a culturally appropriate formula for this question.
Which percentage of households hold formal tenure of the land?	
What is the average land surface for each agricultural land plot?	
What are the main livelihood sources in the community? please rank by level of importance	Please specifically list those different from agriculture (nearby industries, public jobs etc)
What are the main crops cultivated in this community? How has production and land structure changed in recent years?	Please obtain information regarding the town as a whole, and also specifically for the plots closest to the project area (use map as a visual aid)
Is production mostly for self-consumption or sold to any markets?	
What is the participation of household member in agricultural work? Do the use hired labour?	
Which percentage of households have livestock? Has livestock activities increased recently?	

Question	Comments
Are there any particular socioeconomic issues (public health, conflict, employment) we should be aware of in this particular area?	
What is the average education level in the area?	Please use a culturally appropriate formula for this question. We are interested to get just an approximation of the proportion of population with basic, middle and high levels of education
How many schools are there in the community	If possible, try to obtain name and location
Are there any health facilities in the community? What type (clinic, hospital, etc.)	Please try to obtain name and location
Is access to power available to community members? Is service reliable?	
Are there any mosques, temples or other culturally relevant buildings?	Please try to obtain name and location
IMPACT QUESTIONS (We should also take account of all their questions and inquiries during the conversation (please emphasize that we are here to make sure that their concerns are taken into account). The following questions need to be addressed with the visual aid of a map of the project affected area	
What is the main source of drinking water in the village? What is the main source of water for other purposes (livestock, cleaning, etc.)?	Please elaborate on main access conditions and water quality. If possible collect information of available water infrastructure (ponds, wells, pumps, etc.)
How long have the communities been settled in this area? How long have been using the land next to the canal for agricultural purposes?	Here we need to understand whether agricultural developments are recent in the area and due to the seepage from the canal
What are the main uses of water canal by community members?	
Is water being extracted from the canal through pumps or other mechanized means? How often?	
What is the main source of water for the agricultural plots situated near the canal? Are farmers aware of the origin of the water currents stemming from the canal?	Here we really need to understand to what degree communities are aware of the fact that the water running through their fields comes from the anal or other possible natural sources. Please investigate: could the cracks in the infrastructure have been caused intentionally?
Do farmers hold agricultural plots at the opposite side of the canal from their residence?	

Appendix C – Summary of Preliminary Mitigation Measures for Identified Risk/Impacts

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
				Air Quality		
Fugitive dust during construction	PS1/ PS 3/ PS4	• Using spray trucks to minimize dust emissions, impacts on nearby crops and community grievances • Regular washing down of equipment and vehicles, • Minimizing use of unpaved roads • Respond and address community grievances promptly. • Worker EHS Awareness Training • Keep construction laydown areas away from residential areas	Construction Phase ESMP Community Grievance Mechanism	• Daily EHS Supervision • Monitor TPM, PM10, PM2.5 • Internal audits • Grievance mechanism	Daily during construction Audits: Monthly during construction	E
CO2 emissions	PS1/ PS3	• Regular vehicle maintenance • Minimize vehicle idling • Worker EHS Awareness Training	Construction Phase ESMP	• Daily EHS Supervision • Internal audits	Daily during construction Audits: Monthly during construction	E
Noise during Construction (Community)	PS1/ PS3/ PS4	• Follow the strictest between IFC General EHS Guidelines and Sindh Env. Qual. Standards for noise standards depending on time of day and zoning. • Respond and address community grievances promptly. • Minimize vehicle idling • Worker EHS Awareness Training • Keep construction laydown areas away from residential areas • consider noise barriers as needed	Construction Phase ESMP	• Daily EHS Supervision • Internal audits • Grievance mechanism • If grievances arise due to noise, monitor noise levels for compliance with standards	Daily during construction Audits: Monthly during construction	E
Noise during Operations	PS1/ PS3	• Follow IFC General EHS Guidelines for noise standards • Consider noise barriers around transformers, noise abatement enclosures around inverter/power blocks if any sensitive receptors are nearby • Respond and address community grievances promptly.	Design Considerations and Operations Phase ESMP and Monitoring Program	• If grievances arise due to noise, monitor noise levels for compliance with standards	As necessary	D
				Surface Water Bodies		
Direct impact to waterbody footprint or flow in streams during construction	PS1/ PS3	• Identify set-back distances from waterbodies and use markers/barrier tape to minimize disturbance to waterbodies. • divert flow from trenching excavation areas using temporary channels or culverts • rehabilitate streambeds with similar substrate and characteristics • restore any riparian vegetation and vegetated areas that were disturbed or removed during construction to prevent erosion and sediment transport into surface water bodies.	Construction Phase ESMP	• Daily EHS Supervision • Internal audits	Daily during construction Audits: Monthly during construction	E
Permanent ponds, wetlands and streams that were influenced by seepage may dry up or become seasonal during operations	PS1/ PS3	• Monitoring of surface water bodies to determine the extent of impact on surface water bodies	Operation Phase ESMP	• Monthly monitoring over one to two years or as determined in the ESIA	Monthly Annual Report	P

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
Water usage for Solar PV cleaning	PS1/ PS3	• Minimise use of water for solar PV cleaning by using dry cleaning methods • Cleaning schedule optimization to minimize the annual volume of water used for panel cleaning	Design Considerations and Operation Phase ESMP	• Monitoring of water consumption	When needed	P
Surface Water and Groundwater Quality						
Stormwater drainage during construction	PS1/ PS3	• Have a stormwater drainage plan for construction (see main body of text for details). • Use silt curtains/check dams/barriers near waterbodies (streams, ponds, wetlands, irrigation channels). • Minimize any vegetation removal prior to heavy rainfall periods to avoid exposed soil erosion. • Stormwater drainage system should be regularly cleared of debris • Worker EHS Awareness Training	Construction Phase ESMP	• Daily EHS Supervision • Internal audits	Daily during construction Audits: Monthly during construction	E
Stormwater drainage during operation	PS1/ PS3	• Permanent stormwater drainage design for project components including the PV plant should take into account runoff from contributing catchments and include adequately sized culvert and ditches. • Stormwater drainage system should be regularly cleared of debris	Design Considerations and Operations Phase ESMP and Monitoring Program	• Daily EHS Supervision • Internal audits	As necessary	D /(
Surface and groundwater quality during construction	PS1/ PS3	• Spill Prevention Plan, secondary containment around all hazardous substances and petroleum hydrocarbon tanks and containers • Waste management plan • Hazardous Materials handling Procedures • Emergency Response Plan - construction • Have spill kits available on site in high risk areas • Worker EHS Awareness Training • Identify a set-back distance from waterbodies and use markers or barrier tape to minimize disturbance to these area during construction	Construction Phase ESMP and Monitoring Program	• Daily EHS Supervision • Surface and groundwater quality monitoring program • Internal audits	Daily	E
Surface and groundwater quality during operations	PS1/ PS3	• Spill Prevention Plan, secondary containment around all hazardous substances and petroleum hydrocarbon tanks and containers • Waste management plan • Hazardous Materials handling Procedures • Emergency Response Plan - operation • Have spill kits available on site in high risk areas • Worker EHS Awareness Training	Operations Phase ESMP and Monitoring Program	• EHS Supervision • Surface and groundwater quality monitoring program • Internal audits	As necessary	P
Sanitary wastewater during construction (construction camp)	PS1/ PS3	• Should not be discharged to a surface water body without being treated and need to meet effluent guidelines or use septic tanks.	Construction Phase ESMP and Monitoring Program	• EHS Supervision • Surface and groundwater quality monitoring program • Internal audits	As necessary	E
Sanitary wastewater during operations	PS1/ PS3	• Septic tank for sanitary wastewater	Operations Phase ESMP and Monitoring Program	• EHS Supervision • Internal audits	As necessary	P

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
Groundwater quality and water levels during construction	PS1/ PS3	• Monitor groundwater quality and water levels of nearby wells during construction	Construction Phase ESMP and Monitoring Program	• EHS supervision • Surface and groundwater quality monitoring program • Internal audits	Monthly or more often as necessary	E
Groundwater quality and water levels during operation	PS1/ PS3	• Monitor groundwater levels of nearby wells during operation to monitor effect of cessation of seepage • If wells impacted, compensation to well owners, as needed	Operations Phase ESMP and Monitoring Program	• EHS Supervision • Surface and groundwater quality monitoring program • Internal audits	Rainy season and dry season (minimum twice a year)	P
Erosion and Sediment Transport						
Stormwater drainage during construction	PS1/ PS3	• Use appropriate setbacks from water bodies and use markers or barrier tape to minimize disturbance of water bodies. • Stormwater drainage plan for construction • Use silt curtains/barriers near waterbodies (streams or irrigation channels). • Worker EHS Awareness Training	Construction Phase ESMP	• Daily EHS Supervision • Internal audits	Daily during construction Audits: Monthly during construction	E
Erosion and sediment transport	PS1/ PS3	• During site preparation, earth movement and grading activities, maintain topsoil, subsoil and muck in separate covered piles to be re-used to rehabilitate exposed areas and disused cana section in-filling once pipeline installation and PV plant components are completed. • Avoid leaving cleared unvegetated soil exposed for long periods of time. • Cover topsoil piles with plastic sheeting. • Rehabilitate/revegetate with native grass species any areas where construction is completed promptly.	Construction Phase ESMP	• Daily EHS Supervision • Internal audits	Daily	E
Stormwater drainage during operation	PS1/ PS3	• Stormwater drainage of the PV plant should take into account runoff from contributing catchments and include adequately sized culvert and ditches. • Stormwater drainage system should be regularly cleared of debris	Design Considerations and Operations Phase ESMP and Monitoring Program	• Daily EHS Supervision • Internal audits	As necessary	D
Soil Moisture						
Decrease in Soil Moisture	PS1/ PS3/ PS4	• Monitoring of impacts related to decrease in soil moisture levels due to lack of seepage during operations • ESIA to determine if any compensation required due to impacts on cropland, grazing areas etc.	Operations Phase ESMP and Monitoring Program	• Monitoring Program (if required)	Quarterly over 1 or 2 years, as determined in ESIA	M d o

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
			Soil Contamination and Pollution Prevention			
Soil contamination and Prevention Construction	PS1/ PS3	• Spill Prevention Plan, secondary containment around all hazardous substances and petroleum hydrocarbon tanks and containers • Waste management plan • Hazardous Materials handling Procedures • Emergency Response Plan - construction • Have spill kits available on site in high risk areas • Worker EHS Awareness Training	Construction Phase ESMP and Monitoring Program	Daily EHS Supervision Internal audits	Daily	E
Soil contamination and Prevention Operations	PS1/ PS3	• Transformer(s) at the solar PV substation should have secondary containment and/or drainage leading to an oil/water separator	Design Considerations and monitoring program	Engineering and EHS supervision over the life of the plant	As necessary	D
Soil contamination and Prevention Operations	PS1/ PS3	• Spill Prevention Plan, secondary containment around all hazardous substances and petroleum hydrocarbon tanks and containers • Waste Management Plan • Hazardous Materials handling Procedures • Emergency Response Plan - operations • Spill kits on site in high-risk areas where needed • Worker EHS Awareness Training	Operations Phase ESMP and Monitoring Program	EHS Supervision Internal audits	As necessary	P
			Soil Structure, Characteristics and Quality			
Excavated soils management	PS1/ PS3	• Excavated topsoil and subsoil shall be separated and kept separately in dedicated covered piles. • Topsoil stored in piles for long periods of time will need to be raked and aerated to avoid compaction	Construction Phase ESMP and Monitoring Program	Daily EHS Supervision Internal audits	Daily	E
Minimise soil compaction	PS1/ PS3	• Construction staging and planning within the canal ROW will minimise vegetation clearing and footprint of working areas. • Working areas will be restored to their initial conditions and levelled, any affected areas not being used as service roads after construction will be revegetated using stored topsoil and local species.	Construction Phase ESMP and Monitoring Program	Daily EHS Supervision Internal audits	Daily	E
			Vegetation/Flora			
Impacts on flora – general footprint		• Use appropriate setbacks from vegetated areas and water bodies by using markers or barrier tape to minimize disturbance and creeping of construction areas into neighbouring green space.	Construction Phase ESMP	EHS Supervision Internal audits	Daily during construction	E
Impacts of fugitive dust during construction on surrounding crops and vegetation	PS1/ PS3	• Using spray trucks to minimize dust emissions and community grievances as well as impacts on nearby crops. • Regular washing equipment and vehicles, • Minimizing use of unpaved roads • Respond and address community grievances promptly. • Worker EHS Awareness Training	Construction Phase ESMP Community Grievance Mechanism (for cropland, grazing areas)	Particulate matter sampling during construction	Daily during construction	E

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
Conservation of *Commiphora wightii* (CR) during construction		• Identify the location of the Guggar/Gugel plant identified during the biodiversity surveys (*Commiphora wightii,* a critically endangered species (CR)) and use taped barriers or other barriers to establish a set-back around it to avoid any impacts during construction (• Have biologists on site during construction to identify any EN or CR species (and other individual Guggar/Gugel plants), if damage is unavoidable due to project activities, attempt to transplant ahead of project activities, if possible. • implementation of any activities detailed in the BAP	Construction Phase ESMP Biodiversity Action Plan	EHS Supervision Internal audits Supervision by qualified biologist/ ecologist	Daily during construction and as required in BAP	C P B D a
Conservation of *Commiphora wightii* (CR) during operation	PS1/ PS6	Implement Biodiversity Action Plan for *Commiphora wightii* detailed in the BAP in collaboration with the Sindh Forestry Department	Operation Phase ESMP And Monitoring Program Biodiversity Action Plan (BAP)	Supervision by qualified biologist/ ecologist	As required in BAP	K ir S a
Fauna						
Fauna (construction)	PS1/ PS6	• Have biologists/ecologists on site to monitor for the presence of Indian Pangolin and other species of interest included in the BAP and to carry out capture and relocation of fauna, as required. • Avoid tree clearing during construction, if laydown areas are required, select areas that have scarce vegetation or that are already cleared and are not near water bodies and streams. • Identify a set-back distance from waterbodies and use markers or barrier tape to minimize disturbance to aquatic fauna and minimise disturbance and creeping of construction areas into neighbouring green space/wildlife habitat during construction. • Select the location of construction camps and laydown areas with the aim of avoiding the clearing of vegetation, by using available modified and peri-urban areas. • Maintain connectivity for wildlife under aqueducts or over canal at regular intervals. • Avoid impacts to the following protected species: Steppe eagle and the Saker falcon (and other raptors in the area).	Construction Phase ESMP And Monitoring Program Biodiversity Action Plan (BAP)	Daily EHS Supervision Internal audits Supervision by qualified biologist/ ecologist	Daily during construction and as required in BAP	C B D a
Fauna (operation)	PS1/ PS6	Implement Biodiversity Action Plan (Indian Pangolin and other species identified in the BAP)	Operation Phase ESMP And Monitoring Program Biodiversity Action Plan (BAP)	Supervision by qualified biologist/ ecologist	As required in BAP	K ir th a
Waste Management						

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
Solid, liquid and hazardous waste – Construction	PS1/ PS3	• Waste Management Plan for solid, liquid and hazardous based on a hierarchy that considers prevention, recycling and reuse, treatment and disposal. • Engage with the nearby Jam Chakro landfill site for waste disposal and recycling of construction phase waste streams. • Waste is to be collected by licensed waste disposal companies and disposed of at a landfill permitted to receive these wastes. • Enter into partnerships with scrap metal, recycling operations and hazardous waste management companies • Segregate waste at the source and store in designated areas. • Waste should be removed and disposed of at regular intervals and not allowed to accumulate. • Wastewater effluent treatment plan (see also Water Quality above).	Construction Phase ESMP And Monitoring Program	Daily EHS Supervision Internal audits	Daily	E
Solid, liquid and hazardous waste – Operations	PS1/ PS3	• Waste Management Plan based on a hierarchy that considers prevention, recycling and reuse, treatment and disposal (to include sludge from WFP). • Engage with the nearby Municipalities for waste collection service and recycling. • Waste is to be collected by local licensed waste disposal companies and disposed of at a landfill permitted to receive these wastes. • Enter into partnerships with scrap metal, recycling operations and hazardous waste management companies. • Segregate waste at the source and store in designated areas. • Waste should be removed at regular intervals and not allowed to accumulate. • Wastewater effluent treatment plan.	Operation Phase ESMP And Monitoring Program	EHS Supervision Internal audits	As necessary	P
Access to water by affected communities						
Limitation of access to canal water for basic consumption and domestic needs for around 8,000 inhabitants from six different communities	PS1/ PS4	Community Water Access System, including a mix of different alternatives are offered to the community, particularly in the form of distribution through tankers and direct collection at watering points.	Design options, physical investment and operational management	Metered records of water consumption and periodic consultations with community representatives	Weekly reports during construction Monthly reports during operation	D D M
Dependence of agricultural land on seepage water						
Rehabilitation of the infrastructure may negatively affect soil moisture and agricultural yield in the vicinity of the canal as a consequence of the elimination of seepage	PS1/ PS4	In depth studies to determine exact water demands in order to address the dependence of agricultural land on seepage water	ESIA study	Metered records of water discharges and periodic observations of impacts over habitats and land productivity, including consultations with farmers representatives	Monthly reports during the first year of operation. Semester reports during the rest of operation period	D
Community/Public Safety						

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
Community/Public Safety	PS1/ PS4	During Construction: Enhance and promote public safety around the open canal section (while still in operation), such as fencing, security, awareness campaigns, signage to avoid drowning and other community safety risks. During operation: • The installation of a pipeline section will prevent drowning hazard, potentially saving up to 10-15 fatalities every year • Enhance and promote public safety around open canal and pipeline sections, security (for community and infrastructure safety to avoid vandalism and illegal tapping of pipeline and/or illegal extraction of water from canal section), awareness campaigns, signage	Construction Phase ESMP and Community Health and Safety Plan (CHSP) Operation Phase ESMP and Community Health and Safety Plan (CHSP)	EHS Supervision Internal audits Monitoring reports during construction (as part of monitoring of CHSP)	Daily during construction As necessary during operations	D D
Substitution of KWSB workers						
Substitution of part of the current KWSB staff by Project Developer´s personnel	PS2	The labour force currently involved in the management of the Canal hub infrastructure will be transferred to other available projects in the area, RBC	Construction and operation	KWSB and Project Developer	KWSB and Project Developer	K
		Some selected positions will be proposed to be transferred to the private Project Developer after an adequate training plan				P
Land related impacts of proposed PV Plant						
No impacts expected	PS5	No mitigation action needed	n/a	n/a	n/a	n
Presence of Indigenous Peoples						
No presence of Indigenous Peoples	PS7	No mitigation action needed	n/a	n/a	n/a	n
Impacts over land and assets along the Canal's corridor						
No land acquisition or resettlement impacts are expected along the corridor of the project.	PS5	No RAP process expected	n/a	n/a	n/a	n
Some identified narrower areas, in which the existing right of way seems to have been compromised will need to be taken into consideration before the commencement of the works	PS5/ PS1	Feasible solutions in the sequencing of the works and the location of construction elements in narrower areas of corridor	Construction: Operational management of works	Implementation reports	Weekly	P
Impact over community mobility and crossing paths during construction						
Mobility restrictions during construction stage for local population, particularly in some specific settlements where villagers are highly dependent on the auxiliary road along the canal. Crossing paths used by villagers to access the opposite side of the canal will be also temporarily affected.	PS1	Provision of alternative routing and crossing paths in particularly sensitive areas (safe corridors, provision of collective transportation means during the construction works, etc.).	Construction: Community Health and Safety Plan (CHSP)	Monitoring reports during construction (as part of monitoring of CHSP)	Weekly	P

E&S Risks and Impacts	IFC PS Flagged	Mitigation Measure Compliant with National Regulations and IFC PS	Project Phase	Monitoring Action	Timeline for Implementation (or Frequency)	
	PS1	Permanent blockage of the existing road infrastructure along the canal should be avoided.				
Job opportunities						
Locally generated job opportunities during construction and operation of the project. Skills and capacities of the local workforce to be enhanced in order to meet the demand of works	PS1/ PS2	The project developer shall implement a local hiring plan in consultation with PAP, makhallas and district representatives	For Construction: Local Employment Plan	Reporting on local workforce employed in the project	Monthly	P a
	PS1	Investigate possibilities for local sourcing and procurement opportunities to promote sustainable local business development, as well possible capacity building actions to enable them to meet standards for procurement.	ESIA (study)	ESIA report	ESIA report	P
Presence of Workers and Security, Interaction with PAP and COVID-19						
Community health and safety may be at risk from worker migration and the presence of workers in the PAA, resulting in a potential change in the disease profile of the local population	PS4	ESIA to investigate potential impact on local hospitals and medical facilities (including outbreaks of Covid-19 at the worker's accommodation, and other outbreaks and accidents).	ESIA (study)	ESIA report	ESIA report	P
Safety and conflict risk from Worker Influx during construction and Presence of Security during construction & operation	PS4/ PS2	• Community Health and Safety Plan (which includes a Community Grievance mechanism) and Occupational Health, Industrial Safety and Accidents Prevention Program • Workers Code of Conduct • Minimise risks to the community from project security, guided by the principles of proportionality and good international practice (see details/references in section 9.3.9) in relation to hiring, rules of conduct, training, equipping, and monitoring of such workers, and by applicable law.	Construction and Operation	CHSP Monitoring reports during construction and operation EHS Supervision during construction & EPC Contractor OHS Reports EHS supervision during operation	Weekly during construction Monthly during operations	P P

Appendix D – ERT Report

Appendix E – Habitat Mapping

Appendix F – Social Mapping

Appendix G – Roles and Responsibilities

The understanding of the roles and responsibilities within the government entities for E&S matters pertaining to the Project are crucial in order to identify bottlenecks and areas that would benefit from improvement. The following table identifies the different stakeholders, their role in the Project, when their participation is required, their current capacity to carry out these activities (if known) and additional requirements (if needed to increase capacity).

Stakeholder	Function	Role/Responsibility and Timing	Capacity	Additional Requirements / Comments
KWSB	As Owner	KWSB should be actively involved throughout all phases of the project, more closely during the ESIA and permitting phases and to help the concessionaire liaise with government entities. Detailed responsibilities included in Appendix C.	For E&S: limited	Capacity Building on IFC PSs is recommended
KWSB	As Employer	• KWSB to consider how to best redirect workers towards other employment opportunities (those that will not be integrated into the concessionaire's organization) • The Concessionaire will be responsible for training and skills recycling for those that will be incorporated into the new organization.	Unknown	Transitional Plan for the recycling of positions and transfer to other projects.
WAPDA	Owner and operator of the WAPDA canal (8km upper section of canal) and Hub Dam. Supplier of water to the Hub Canal	Open and fluid communication is required with WAPDA throughout all phases of the Project for information such as flow forecasts that are related to the water levels in Hub Dam that have an impact on the quantity of water that will be delivered at community distribution points.	Unknown	Important for the concessionaire to establish a relationship with WAPDA as they are responsible for supplying water to the Hub Canal and have access to data that will be used during detailed design and the ESIA.

Sindh Wildlife Department (SWD)	Manage the Hub Wildlife Sanctuary Issue an NOC for Project to go ahead.	1. Request for NOC to be submitted to SWD ASAP to obtain NOC during the ESIA process prior to construction. 2. Engagement required to define mitigation and compensation measures for impacts on wildlife during the ESIA phase. 3. Engagement required during implementation of BAP activities related to wildlife	Excellent/High knowledge of wildlife sanctuaries and local wildlife and wildlife habitat. Assumed Moderate knowledge of IFC PSs, potentially limited knowledge of how critical habitat is defined according to PS6	Working with SWD to develop mitigation measures that meet PS6 will build capacity in the department. It is an opportunity for training and capacity building within SWD.
Sindh Forest Department (SFD)	Responsible for threatened flora and trees species such as the *Commiphora w.*	1. Engagement required to define mitigation and compensation measures for impacts *Commiphora w.* during the ESIA phase. 2. Engagement required during implementation of BAP activities related to *Commiphora w.*	Assumed excellent/high knowledge and capacity related to local flora and habitats.	Working with SFD to develop mitigation measures that meet PS6 will build capacity in the department. It is an opportunity for training and capacity building within SFD.
Sindh Environmental Protection Agency (SEPA)	Responsible for review and approval of Project EIA. Issue an NOC for Project to go ahead.	• Early engagement recommended during the early ESIA process. • Engagement required during the approval/NOC process. • Engagement required during construction and operations related to ongoing compliance commitments and requirements as per conditions of approval.	Assumed excellent/high knowledge and capacity related to local regulatory framework. Assumed good/moderate knowledge and capacity of international standards (from large projects funded by IFIs)	Opportunities for capacity building of SWD and SFD could be extended to SEPA.
Land utilization department (district and province level)	Responsible for land tenure and titles	Engagement during ESIA for baseline data	Unknown	None
Irrigation department (district level)	Responsible for irrigation schemes at the district level	Engagement during ESIA for baseline data, potential role in mitigation measures of any impacts to agricultural land.	Unknown	None
Agricultural department (district level)	Responsible for Agricultural land allotments at the district level	Engagement during ESIA for baseline data, potential role in mitigation measures of any impacts to agricultural land.	Unknown	None

Revenue department (district level)	Controlling authority in all matters connected with the administration of Revenue collection including land taxes, land revenue, preparation of land record and other matters relating thereto	Engagement during ESIA for baseline data. Leading authority in land acquisition process (not triggered in the framework of the project). Leading authority in settlement formalization process	Poor data on registered land plots (digitalization in progress)	None
Village Representatives	Represent community members and speak on their behalf	• The project proponent/concessionaire must maintain close engagement and consultation throughout the ESIA process. • The project proponent/concessionaire must maintain continued and ongoing engagement during construction and operations phases	Low to Moderate depending on community	Capacity Building opportunities
IUCN, WWF, BirdLife International etc.	Conservation NGOs and entities	• Engagement during the ESIA process for baseline information • Engagement during ESIA process for development of BAP mitigation and compensation measures, as appropriate • Engagement during implementation of BAP, as appropriate	High	Could potentially participate in capacity building activities aimed at government entities (SWD, SFD, SEPA).

VOLUME III
CONCESSION AGREEMENT

between

(1) THE GOVERNOR OF SINDH
(THROUGH THE LOCAL GOVERNMENT & HOUSING TOWN PLANNING DEPARTMENT, GOVERNMENT OF SINDH)

(2) THE KARACHI WATER AND SEWERAGE BOARD

- and -

(3) [THE COMPANY]

relating to
KARACHI HUB WATER CANAL PROJECT

Dated [●]

Drafting Notes:

1. ***Bidders should note that appendix 1 to the Concession Agreement will comprise Volume II of the RFP and will be inserted at signing with any necessary changes for references to the Proposal. References in this draft Concession Agreement to appendix 1 and to sections of appendix 1 should be read as references to sections of Volume II of the RFP.***

2. ***Items highlighted in green within the draft Concession Agreement (including the appendices) will be inserted prior to signing and (where stated) extracted from the relevant document referenced in the footnotes.***

3. ***Provisions relating to the solar plant will be deleted if the Proposal does not provide for the same.***

CONTENTS

1. DEFINITIONS AND INTERPRETATION 2
2. CONCESSION AND TERM 34
3. MOBILISATION AND COMMENCEMENT 35
4. PROJECT IMPLEMENTATION 39
5. SITE 45
6. CONSTRUCTION AND REHABILITATION 48
7. IMPLEMENTATION SCHEDULE AND DELAYS 52
8. MOBILISATION, START-UP AND COMMERCIAL OPERATION 55
9. ELECTRICITY AND OTHER UTILITIES 57
10. OPERATION AND MAINTENANCE 58
11. SALE AND PURCHASE 63
12. PAYMENT ACCOUNTS AND GOS TERMINATION SBLC 64
13. INVOICING AND PAYMENT 67
14. METERING SYSTEMS AND MONITORING SYSTEMS 70
15. RECORDS, REPORTING AND AUDIT 76
16. COVENANTS 78
17. INDEPENDENT APPOINTEES 82
18. INSURANCE 86
19. FORCE MAJEURE 89
20. INCREASED COSTS OR SAVINGS 98
21. TERMINATION 100
22. REINSTATEMENT 110
23. INDEMNITIES 110
24. ASSIGNMENT 112
25. REPRESENTATIONS AND WARRANTIES 113
26. GOVERNING LAW 116
27. DISPUTE RESOLUTION 116
28. INTELLECTUAL PROPERTY RIGHTS 117
29. CONFIDENTIALITY 119
30. NOTICES 121
31. MISCELLANEOUS 122

APPENDIX 1: TECHNICAL SPECIFICATIONS 124

APPENDIX 2: IMPLEMENTATION SCHEDULE 125

APPENDIX 3: MINIMUM INSURANCE REQUIREMENTS 127
APPENDIX 4: CONDITIONS 134
APPENDIX 5: TESTING 140
APPENDIX 6: PERFORMANCE SECURITIES 157
APPENDIX 7: FORM OF CONCESSION & LICENSE DIRECT AGREEMENT 163
APPENDIX 8: SERVICE PAYMENT CALCULATIONS 187
APPENDIX 9: GOS PAYMENT ACCOUNT STANDING INSTRUCTIONS 223
APPENDIX 10: INDEPENDENT APPOINTEES TERMS OF REFERENCE 227
APPENDIX 11: LICENSE AGREEMENT 241
APPENDIX 12: ENVIRONMENT, HEALTH AND SAFETY REQUIREMENTS 249
SIGNATURE PAGES 287

THIS CONCESSION AGREEMENT is made on **[●]**, 2022 at Karachi, Pakistan.

BETWEEN:

(1) **THE GOVERNOR OF SINDH** (through Secretary, Local Government & Housing Town Planning Department, Government of Sindh) having its office located at Local Government Department, Ground Floor, Tughlaq House, Sindh Secretariat, Karachi, Pakistan, for and on behalf of the Government of Sindh (the **"GoS"**, which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors and assigns);

(2) **KARACHI WATER AND SEWERAGE BOARD,** a statutory body constituted pursuant to section 3 of the Karachi Water and Sewerage Board Act, 1996, with its office located at 9th Mile, Karsaz, Karachi, Pakistan (**"KW&SB"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns); and

(3) **[COMPANY]**[1], a company incorporated under the Laws of Pakistan whose registered office is located at [●] (the **"Company"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns).

RECITALS:

A KW&SB invited proposals from prequalified parties to undertake the Project pursuant to a request for proposals issued on [●] (as amended, varied or supplemented, the **"RFP"**).

B The Project has, pursuant to the process described in the RFP, been awarded to the Successful Bidder as set out in the letter of award issued by KW&SB on [●].

C In accordance with the RFP, the Successful Bidder has incorporated the Company as a special purpose company to implement the Project and perform the obligations and exercise the rights of the Company, including the obligation to enter into this Agreement.

D The Project will consist of the Mobilisation Activities during the Mobilisation Period, the C&O Activities during the C&O Period, and the O&M Activities during the Operating Period, in each case, as more particularly described in appendix 1.

E The Company acknowledges and confirms that it has, based on the RFP, undertaken a thorough due diligence (including technical and financial viability and legal due diligence) of the Project and its requirements, and on the basis of its independent satisfaction, is entering into this Agreement for the purpose of accepting the Concession for the implementation of the Project on a "DFBROMT" basis, in accordance with the terms and conditions of this Agreement.

F This Agreement sets out the terms and conditions on which the Company shall undertake the Project.

[1] Insert name of the company incorporated by the Sponsors as per the requirements of the RFP.

NOW THEREFORE, in consideration of the mutual covenants contained herein, the Parties agree as follows:

1. DEFINITIONS AND INTERPRETATION

1.1 Definitions

Except when the context requires otherwise, the capitalised terms used in this Agreement (including the recitals) shall have the following meanings:

"Abandonment" means:

(a) in relation to any period prior to the Project Commercial Operations Date, the Company's failure to demonstrate to the Independent Engineer its ability to perform its obligations under this Agreement (taking into account its ability to accelerate the works and services under the EPC Contract) such as to demonstrate that the Project Commercial Operations Date will be achieved on or before the Long Stop Date, except where such failure to demonstrate is attributable to a Force Majeure Event or a Relief Event; and

(b) during the Operating Period, in the opinion of the Independent Engineer, other than due to a Force Majeure Event or a Relief Event:

(i) a persistent failure of the Company to perform its obligations hereunder such as to suggest an intention to repudiate this Agreement; or

(ii) failure by the Company to resume and continue the performance of substantially all of its obligations under this Agreement within a reasonable period following the cessation of a Force Majeure Event or a Relief Event, in each case, which prevented, hindered or delayed such performance,

and **"Abandons"** shall be construed accordingly;

"Acceptable Bank" means (a) together the Foreign Bank and the Acceptable Pakistani Bank, which is counter-guaranteeing the obligations of the Foreign Bank, or (b) an Acceptable Pakistani Bank, as the case maybe;

"Acceptable Pakistani Bank" means a scheduled bank or a financial institution incorporated or organised in Pakistan having a credit rating of at least AA or higher by PACRA, or AA or higher by VIS, or A3 or higher by Moody's or equivalent rating by Fitch or Standard and Poor, approved by the GoS, such approval not to be unreasonably withheld or delayed;

"Accounting Principles" means the International Financial Reporting Standards, as may be amended from time to time, applicable in Pakistan;

"Actual Loss of Water Output" has the meaning given to it in appendix 8;

"Actual NRW" means (expressed as a percentage), for any given period, the Non-Revenue Water in such period divided by the Net Water Input in the same period;

"ADB Standards" means the principles and requirements set forth in the Asian Development Bank's Safeguard Policy Statement, 2009;

"Adjoining Property" means any land and/or property adjoining or adjacent to any part of the Site, including all conduits, roads, footpaths, walls, fences, buildings, pipelines, cables, wires and other erections, structures and other apparatus on, under or within such land and/or property;

"Adverse Person" means:

(a) any person whose primary residence is in or who is incorporated or organized under the laws of a country:

(i) which is subject to sanctions levied by the United Nations (or the Security Council thereof) pursuant to authority derived from Article 41 of Chapter 7 of the United Nations Charter (a **"Sanctioned Country"**); or

(ii) with which the Government of Pakistan does not have commercial or trade relations or otherwise does not maintain official diplomatic relations (an **"Unfriendly Country"**);

(b) any national government, or any political subdivision, of any Sanctioned Country or Unfriendly Country;

(c) any ministry, department, authority, or statutory corporation of, or any corporation or other entity (including a trust), owned or controlled directly or indirectly by the national government, or any political subdivision, of any Sanctioned Country or Unfriendly Country; or

(d) any person who has been blacklisted by any federal or provincial government, governmental body or non-governmental department / agency whether in Pakistan or the government or governmental body of any foreign countries and/or international organizations;

"Affected Community" means the Settlements that will be directly impacted by changes induced by Project Activities;

"Affected Party" has the meaning given to it in clause 19.5.1;

"Affiliate" means, in relation to a person, a company or entity that directly or indirectly Controls, or is Controlled by, or is under common Control with that person;

"Agreement" means this Concession Agreement (including the recitals and appendices hereto), as amended and supplemented from time to time;

"Allowable NRW" has the meaning given to it in appendix 8;

"Approvals" means all such permits, licences, consents, authorisations, approvals, registrations, grants, acknowledgements or agreements required under the Laws to be obtained from any Competent Authority for the Project Activities (including the Environmental and Social Approvals) and **"Approval"** shall be construed accordingly;

"Arbitration" has the meaning given to it in clause 27.3.1.1;

"Arbitrators" has the meaning given to it in clause 27.3.1.1;

"Archaeological Delay Event" means the discovery of any Archaeological Items found or located on or under the Site that results in a delay to the design, construction, rehabilitation, testing or commissioning of the KWC;

"Archaeological Items" means articles of archaeological value, interest or antiquity, historical structures, human remains or other substances, objects or things of archaeological or historic interest;

"Availability" has the meaning given to it in appendix 8;

"Availability Payment" has the meaning given to it in appendix 8;

"Award" has the meaning given to it in clause 27.3.4;

"Back-up Bypass Output Water Metering System" has the meaning given to it in clause 14.2.17;

"Back-up HD Input Water Metering System" has the meaning given to it in clause 14.2.3;

"Back-up KIII Input Water Metering System" has the meaning given to it in clause 14.2.6;

"Back-up Metering System" means the Back-up HD Input Water Metering System, the Back-up KIII Input Water Metering System, the Back-up Water Access Point Metering System, the Back-up Bypass Output Water Metering System and the Back-up Output Metering System;

"Back-up Output Metering System" has the meaning given to it in clause 14.2.19;

"Back-up Water Access Point Metering System" has the meaning given to it in clause 14.2.9;

"Base Case Financial Model" means the financial model in Microsoft Excel electronic format submitted as part of the Proposal;

"Bid Submission Date" means [●];

"Billing Period" has the meaning given to it in appendix 8;

"Biodiversity Action Plan" means the action plan and compliance protocols to be prepared by the Company in consultation with the Independent Engineer and the Sindh Forest and Wildlife Department, Government of Sindh to carry out mitigation measures to protect the commiphora-wightii tree and other conservation significant species from any adverse environmental impact that may be caused by the Project, as may be specified in the Environmental and Social Documents;

"Board Resolution" means a resolution passed by the board of directors of the Company;

"Business Day" means any Day that is not declared a public holiday in Karachi, Pakistan, during which banks are generally open for business in Karachi, Pakistan;

"Bypass Input Water" has the meaning given to it in appendix 8;

"Bypass Off-Spec Mixed Water" has the meaning given to it in appendix 8;

"Bypass Water Connection Point" has the meaning given to it in appendix 8;

"Bypass Water Output" has the meaning given to it in appendix 8;

"C&O Activities" means all works, services and obligations to be performed by the Company by the Scheduled Project Commercial Operations Date (other than the Mobilisation Activities), including, design, construction, rehabilitation, procurement, installing, operations, maintenance, testing and commissioning as more fully described in appendix 1;

"C&O Performance Security" means the irrevocable, unconditional and on-demand bank guarantee (and any replacement thereof), in favour of GoS, in an amount equal to Pakistani Rupees one billion only (PKR 1,000,000,000/-), issued by an Acceptable Bank in the form set out in part 1 of appendix 6;

"C&O Performance Security Expiry Date" has the meaning given to it in clause 4.1.1;

"C&O Period" means the period commencing at 00:00 hours on the Commencement Date and ending at 23:59 hours on the Day immediately preceding the Project Commercial Operations Date;

"Casualty Proceeds" has the meaning given to it in clause 19.10.1;

"Change in Law" means any of the following events:

(a) the introduction, adoption, enactment or promulgation of any new Law by a Competent Authority;

(b) the change or repeal by any Competent Authority of any Law;

(c) a change by a Competent Authority and having the force of Law (i) in the manner in which a Law is applied or (ii) in the interpretation of any Law;

(d) the introduction, adoption, change or repeal by any Competent Authority of any material condition in connection with the issue, renewal, or modification of any Approval; and

(e) a change in the World Health Organisation standards for potable water to the extent that the Company is obliged to comply with them in accordance with this Agreement,

which occurs after the Bid Submission Date and which:

(i) results in any imposition of, or change in Taxes, duties or levies payable by one or more of the Company, the EPC Contractor, or the O&M Contractor, in relation to the Project Activities; or

(ii) results in change in or repeal of any of the requirements applicable to the Project Activities,

it is clarified that Change in Law shall not include: (A) any change in any withholding tax, or other similar taxes, on income or dividends or other distributions distributed by the Company, the EPC Contractor or the O&M Contractor; and (B) the coming into effect of, on or after the

Bid Submission Date, any provision of a Law, which is already gazetted in accordance with the Law;

"Change in Scope" means any alteration in the technical requirements, the scope of the Project, or the designs and drawings applicable to the Project, as instructed by the GoS Parties or proposed by the Company, in accordance with clause 6.3;

"Change in Scope Order" means an order issued by the GoS Parties certifying approval of a proposed Change in Scope and recording the terms and conditions on which the proposed Change in Scope is required to be implemented;

"Claim" means any suits, actions, legal or administrative proceedings, claims, demands, losses, damages, liabilities, fines, costs and expenses of whatsoever kind or nature (including reasonable attorney's fees and expenses and pre- and post- judgment interest and penalties), whether arising before or after the Final Expiry Date, but excluding any indirect or consequential damages;

"Class A Shares" has the meaning given to it in the EFU Agreement;

"Class B Shares" has the meaning given to it in the EFU Agreement;

"Commencement Certificate" means the certificate duly signed and issued by the Independent Appointees to the Parties, certifying that each of the Commencement Conditions Precedent have been satisfied, waived or deferred in terms of this Agreement;

"Commencement Conditions Precedent" means the conditions precedent for commencement of C&O Activities as set out in part 2 of appendix 4;

"Commencement Date" has the meaning given to it in clause 3.4.1;

"Commencement Date Delay Notice" has the meaning given to it in clause 3.6.3;

"Commercial Parties" means the GoS and the Company, in their respective capacities as a Party to this Agreement and **"Commercial Party"** means either of them;

"Company Cure Period" has the meaning given to it in clause 21.7.2;

"Company Demand" has the meaning given to it in clause 12.2.1;

"Company Event of Default" has the meaning given to it in clause 21.5;

"Company Indemnified Parties" has the meaning given to it in clause 23.2;

"Company IPR" means all Intellectual Property Rights owned by the Company (or its relevant licensor) as at the Effective Date including all information provided as part of its Proposal;

"Company Notice of Intent to Terminate" has the meaning given to it in clause 21.7.1;

"Company Payment Account" means the account to be established and maintained by the Company, in which Service Payments payable by the GoS in terms of this Agreement are paid;

"Competent Authority" means the Government of Pakistan, the GoS, or any ministry, department or political subdivision thereof, any municipality, any court or tribunal or any other

governmental entity, instrumentality, agency, authority, committee or commission, under the direct or indirect control of the Government of Pakistan or the GoS, or any department or political subdivision thereof, or any independent regulatory authority relating thereto, having jurisdiction under the Law over the Company, KW&SB, the EPC Contractor, or the O&M Contractor, in each case within Pakistan, provided that, for the purposes of this Agreement, neither the GoS nor KW&SB in their respective capacities as a party to any of the Project Agreements shall be considered a Competent Authority;

"Component BW" has the meaning given to it in appendix 8;

"Concession" has the meaning given to it in clause 2.1.1;

"Concession and License Direct Agreement" means the agreement substantially in the form set out in appendix 7;

"Concession Period" means the period commencing at 00:00 hours on the Commencement Date and ending at 23:59 hours on the Final Expiry Date;

"Confidential Information" has the meaning given to it in clause 29.5;

"Construction Contract Year" or **"CCY"** means the twelve (12) Month period commencing at 00:00 hours on the Commencement Date and ending at 23:59 hours on the Day immediately preceding the anniversary of the Commencement Date and each subsequent twelve (12) Month period during the C&O Period ending at 23:39 hours on the Day immediately preceding each subsequent anniversary of the Commencement Date, provided that the last Construction Contract Year shall end at 23:59 hours on the Day immediately preceding the Project Commercial Operations Date;

"Construction Documents" means each of the Detailed Engineering Design and the Construction Drawings approved in accordance with clause 6.1;

"Construction Drawings" means the drawings and designs prepared by the Company pursuant to the standards and design requirements that pertain to the Project, set out in appendix 1;

"Contract Year" means a Construction Contract Year or an Operating Contract Year, as applicable;

"Contracted Availability" has the meaning given to it in appendix 8;

"Contracted Specific Net Electricity Consumption" has the meaning given to it in appendix 8;

"Contractors" means the EPC Contractor and the O&M Contractor;

"Control" means:

(a) ownership or control (whether directly or otherwise) of more than fifty percent (50%) of the equity share capital, voting capital, or the like, of the controlled entity;

(b) ownership of equity share capital, voting capital, or the like, by contract or otherwise, conferring control of or power to (i) control the composition of, or power to appoint more than fifty percent (50%) of the members of the board of directors, board of

management, or other equivalent or analogous body of the controlled entity or (ii) appoint the key managers of such entity; or

(c) power to influence (whether directly or indirectly) any decision of the board of the Company through contract, agency or otherwise;

and **"Controls" "Controlling"** or **"Controlled"** shall be construed accordingly;

"Cure Period" means the Company Cure Period or the GoS Cure Period, as the case maybe;

"Day" means a 24-hour period beginning at 00:00 hours and ending at 23:59 hours;

"Deductible Termination Amounts" means, to the extent it is a positive amount, the aggregate, up to the date immediately preceding the Termination Date, of:

(a) all credit balances on any bank accounts, held by or on behalf of the Company on the Termination Date, the value of any right of the Company and/or the Financing Parties to receive insurance proceeds and of any such proceeds actually received (save where such credit balances or proceeds are paid to the GoS, KW&SB and/or to be applied in reinstatement), sums due and payable from the Contractors and any third parties, proceeds from the liquidation of any authorized investment, and letters of credit issued in lieu of maintaining credit balance in any account; and

(b) amounts GoS is entitled to off-set due to deductions/adjustments in terms of this Agreement;

"Deductions" has the meaning given to it in appendix 8;

"Deduction for Off-Spec Output Water" has the meaning given to it in appendix 8;

"Deduction for Reduced Water Availability" has the meaning given to it in appendix 8;

"Deemed Availability" means the average Availability, during the immediately preceding four (4) Billing Periods, or if less than four (4) Billing Periods have occurred, such number of Billing Periods as there have been, provided that if there are none, then it shall be based on the Contracted Availability (subject to deduction for Outages determined by the Independent Appointees) and provided further that any hour in which the Availability was reduced during any such Billing Period as a result of the occurrence of a Force Majeure Event or a Relief Event shall be disregarded;

"Deemed Commissioning Event" has the meaning given to it in clause 8.4.1;

"Defaulting Party" means the GoS in the case of a GoS Event of Default or the Company in the case of a Company Event of Default;

"Defective Metering Event" means, in relation to any of the Metering Systems or Monitoring Systems, that:

(a) such Metering System or Monitoring System is not in service;

(b) any seal on a metering or monitoring device constituting part of that Metering System or Monitoring System is found to be broken; or

(c) a metering device constituting part of that Metering System fails to register or, upon testing, in the case of a Metering System, is found to vary by more than the Metering Tolerance;

"Detailed Engineering Design" means the detailed engineering design for the Project prepared by the Company in accordance with appendix 1;

"DFBROMT" means the design, finance, build, rehabilitate, operate, maintain and transfer mode, being the public-private partnership mode pursuant to which the Project is undertaken in terms of the Sindh Public-Private Partnership Act, 2010;

"Dispute" means a dispute, controversy, difference or claim between the Parties arising out of or in relation to this Agreement or the Parties' performance or non-performance of this Agreement;

"Disputed Obligation" means any dispute, by a GoS Party, in respect of the requirement to comply with an obligation expressed to be assumed by such GoS Party in any Relevant Agreement on the basis that such obligation is illegal, invalid, void, voidable or unenforceable under the applicable Legal Requirements;

"Distributions" means:

(a) whether in cash or in kind, any remittance to the Shareholders or any of their Affiliates of:

(i) dividends or other distributions in respect of any revenue account balance or the share capital of the Company;

(ii) dividends or other distributions in respect of release of debt service reserve account or liability reserve account funding;

(iii) capitalisation of profits, bonus issue, reduction of capital, redemption or purchase of shares or any other reorganisation or amendment to the share capital of the Company;

(iv) payment, loan, contractual arrangement or transfer of assets or rights to the extent (in each case) it was put in place at or after Financial Closing and was neither in the ordinary course of business nor on reasonable commercial terms; or

(v) the receipt of any other benefit that is not received in the ordinary course of business and on reasonable commercial terms; or

(b) the early release of any contingent funding liabilities;

"Effective Date" means the date of this Agreement;

"EFU Agreement" means the equity funding and utilisation agreement executed between the Commercial Parties and the Sponsors on or about the date hereof;

"Electricity" means the electrical energy to be delivered by the Electricity Supplier to the KWC at the Electricity Connection Point;

"Electricity Connection Point" has the meaning given to it in appendix 8;

"Electricity Price" or **"EP"** has the meaning given to it in appendix 8;

"Electricity Supplier" means as of the Effective Date, K-Electric Limited, or such other supplier of electric power to the KWC as approved by the GoS Parties;

"Electricity Supply Failure" means any disruption in the supply of Electricity from the Electricity Supplier beyond three (3) consecutive hours in a Day, needed to start up, test, commission or operate the KWC, but only if and to the extent that such disruption:

(a) materially adversely affects the ability of the Company to start up, test, commission or operate the KWC in accordance with Good International Industry Practice;

(b) is not the direct or indirect result of a breach by the Company (or its Contractors) of its obligations under this Agreement; and

(c) is not the direct or indirect result of the Company failing to make any payment due to the Electricity Supplier;

"Employee Redeployment Plan" has the meaning given to it in clause 4.11.1;

"Encashed Sums" has the meaning given to it in clause 12.2.8;

"Encumbrance" means any encumbrance on an asset, including but not restricted to mortgage, charge, pledge, lien, hypothecation or any security interest, assignment, privilege or priority of any kind having the effect of security or other such obligations and shall include, without limitation, any designation of loss payees or beneficiaries or any similar arrangement under any insurance policy pertaining to the KWC, the Site or any part or portion thereof and physical encumbrances and encroachments thereon;

"Environmental and Social Approvals" means any permits, certificates and other Approvals (including any conditions which attach to the foregoing) required under Environmental and Social Laws;

"Environmental and Social Documents" means:

(a) the Environmental and Social Impact Assessment;

(b) each no objection certificate issued by the Sindh Environmental Protection Agency, Government of Sindh, with respect to the Project;

(c) any other document, plan or programme to be prepared under the Environmental and Social Management System and the Environmental and Social Impact Assessment; and

(d) any documents required at any time to be prepared under the Environmental and Social Requirements as a result of any unanticipated impacts found during the execution of the Project Activities;

"Environmental and Social Impact Assessment" or **"ESIA"** means the environmental impact assessment titled "Environmental and Social Impact Assessment" in relation to the

Project including all other supplements, modifications and amendments thereto, to be prepared in accordance with the requirements set out in part 1 of appendix 12 by the Company;

"Environmental and Social Laws" means all applicable Laws relating to Environmental Matters, Hazardous Substances, Social Matters, involuntary resettlement, human health or safety, or laws relating to social issues, including minimum labour standards and laws prohibiting forced labour or harmful child labour, and including the conventions of the International Labour Organisation signed and ratified by Pakistan;

"Environmental and Social Management System" or **"ESMS"** means the part of the overall management system of the Company developed in compliance with the E&S Standards, that shall include relevant policies, organisational structure, planning activities, responsibilities, practices, procedures and resources for developing, implementing, achieving, reviewing and maintaining compliance with the Environmental and Social Requirements and which shall be dedicated to the structural improvement of the environmental and social performance of the Company, established and maintained in accordance with the requirements of part 2 of appendix 12;

"Environmental and Social Requirements" means:

(a) any Environmental and Social Law (as amended from time to time);

(b) any Environmental and Social Approval issued by any Competent Authority or otherwise under any Environmental and Social Law;

(c) the E&S Standards; and

(d) the Environmental and Social Documents;

"Environmental and Social Standards" or **"E&S Standards"** means the IFC Performance Standards, the World Bank Group Environmental, Safety and Health Guidelines, the IFC Environmental, Safety and Health Guidelines, and the ADB Standards, along with any other Good International Industry Practice standards identified as relevant and specifically referenced within the Environmental and Social Documents;

"Environmental Matters" means any of the following:

(a) any emission, release, entry or introduction into the air of any Hazardous Substance including the air within buildings and other natural or man-made structures above or below ground;

(b) any discharge, release, entry or introduction into water of any Hazardous Substance including into any river, watercourse, lake or pond (whether natural or artificial, above or below ground) or reservoir, or the surface of the riverbed or of other land supporting such waters, ground waters, sewer or the sea;

(c) any deposit, release, keeping or disposal in land or on land, whether or not covered by water, of any Hazardous Substance;

(d) any deposit, disposal, keeping, treatment, importation, production or carrying of any waste, including any substance which constitutes a scrap material or an effluent or other unwanted surplus substance arising from the application of any process or activity

(including making it re-usable or reclaiming substances from it) and any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled; and

(e) nuisance, noise, defective premises, health and safety at work, preservation or protection of the natural environment or of man or any living organisms supported by the environment;

"EPC Contract" means the contract to be entered into between the Company and the EPC Contractor for, as applicable, the design, engineering, procurement, manufacture, factory testing, transportation, construction, rehabilitation, erection, installation, completion, testing, commissioning and warranty of the KWC;

"EPC Contractor" means the contractor(s) hired by the Company as advised in the Proposal (unless otherwise approved by KW&SB (in consultation with the Independent Engineer) pursuant to clause 16);

"Equity Held USD Amounts" means amounts contributed to Fund, from time to time, the Sponsor Funding Amount in USD and held in a USD account of the Company but not considered as 'USD Equity Contribution' (as defined in the definition of USD Equity Return);

"Equity Return" means (expressed and payable in PKR) the sum of the USD Equity Return and the PKR Equity Return, as applicable;

"Estimated Remedial Costs" has the meaning given to it in clause 21.10.2.2;

"Event of Default" means, as the context requires, a Company Event of Default or a GoS Event of Default;

"Event of Loss" means an event that causes all or a portion of the KWC to be damaged, destroyed or rendered unfit for normal operation in accordance with this Agreement;

"Final Expiry Date" means earlier of: (a) Term Expiry Date; and (b) the Termination Date;

"Financial Closing" means that: (a) Financing Documents covering hundred percent (100%) of the total capital cost of the Project (other than the amounts to be funded by Sponsors or GoS in terms of the EFU Agreement) shall have been signed and are in full force and effect; (b) all funds under the Financing Documents are fully committed; and (c) all conditions to the first drawdown of funds under the Financing Documents have been satisfied or waived by the Financing Parties;

"Financial Model" means the Base Case Financial Model, as updated prior to the Financial Closing or otherwise adjusted to the extent expressly permitted or required under this Agreement or the EFU Agreement;

"Financing Documents" means (other than any documents relating to Sponsor Loans, indebtedness constituting Sponsor Equity or any other indebtedness to Shareholders), any and all loan agreements, notes, bonds, indentures, security agreements, direct agreements, assignments and acknowledgements, registration or disclosure statements, subordination agreements, mortgages, deeds of trust, credit agreements, intercreditor agreements, note or bond purchase agreements, hedging agreements, participation agreements, Islamic financing documents and any other documents entered into by the Company relating to the financing of

the Project, including any modifications, supplements, extensions, renewals and replacements of any such financing or Refinancing, in each case, executed in accordance with clause 16.3;

"Financing Due" means the aggregate of the following sums outstanding and payable to the Financing Parties up to the date immediately preceding the Termination Date:

(a) the Outstanding Principal Amount; and

(b) the interest or mark-up (or any other term connoting the return paid to Financing Parties on debt financing) accruing on the Outstanding Principal Amount;

notwithstanding anything to the contrary herein, no interest, mark-up or profit, or default interest, mark-up or profit accrued shall be paid by the GoS for any interest, mark-up or profit that accrued under the Financing Documents from and after a default by the Company thereunder, unless such default results directly from a GoS Event of Default;

"Financing Party" means any person providing hedge, debt, Islamic finance, bond or capital market financing, export credit loan or Refinancing (approved in the accordance with clause 16.3), under the Financing Documents, and their permitted successors and assigns, including any agent or trustee for such person, in each case, not objected to by the GoS, but excluding a Shareholder or its Affiliate(s) with respect to any indebtedness constituting Sponsor Equity or indebtedness to Shareholders;

"Financing Termination Date" means the earlier of (a) [●][2], and (b) the date on which no part of the Financing Due is outstanding and all amounts due and payable by the Company to the Financing Parties are paid in accordance with the Financing Documents, as confirmed in writing by the Independent Auditor;

"First IA List" has the meaning given to it in clause 17.7.1;

"First IE List" has the meaning given to it in clause 17.1.1;

"Force Majeure Event" has the meaning given to it in clause 19.1;

"Foreign Bank" means a scheduled bank or financial institution incorporated or organized outside Pakistan having a credit rating of at least AA or higher by PACRA, or AA or higher by VIS, or A3 or higher by Moody's or equivalent rating by Fitch or Standard and Poor;

"Good International Industry Practice" or **"GIIP"** means those practices, skills, diligence, prudence, foresight, methods, equipment, specifications and standards of safety and performance (as may change from time to time) employed by experienced professional international contractors or operators in activities or undertakings of the same or similar circumstances and conditions as the Project Activities, which in the exercise of reasonable judgement in light of the facts known at the time the judgement was made, are considered good, safe and prudent practices commensurate with standards of safety, performance, dependability, efficiency and economy;

[2] Insert the last repayment date of principal debt set out in attachment E of appendix 8.

"GoS Account Funding Date" means:

(a) in the period prior to the Project Commercial Operations Date, within thirty (30) Days of issuance of the Partial FC Letter and thereafter, at least five (5) Days prior to the start of each Quarter in a Construction Contract Year; and

(b) in the period following the Project Commercial Operations Date, within thirty (30) Days of the Project Commercial Operations Date and thereafter, at least five (5) Days prior to the start of each Quarter in an Operating Contract Year;

"GoS Account One" means GoS account titled "Government of Sindh Non-Food Account No.1" maintained with SBP;

"GoS Appointed IA" has the meaning given to it in clause 17.11.1;

"GoS Appointed IE" has the meaning given to it in clause 17.5.1;

"GoS Cure Period" has the meaning given to it in clause 21.7.1;

"GoS Equity Account" has the meaning given to it in the EFU Agreement;

"GoS Equity Account Standing Instructions" has the meaning given to it in the EFU Agreement;

"GoS Indemnified Parties" has the meaning given to it in clause 23.1;

"GoS Notice of Intent to Terminate" has the meaning given to it in clause 21.7.2;

"GoS Parties" means the GoS and KW&SB, in their respective capacities as a Party to this Agreement and **"GoS Party"** means either of them;

"GoS Payment Account" means the account established, funded and maintained by the GoS in accordance with clause 12.1;

"GoS Payment Account Bank" means a scheduled bank in Pakistan with a minimum credit rating of at least 'AA-' as rated by VIS or an equivalent rating by PACRA;

"GoS Payment Account Certificate" has the meaning given to it in clause 12.1.2;

"GoS Payment Account Required Balance" means an amount equal to the projected Service Payment due in any Contract Year, where the projected Output Payments will be calculated based on Net Water Output equal to Contracted Availability (subject to deductions for Outages), as stated in the GoS Payment Account Certificate;

"GoS Payment Account Standing Instructions" means the standing instructions issued to the GoS Payment Account Bank, in the form attached in appendix 9;

"GoS Protected Assets" has the meaning given to it in clause 25.4.1.2;

"GoS SBLC Amount" means an amount not exceeding three-forth (3/4) of the GoS Payment Account Required Balance, as stated in the GoS Payment Account Certificate;

"GoS SBLC Issuing Bank" means a scheduled bank in Pakistan with a minimum credit rating of at least 'AA-' as rated by VIS or an equivalent rating by PACRA;

"GoS Service Payment SBLC" means (if applicable) an irrevocable and unconditional stand-by letter of credit issued by the GoS SBLC Issuing Bank in favour of the Company in an amount equal to the GoS SBLC Amount, in accordance with clause 12.1.9;

"GoS Termination SBLC" means an irrevocable and unconditional stand-by letter of credit issued by the GoS Termination SBLC Issuing Bank in favour of the Company in accordance with clause 12.2.2;

"GoS Termination Secured Amount" means, at any given time, an amount equal to fifty percent (50%) of the Outstanding Principal Amount, as certified by the Independent Auditor;

"GoS Termination SBLC Amount" means GoS Termination Secured Amount applicable on the GoS Termination SBLC Renewal Date, as determined from time to time, by the Independent Auditor and stated in the GoS Termination SBLC Certificate;

"GoS Termination SBLC Certificate" has the meaning given to it in clause 12.2.6;

"GoS Termination SBLC Renewal Date" has the meaning given to it in clause 12.2.6;

"GoS Termination SBLC Failure Certificate" has the meaning given to it in clause 12.2.8;

"GoS Termination SBLC Issuing Bank" means a scheduled bank in Pakistan with a minimum credit rating of at least 'AA-' as rated by VIS or an equivalent rating by PACRA;

"GoS Termination SBLC Validity Period" has the meaning given to it in clause 12.2.8;

"Government of Pakistan" means the government of the Islamic Republic of Pakistan;

"Grievance Redress Mechanism" has the meaning given to it in clause 25.5.1.2;

"Handover Certificate" means the certificate to be issued by the Independent Appointees certifying the satisfaction of the Handover Conditions in terms of clause 21.10;

"Handover Conditions" means that, as at the Final Expiry Date:

(a) where the Project Commercial Operations Date is not achieved, KWC will be in a condition of repair, cleanliness and appearance that is consistent with the standards required in this Agreement (including as set out in appendix 1);

(b) where the Project Commercial Operations Date has been achieved, KWC is in the same condition (disrepair by reasonable ordinary wear and tear excepted) as on the Project Commercial Operations Date and the requirements for handover set out in appendix 5 have been met;

(c) the Company has completed training of the KW&SB employees (or KW&SB nominees) to ensure smooth taking over operations of the KWC to a standard satisfactory to the Independent Engineer and KW&SB; and

(d) the Site shall be:

(i) free and clear from obstructions, impediments placed by the Company, used consumables and waste, and Hazardous Substances;

(ii) neat and tidy; and

(iii) made safe and secure in accordance with Good International Industry Practice;

"Hazardous Substances" means any solid, liquid or gaseous material, substance, constituent, chemical, mixture, raw material, intermediate product or by-product which is defined as **"hazardous waste"**, **"hazardous material"**, **"toxic substance"** or **"toxic pollutant"** under, or is otherwise regulated by the Environmental and Social Requirements;

"HD Input Online Quality Monitoring System" has the meaning given to it in clause 14.2.4;

"HD Input Water Metering System" has the meaning given to it in clause 14.2.1;

"HD Water Connection Point" means the physical point where water enters the WAPDA Canal from the Hub Dam;

"Head Regulator" has the meaning given to it in appendix 1;

"Hub Dam" means the reservoir on the Hub river, located on the provincial border of Sindh and Balochistan;

"HR Policy and Procedure" has the meaning given to it in clause 4.9.1;

"IFC" means the International Finance Corporation, a member of the World Bank Group;

"IFC Environmental, Safety and Health Guidelines" means the IFC Environmental, Safety and Health Guidelines, dated 30 April 2007, available at https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines/ehsguidelines;

"IFC Performance Standards" means IFC's Performance Standards on Social & Environmental Sustainability, dated 01 January 2012, available at https://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/Performance-Standards;

"Implementation Schedule" means the implementation schedule set out in appendix 2, as may be revised from time to time, pursuant to this Agreement;

"Increased Costs" means any increased costs or expenses relating to the Project that are incurred or suffered by the Company resulting from any circumstance described in clause 20.1, and not otherwise covered by the receipt of insurance proceeds, which costs and expenses may include one or more of:

(a) capital costs;

(b) costs and expenses in respect of the design, engineering, procurement, manufacture, construction, rehabilitation, commissioning, testing and completion of the KWC;

(c) financing costs;

(d) costs of operation and maintenance;

(e) costs of Taxes imposed on or payable by the Company; and

(f) reduction in the revenue received by the Company;

"Independent Appointees" means the Independent Auditor and the Independent Engineer;

"Independent Auditor" means the auditor appointed for the Project in accordance with clause 17.7 and in terms of the Independent Auditor Contract meeting the Independent Auditor Criteria and includes any replacement Independent Auditor appointed in terms of this Agreement;

"Independent Auditor Initial Term" has the meaning given to it in clause 17.8.1;

"Independent Auditor Authorized Representative(s)" has the meaning given to it in clause 17.9.1;

"Independent Auditor Contract" means the contract to be entered into between the Parties, the Sponsors and the Independent Auditor in accordance with clause 17 and includes any contract subsequently executed with any replacement Independent Auditor in terms of this Agreement;

"Independent Auditor Criteria" means the minimum criteria for selection of firms of auditors for the appointment of Independent Auditor, set out in part 1 of appendix 10;

"Independent Auditor Payment Account" means the account established and maintained by the Company pursuant to clause 17.12;

"Independent Auditor Payment Account Bank" means the financial institution in Pakistan selected by the Company, the Sponsors and the GoS where the Independent Auditor Payment Account is held;

"Independent Auditor Payment Account Standing Instructions" has the meaning given to it in clause 17.12.2;

"Independent Auditor Payments" has the meaning given to it in clause 17.11.1;

"Indicative Independent Auditor Terms of Reference" means the indicative duties, functions and the scope of work to be performed by the Independent Auditor, as set out in part 1 of appendix 10;

"Independent Engineer" means the engineer appointed for the Project in accordance with clause 17.1 and in terms of the Independent Engineer Contract meeting the Independent Engineer Criteria and includes any replacement Independent Engineer appointed in terms of this Agreement;

"Independent Engineer Initial Term" has the meaning given to it in clause 17.2.1;

"Independent Engineer Authorized Representative(s)" has the meaning given to it in clause 17.3.1;

"Independent Engineer Contract" means the contract to be entered into between the Parties, the Sponsors and the Independent Engineer in accordance with clause 17 and includes any contract subsequently executed with any replacement Independent Engineer in terms of this Agreement;

"Independent Engineer Criteria" means the minimum criteria for selection of firms of engineers for the appointment of Independent Engineer, set out in appendix 10;

"Independent Engineer Payment Account" means the account established and maintained by the Company pursuant to clause 17.6;

"Independent Engineer Payment Account Bank" means the financial institution in Pakistan selected by the Company, Sponsors and GoS where the Independent Engineer Payment Account is held;

"Independent Engineer Payment Account Standing Instructions" has the meaning given to it in clause 17.6.2;

"Independent Engineer Payments" has the meaning given to it in clause 17.5.1;

"Indicative Independent Engineer Terms of Reference" means the indicative duties, functions and the scope of work to be performed by the Independent Engineer, as set out in part 2 of appendix 10;

"Input HD Water Connection Point" has the meaning given to it in appendix 8;

"Input KIII Water Connection Point" has the meaning given to it in appendix 8;

"Input Water Connection Point" has the meaning given to it in appendix 8;

"Insurance Policies" has the meaning given to it in clause 18.1.1;

"Intellectual Property Rights" means all patents, rights to inventions, utility models, copyright and related rights, trademarks, service marks, trade, business and domain names, rights in trade dress or get-up, rights in goodwill or to sue for passing off, unfair competition rights, rights in designs, rights in computer software (including manuals, user guides and other materials or information relating to such software in whatever form), database rights, topography rights, moral rights, rights in confidential information (including know-how and trade secrets) and any other intellectual property rights, in each case whether registered or unregistered and including all applications for and renewals or extensions of such rights, and all similar or equivalent rights or forms of protection in any part of the world;

"International Financial Reporting Standards" means any International Financial Reporting Standards promulgated by the International Accounting Standards Board (which includes standards and interpretations approved by the International Accounting Standards Board issued under previous constitutions), together with its pronouncements thereon from time to time;

"International Accounting Standards Board" means the independent accounting standard-setting body of the International Financial Reporting Standards Foundation (IFRS Foundation);

"Invoicing Party" has the meaning given to it in clause 13.6.1.1;

"KIII Conduit" means the water conduit running from Kheenjar lake to the Input KIII Water Connection Point;

"KIII Input Online Quality Monitoring System" has the meaning given to it in clause 14.2.7;

"KIBOR" has the meaning given to it in appendix 8;

"KWC" or **"Karachi Water Canal System"** means water canal system running from the Head Regulator located at the Input HD Water Connection Point to the Output Water Connection Point (including the Input KIII Water Connection Point), the water treatment plant, canal, the pipe, the pumping station(s), raising mains, power supply systems (including the Solar Plant, if applicable), raw sewage conveyance, sewage treatment, sludge handling and treated effluent discharge infrastructure, the by-pass system, the Metering Systems and the Monitoring Systems, the Reservoir, the Water Access Connection Points and all associated facilities and infrastructure, whether already constructed and in operation or to be constructed, rehabilitated, operated or maintained as part of the Project Activities;

"Late Payment Rate" means the three (3) Months KIBOR plus two percent (2%), compounded semi-annually, calculated for the actual number of Days for which the relevant amount remains unpaid on the basis of three hundred sixty-five (365) Days year;

"Law" means all federal, provincial and local laws of Pakistan, and all orders, rules, regulations, executive orders, statutory regulatory orders, decrees, judicial decisions, notifications, or other similar directives issued by any a Competent Authority pursuant thereto, including the Environmental and Social Requirements, as any of them may be amended, substituted, replaced or re-promulgated from time to time;

"Legal Requirements" means all Laws and Approvals;

"License Agreement" means the agreement between KW&SB and the Company, substantially in the form set out in appendix 11;

"Long Stop Date" means the date that is one hundred eighty (180) Days after the Scheduled Project Commercial Operations Date;

"Maintenance Schedule" has the meaning given to it in clause 10.4.1;

"Maximum Volume" means the maximum volume of water to be delivered by the Company to each Water Access Point Consumers at the relevant Water Access Connection Point, as set out below:

(a) for Hamdard University: 4000 m^3/day;

(b) for Hamdard Laboratories: 200 m^3/day;

(c) for Sherriar Ashraf (Gulf Mineral): 60 m^3/day;

(d) for the Public Health Engineering and Rural Department (Government of Sindh): 600 m^3/day; and

(e) for [Marble City Connection][3]: 9100 m^3/day;

"Metering Systems" means the HD Input Water Metering System, the Primary HD Input Metering System, the Back-up HD Input Metering System, the Primary KIII Input Water Metering System, the Back-up KIII Input Water Metering System, the Primary Water Access Point Metering System, the Back-up Water Access Point Metering System, the Pumping Station Metering Station, the Mixed Water Metering System, the Reservoir Water Metering System, the Primary Bypass Output Water Metering System, the Back-up Bypass Output Water Metering System, the Primary Output Metering System and the Back-up Output Metering System;

"Metering Tolerance" means in relation to any component of the Metering System or the Monitoring System, plus or minus three percent (3%) from the measurement made by the standard meter used in a test of such component;

"Mixed Water Monitoring Point" has the meaning given to it in appendix 8;

"Mobilisation Activities" means all works, services and obligations to be performed by the Company during the Mobilisation Period as set out in appendix 1;

"Mobilisation Certificate" means the certificate duly signed and issued by the Independent Appointees to the Parties, certifying that each of the Mobilisation Conditions Precedent have been satisfied, waived or deferred in terms of this Agreement;

"Mobilisation Conditions Precedent" means the conditions precedent for commencement of the Mobilisation Activities as set out in part 1 of appendix 4;

"Mobilisation Date" has the meaning given to it in clause 3.1.1;

"Mobilisation Date Delay Notice" has the meaning given to it in clause 3.3.3;

"Mobilisation Period" means the period commencing at 00:00 hours on the Mobilisation Date and ending at 23:59 hours on the Day immediately preceding the Commencement Date;

"Mobilisation Testing" has the meaning given to it in appendix 5;

"Mobilisation Testing Acceptance Certificate" means the certificate issued by the Independent Engineer following completion of the Mobilisation Testing setting out, *inter alia*, Contracted Specific Net Electricity Consumption, Allowable NRW and the Output Water Quality Specifications, in each case, as applicable during the C&O Period;

"Monitoring Systems" means the Online Output Quality Monitoring System, the HD Input Online Quality Monitoring System, the KIII Input Online Quality Monitoring System, the Pumping Station Online Quality Monitoring System, the Mixed Online Quality Monitoring System, and the Reservoir Online Quality Monitoring System;

"Month" means a calendar month beginning at 00:00 on the first Day of the month and ending at 23:59 on the last Day of the month;

[3] Name of Consumer to be advised by KW&SB

"Natural Force Majeure Event" has the meaning given to it in clause 19.2;

"Net Equity" means (expressed and payable in PKR) the sum of the USD Net Equity and the PKR Net Equity, as applicable;

"Net Water Input" has the meaning given to it in appendix 8;

"Net Water Output" has the meaning given to it in appendix 8;

"NFME Period" means the duration of a Natural Force Majeure Event as determined by the Independent Engineer, provided that if more than one Natural Force Majeure Event is ongoing at the same time, for the purposes of determining the NFME Period, such Natural Force Majeure Events shall be considered as running concurrently;

"Non-Revenue Water" has the meaning given to it in appendix 8;

"O&M Activities" means all works, services and obligations to be performed by the Company during the Operating Period, including operations and maintenance of the KWC, as more fully described in appendix 1;

"O&M Contract" means the agreement between the Company and the O&M Contractor for the management, operation, maintenance and repair of the KWC;

"O&M Contractor" means the contractor(s) hired by the Company as advised in the Proposal (unless otherwise approved by KW&SB (in consultation with the Independent Engineer) pursuant to clause 16);

"O&M Performance Security" means the irrevocable, unconditional and on-demand bank guarantee (and any replacement thereof), in favour of GoS, in an amount equal to Pakistani Rupees five hundred million only (PKR 500,000,000/-), issued by an Acceptable Bank in the form set out in part 2 of appendix 6;

"O&M Performance Security Expiry Date" has the meaning given to it in clause 4.1.2;

"Off-Spec Input Water" has the meaning given to it in appendix 8;

"Off-Spec Mixed Water" has the meaning given to it in appendix 8;

"Off-Spec Output Water" has the meaning given to it in appendix 8;

"Online Output Quality Monitoring System" has the meaning given to it in clause 14.2.20;

"Operations Handover Certificate" means a certificate issued by the Independent Engineer certifying that Operations Handover Conditions have been satisfied;

"Operations Handover Conditions" means the conditions for handover of the KWC to the Company on the Commencement Date, as set out in appendix 1;[4]

"Operating and Maintenance Procedures" has the meaning given to it in clause 10.3.1;

[4] Operations Handover Conditions to be included in appendix 1 based on the Proposal.

"Operating Contract Year" or **"OCY"** means the twelve (12) Month period commencing at 00:00 hours on the Project Commercial Operations Date and ending at 23:59 hours on the Day immediately preceding the following anniversary of the Project Commercial Operations Date and each subsequent twelve (12) Month period during the Operating Period ending at 23:59 hours on the Day falling immediately prior to each subsequent anniversary of the Project Commercial Operations Date, provided that the last Operating Contract Year shall end at 23:59 hours on the last Day of the Concession Period;

"Operating Period" means the period commencing at 00:00 hours on the Project Commercial Operations Date and ending at 23:59 hours on the Final Expiry Date;

"Output Payment" has the meaning given to it in appendix 8;

"Output Water Connection Point" has the meaning given to it in appendix 8;

"Output Water Quality Specifications" has the meaning given to it in appendix 8;

"Outstanding Principal Amount" means:

(a) prior to the Project Commercial Operations Date, all actual outstanding principal amount required to be repaid by the Company pursuant to the Financing Documents in effect as of Financial Closing, such amount not to exceed [●];[5] and

(b) at any time thereafter, the actual outstanding principal amount required to be repaid by the Company pursuant to the Financing Documents in effect as of Financial Closing, such amount not exceeding the principal amount stated for the relevant time period set out in attachment E of appendix 8;

in each case, to the extent such principal amount was actually applied for the purposes of financing the Project;

"PACRA" means the Pakistan Credit Rating Agency Limited;

"Pakistan" means the Islamic Republic of Pakistan;

"Pakistani Rupees" or **"PKR"** means Pakistani Rupees, the lawful currency of Pakistan;

"Partial FC Letter" has the meaning given to it in paragraph 5.1 of part 2 of appendix 4;

"Parties" means the GoS, KW&SB and the Company and **"Party"** means any of them;

"Payment Certificate" means the certificate issued by the Independent Appointees in accordance with clause 13.5.1;

"Payment Date" has the meaning given to it in clause 13.3;

"Performance Securities" means the C&O Performance Security and the O&M Performance Security and **"Performance Security"** mean either of them;

[5] Insert principal amount specified for the first repayment date in Bidding Form F3-G of the Proposal.

"PFME Period" means the duration of a Political Force Majeure Event as determined by the Independent Engineer, provided that if more than one Political Force Majeure Event is ongoing at the same time, for the purposes of determining the PFME Period, such Political Force Majeure Events shall be considered as running concurrently;

"PKR Equity Return" means, for Sponsor Equity in PKR by a resident Sponsor, as follows:

$$Max(\sum_{i=1}^{t}[(PKR\ Equity\ Contribution - PKR\ Equity\ Distribution)_i\ x\ (1 + PKR\ EIRR)^{(t-i)}], 0)$$

where:

t = total number of distinct twelve (12)-Month intervals in the period from the Effective Date until the Termination Date; provided that if the last interval is shorter than twelve (12)-Months, it shall be considered a twelve (12)-Month interval;

i = index denoting a specific twelve (12)-Month interval (where i=1 for the 1st twelve (12)-Month interval and i=t for the last twelve (12)-Month interval, which may be shorter than twelve (12) Months);

PKR Equity Contribution = the nominal amount paid by a Sponsor to the Company in PKR (including Equity Held USD Amounts paid by Sponsor) to fund the Sponsor Funding Amount in accordance with the EFU Agreement, provided that Equity Held USD Amounts, for the purposes of this definition, shall be converted to PKR based on TT&OD selling rate for USD expressed in PKR, as published by the National Bank of Pakistan, applicable on the date of contribution;

PKR Equity Distribution = the product of: (a) percentage for 'Local Equity Tariff Component' for each Operating Contract Year until the Termination Date set out in attachment F of appendix 8; and (b) the sum of amount declared on any given date from time to time until the Termination Date in PKR by the Company for payment to the Shareholders against Class A Shares by way of return on capital, whether in the form of dividends, redemption of capital, payment of principal and interest on any indebtedness to such Shareholders; and

PKR EIRR = lower of (a) [insert Equity IRR (PKR) for Local Equity as per Bidding Form F-3 G] or (b) seventeen percent (17%);

"PKR Net Equity" means, for Sponsor Equity in PKR by a resident Sponsor, as follows:

$$Max(\sum_{i=1}^{t}[(PKR\ Equity\ Contribution - PKR\ Equity\ Distribution)_i]), 0$$

where:

t = Total number of distinct twelve (12)-Month intervals in the period from the Effective Date until the Termination Date; provided that if the last interval is shorter than twelve (12)-Months, it shall be considered a twelve (12)-Month interval;

i = Index denoting a specific twelve (12)-Month interval (where i=1 for the 1st twelve (12)-Month interval and i=t for the last twelve (12)-Month interval, which may be shorter than twelve (12) Months);

'PKR Equity Contribution' has the meaning given to it in the definition of 'PKR Equity Return'; and

'PKR Equity Distribution' has the meaning given to it in the definition of 'PKR Equity Return';

"Planned Outage" has the meaning given to it in appendix 8;

"Political Force Majeure Event" has the meaning given to it in clause 19.3;

"Primary Bypass Output Water Metering System" has the meaning given to it in clause 14.2.16;

"Primary HD Input Water Metering System" has the meaning given to it in clause 14.2.2;

"Primary KIII Input Water Metering System" has the meaning given to it in clause 14.2.5;

"Primary Metering Systems" means the Primary HD Input Water Metering System, Primary KIII Input Water Metering System, Primary Water Access Point Metering System, the Primary Bypass Output Water Metering System, and the Primary Output Metering System;

"Primary Output Metering System" has the meaning given to it in clause 14.2.18;

"Primary Water Access Point Metering System" has the meaning given to it in clause 14.2.8;

"Project" means:

(a) the Project Activities;

(b) the use by the Company, in accordance with the License Agreement, of the Site;

(c) maintaining the Contracted Availability by the Company;

(d) selling the Net Water Output at the Output Water Connection Point in accordance with this Agreement;

(e) the handover of the KWC to the KW&SB in terms of this Agreement; and

(f) all activities incidental to any of the foregoing, in accordance with this Agreement;

"Project Activities" means the Mobilisation Activities, the C&O Activities and O&M Activities;

"Project Agreements" means:

(a) this Agreement;

(b) the EFU Agreement;

(c) the License Agreement;

(d) the EPC Contract; and

(e) the O&M Contract;

"Project Commercial Operations Certificate" means the certificate duly signed and issued by the Independent Engineer to the Parties, certifying that the Project Commercial Operations Testing has been successfully completed;

"Project Commercial Operations Date" has the meaning given to it in clause 8.3.1;

"Project Commercial Operations Testing" has the meaning given to it in appendix 5;

"Project IPR" means all Intellectual Property Rights developed by or for the Company in connection with and for the Project after the Effective Date and prior to the Final Expiry Date, but excluding any Company IPR;

"Project Implementation Unit" means the project implementation unit established by the GoS for the purpose of overseeing the day-to-day implementation of the Project in accordance with the Legal Requirements and for carrying out the functions assigned to it under clause 25.5;

"Projected Loss of Net Water Output" has the meaning given to it in appendix 8;

"Proposal" means the proposal dated [●] delivered by the Successful Bidder to KW&SB on the Bid Submission Date in response to the RFP and any agreed amendments, variations or supplements thereto;

"Proposed Construction Documents" has the meaning given to it in clause 6.1.3;

"Public Private Partnership Policy Board" means the Public Private Partnership Policy Board constituted pursuant to the Sindh Public-Private Partnership Act, 2010;

"Pumping Station Metering System" has the meaning given to it in clause 14.2.10;

"Pumping Station Online Quality Monitoring System" has the meaning given to it in clause 14.2.11;

"Quarter" means each calendar quarter from 1 January to 31 March, 1 April to 30 June, 1 July to 30 September, and 1 October to 31 December;

"RE Period" means the duration of a Relief Event as determined by the Independent Engineer, provided that if more than one Relief Event is ongoing at the same time, for the purposes of determining the RE Period, such Relief Events shall be considered as running concurrently;

"Receiving Party" has the meaning given to it in clause 13.6.1;

"Recipient" has the meaning given to it in clause 29.2.1;

"Reduced Water Availability" has the meaning given to it in appendix 8;

"Refinancing" means:

(a) any amendment, variation, novation, supplement or replacement of any Financing Document;

(b) the exercise of any right, or the grant of any waiver or consent under any Financing Document;

(c) any restructuring of capital;

(d) the disposition of any rights or interests in, or the creation of any rights or interests in respect of, the Financing Documents or the creation or granting of any other form of benefit or interest in the Financing Documents or any revenues, contracts or assets of the Company, whether by way of security or otherwise; or

(e) any other arrangement put in place by the Company or another person which has a similar effect to paragraphs (a) to (d) above or which has the effect of limiting the Company's ability to carry out any of (a) to (d) above,

where such action affects the economic position of the Company, or the Shareholders including (without limitation) by changing or in any way affecting:

(i) amounts and/or payment schedules for margins, fees or other financing costs;

(ii) the maturity or size of the debt or repayment profile or schedule;

(iii) the timing or amount of any Distributions or any release of any contingent equity commitments;

(iv) any reserving requirements; and

(v) any requirement to provide or maintain any guarantee or security;

"Refinancing Gain" has the meaning given to it in clause 16.3.7;

"Relevant Agreement" means:

(a) this Agreement;

(b) the Concession and License Direct Agreement;

(c) the License Agreement; and

(d) the EFU Agreement;

"Relief Event" means the following events or circumstances:

(a) an act of impediment or prevention by a GoS Party or a breach by a GoS Party of any of its obligations under this Agreement or any other Relevant Agreement;

(b) after the Project Commercial Operations Date, an Electricity Supply Failure;

(c) after the Project Commercial Operations Date, Off-Spec Input Water or Off-Spec Mixed Water accepted pursuant to clause 14.8.4, that was rejected by the Company and results in damage or loss to any part of the KWC; and

(d) prior to the Project Commercial Operations Date, an Archaeological Delay Event, but only if and to the extent that the Company has made all reasonable efforts to reduce to a minimum and mitigate the effect of such event;

but only if and to the extent that in any such case, (i) in the opinion of the Independent Appointees, it materially and adversely impairs the ability of the Company, the Sponsors, or any Contractor to perform their respective obligations under the Project Agreements, (ii) the Company is not in breach of its obligation to meet the Contracted Availability, and (iii) such event or circumstance is not the direct or indirect result of a breach by Company (or its Contractors) or the Sponsors of any of their obligations under this Agreement or any other Project Agreement, or any negligent act or omission by the Company, the Contractors or the Sponsors;

"Remedial Plan" has the meaning given to it in clause 21.10.2.2;

"Remedial Report" has the meaning given to it in clause 21.10.2.2;

"Remedial Works" has the meaning given to it in clause 21.10.2.2;

"Reservoir" means the existing potable water storage reservoir located within the Site as more particularly described in appendix 1;

"Reservoir Online Quality Monitoring System" has the meaning given to it in clause 14.2.15;

"Reservoir Water Metering System" has the meaning given to it in clause 14.2.14;

"Restoration Account" has the meaning given to it in clause 19.10.2;

"RFP" has the meaning given to it in recital A;

"Savings" means any increase in revenues received by the Company and/or any savings or reduction of costs or expenses relating to the Project resulting from, or otherwise attributable to, any circumstance described in clause 20.1 that is realised by the Company, which cost or expenses may include one or more of:

(a) capital costs;

(b) financing costs;

(c) costs of operation and maintenance; and

(d) costs of Taxes imposed on or payable by the Company;

"SBP" means the State Bank of Pakistan;

"SBP Debit Authority" has the meaning given to it in clause 12.2.1;

"Scheduled Commencement Date" means the date specified in the Implementation Schedule for the achievement of the Commencement Date (which is [●][6] as at the Effective Date) as

[6] Insert date falling six (6) Months from the Effective Date.

such date may from time to time be amended in accordance with this Agreement;

"Scheduled Mobilisation Date" means the date specified in the Implementation Schedule for the achievement of the Mobilisation Date (which is [●][7] as at the Effective Date) as such date may from time to time be amended in accordance with this Agreement;

"Scheduled Project Commercial Operations Date" means the date specified in the Implementation Schedule for the achievement of the Project Commercial Operations Date (which is [●][8] as at the Effective Date) as such date may from time to time be amended in accordance with this Agreement;

"Service Payments" means following the Commencement Date, the Output Payment and following the Project Commercial Operations Date:

(a) the Availability Payment; and

(b) the Output Payment,

in each case payable in accordance with appendix 8 and the terms of this Agreement;

"Settlements" means communities situated along the KWC as identified in the Environment and Social Impact Assessment;

"Shareholder" means a person who is from time to time registered in the Company's share register as a holder of Class A Shares;

"Site" means the location of the KWC, as more fully described in appendix 1, which is licensed to the Company pursuant to the License Agreement for undertaking the Project Activities;

"Site Information" has the meaning given to it in clause 5.6.1;

"Social Matter" means any:

(a) matter relating to public consultation and disclosure with respect to the Project Activities;

(b) impacts on a person, of any resettlement or land acquisition activities, undertaken in connection with the Project;

(c) impacts to livelihood as a result of the changes induced by the Project Activities;

(d) impacts to community health and safety, infrastructure, or socioeconomics; or

(e) impacts of the Project Activities on vulnerable groups, including those living below the poverty line, female-headed households, individuals with disabilities, and informal settlers;

[7] Insert date falling two (2) Months from the Effective Date.

[8] Insert date falling twenty-four (24) Months from the Effective Date.

"Solar Plant" means the solar power plant that may be established by the Company at the location and meeting the requirements, as specified in appendix 1;

"Sponsors" has the meaning given to it in the EFU Agreement;

"Sponsor Equity" means: (a) Sponsor Loans; and (b) any paid-up capital issued by the Company to a Sponsor, in each case, in cash, to Fund the Sponsor Funding Amount in accordance with the EFU Agreement;

"Sponsor Funding Amount" has the meaning given to it in the EFU Agreement;

"Sponsor Loans" has the meaning given to it in the EFU Agreement;

"Stakeholder Engagement Plan" has the meaning given to it in clause 4.10.3;

"Stakeholders" means any person or group who are directly or indirectly affected by the Project (including the Affected Communities), as well as those who may have interests in the Project and/or the ability to influence its outcome, either positively or negatively, and may include their formal and informal representatives, national or local government authorities, politicians, religious leaders, non-governmental organizations, civil society organizations and groups with special interests, the academic community, or other businesses;

"Successful Bidder" means [●][9];

"Summer Period" or **"Summer"** has the meaning given to it in appendix 8;

"Taxes" means any tax, charge, impost, tariff, duty or fee of any kind charged, imposed or levied, directly or indirectly, by a Competent Authority including any zakat, value added tax, sales tax, notarisation fees, stamp duty, import duty, withholding tax (whether on income, dividends, commission payments, fees, equipment, rentals or otherwise), tax on foreign currency loans or foreign exchange transactions, excise tax, property tax, registration fee or licence, water tax or environmental, energy or fuel tax, including any commission, penalties or additions thereon;

"Technical Parties" means KW&SB and the Company, and **"Technical Party"** means either of them;

"Term Expiry Date" means the fifteenth (15th) anniversary of the Project Commercial Operations Date, as may be extended from time to time in accordance with this Agreement;

"Termination Date" means the date specified for termination in the relevant Termination Notice;

"Termination Notice" means a notice of termination issued by the Company or GoS, as the case may be, pursuant to clauses 21.2, 21.3, 21.4, 21.7, or 21.8.4;

"Termination Payment" means, as the context requires, Value A, Value B, Value C or Value D;

[9] Insert from Letter of Award.

"Termination Payment Date" means the date on which the GoS has made payment of the relevant Termination Payment to the Company, such date being within the period that is ninety (90) Days following the Termination Date, as may be extended pursuant to clauses 21.10.4 and 21.10.5;

"Test Procedures" has the meaning given to it in clause 8.1.1;

"Traffic and Pedestrian Safety Plan" has the meaning given to it in clause 5.5.4;

"Treatment Plant" has the meaning given to it in appendix 8;

"Unavailability Notice" has the meaning given to it in appendix 8;

"Unavailable" or **"Unavailability"** has the meaning given to it in appendix 8;

"Unenforceability Event" means circumstances where:

(a) there is a Disputed Obligation; and

(b) there is a final and binding determination of an arbitral tribunal or of a Pakistan court that the Disputed Obligation is illegal, invalid, void, voidable or unenforceable under the applicable Legal Requirements; and

(c) such illegality, invalidity, voidability or unenforceability under the applicable Legal Requirements materially impairs:

(i) the rights of the Financing Parties under the Financing Documents; or

(ii) the ability of the Company to perform its obligations under the Project Agreements or the Financing Documents,

provided that the Company must have used its best efforts to mitigate such consequences (or the event itself). For the purposes of this definition, "materially" means a material impairment in the Company's rights to receive Service Payments in terms of this Agreement; and

(d) the Company is not otherwise adequately compensated for the material impairment described in paragraph (c) above by way of remedy or relief pursuant to this Agreement or otherwise;

"United States Dollars" or **"USD"** means United States Dollars, the lawful currency of United States of America;

"Unpaid Termination Payment Amount" has the meaning given to it in clause 12.2.9;

"Unpaid Termination Payment Amount Certificate" has the meaning given to it in clause 12.2.9;

"Unplanned Outage Maintenance Program" has the meaning given to it in clause 10.5.2.2;

"Unplanned Outages" has the meaning given to it in appendix 8;

"USD Equity Return" means, for Sponsor Equity issued on a repatriable basis, as follows:

$(Max(\sum_{i=1}^{t}[(USD\ Equity\ Contribution - USD\ Equity\ Distribution)_i\ x\ (1 + USD\ EIRR)^{(t-i)}]), 0) * \text{FX}$

where:

t = total number of distinct twelve (12)-Month intervals in the period from the Effective Date until the Termination Date; provided that if the last interval is shorter than twelve (12)-Months, it shall be considered a twelve (12)-Month interval;

i = index denoting a specific twelve (12)-Month interval (where i=1 for the 1st twelve (12)-Month interval and i=t for the last twelve (12)-Month interval, which may be shorter than twelve (12) Months);

USD Equity Contribution =

If A is greater than seventy percent (70%), then USD Equity Contribution will be equal to seventy percent (70%) of B;

If A is less than or equal to seventy percent (70%), then USD Equity Contribution will be equal to B,

where,

A = Sponsor Equity in the Company registered on a repatriable basis by the SBP or the authorized dealer, as applicable.

B = USD amounts contributed from time to time by a Sponsor to Fund the Sponsor Equity set out, as applicable, in the certificates of deposit, proceeds realization certificates or document(s) evidencing the registration of Sponsor Loan (for Funding the Sponsor Funding Amount in accordance with the EFU Agreement) issued by the authorized dealer or the SBP;

USD Equity Distribution = the product of: (a) percentage for 'Foreign Equity Tariff Component' for each Operating Contract Year until the Termination Date set out in attachment F of appendix 8; and (b) the sum of amount declared on any given date from time to time (the **"Declaration Date"**) until the Termination Date in PKR by the Company for payment to the Shareholders against Class A Shares (registered on a repatriable basis by the SBP) by way of return on capital, whether in the form of dividends, redemption of capital, payment of principal and interest on any indebtedness to such Shareholders. The PKR amounts will be converted to USD based on TT&OD selling rate for USD expressed in PKR, as published by the National Bank of Pakistan, prevailing on the Declaration Date;

FX = USD based on TT&OD selling rate for USD expressed in PKR, as published by the National Bank of Pakistan, prevailing on the Termination Date; and

USD EIRR = lower of: (a) [insert Equity IRR (USD) for Foreign Equity as per Bidding Form F-3 G]; or (b) twelve percent (12%);

"USD Net Equity" means, for Sponsor Equity issued on a repatriable basis, as follows:

$(Max(\sum_{i=1}^{t}[(USD\ Equity\ Contribution - USD\ Equity\ Distribution)_i]), 0) * \text{FX}$

where:

t = Total number of distinct twelve (12)-Month intervals in the period from the Effective Date until the Termination Date; provided that if the last interval is shorter than twelve (12)-Months, it shall be considered a twelve (12)-Month interval;

i = Index denoting a specific twelve (12)-Month interval (where i=1 for th[e] 1st twelve (12)-Month interval and i=t for the last twelve (12)-Month interval, which may be shorter than twelve (12) Months);

FX = USD based on TT&OD selling rate for USD expressed in PKR, as published by the National Bank of Pakistan, prevailing on the Termination Date;

'USD Equity Contribution' has the meaning given to it in the definition of 'USD Equity Return'; and

'USD Equity Distribution' has the meaning given to it in the definition of 'USD Equity Return';

"Value A" means an amount equivalent to:

(a) the Financing Due; *plus*

(b) the Equity Return; *less*

(c) the Deductible Termination Amounts;

"Value B" means an amount equivalent to:

(a) ninety five percent (95%) of the Financing Due; *less*

(b) the Deductible Termination Amounts;

"Value C" means an amount equivalent to:

(a) the Financing Due; *plus*

(b) the Net Equity; *less*

(c) the Deductible Termination Amounts;

"Value D" has the meaning given to it in clause 21.3.1;

"VIS" means the VIS Credit Rating Company Limited (formerly JCR-VIS Credit Rating Company Limited);

"Water Access Point Consumers" means Hamdard University, Hamdard Laboratories, Sherriar Ashraf (Gulf Mineral), the Public Health Engineering and Rural Department (Government of Sindh) and [Marble City Connection][10];

"Water Access Connection Points" means the water access points for delivery of water to the Water Access Point Consumers, located on the KWC, as specified in appendix 1;

"Water Volume Notification" means the notice issued by KW&SB from time to time, in accordance with clause 4.8.2.1, setting out the volume of water per Day to be delivered to each Water Access Connection Point, provided that, the volume of water stated in such notice shall not exceed the Maximum Volume applicable for each Water Access Connection Point;

"WAPDA Canal" means the canal owned and operated by the Pakistan Water and Power Development Authority running from the Hub Dam to the Input HD Water Connection Point;

"Within Spec Input Water" has the meaning given to it in appendix 8; and

"World Bank Group Environmental, Safety and Health Guidelines" means the technical reference documents with general and industry-specific examples of Good International Industry Practice and are referred to in the IFC Performance Standards.

1.2 Interpretation

The following rules of construction and interpretation apply to this Agreement:

1.2.1 periods of time refer to the Gregorian calendar and reference to a time of Day shall be construed as a reference to the time of Day in Pakistan;

1.2.2 a "person" includes any individual, company, corporation, firm, partnership, joint venture, association (whether a body corporate or an unincorporated association of persons) or any government institution, department or establishment, and a person shall be construed as including a reference to its successors, permitted assigns and permitted transferees in accordance with their respective interests;

1.2.3 words importing the singular number include the plural and vice versa, and words importing a gender include the other gender;

1.2.4 the descriptive headings in this Agreement, including the cover page and table of contents, are for convenience of reference only and not for purposes of construction or interpretation of its provisions;

1.2.5 unless specifically provided otherwise, the words "herein" and "hereunder", and words of similar import, refer to the entirety of this Agreement and not only to the clause in which such use occurs;

1.2.6 a reference to a "clause", "appendix" or "attachment" is a reference to a clause of this Agreement, an appendix to this Agreement, or an attachment to an appendix;

1.2.7 this Agreement is to be read and construed as a whole; anything mentioned in any of the documents comprising this Agreement shall be of like effect as if stated or

[10] Name of Consumer to be advised by KW&SB

mentioned in all of them. In the event of a conflict between the clauses and the appendices, the Independent Appointees shall endeavour, in the first instance, to resolve the conflict by reading this Agreement as a whole and the provision that is more specific to the subject matter shall govern. If, notwithstanding the Independent Appointees' good faith efforts to resolve the conflict as provided in the preceding sentence, the conflict continues to persist, the provision in the clauses shall govern;

1.2.8 where an obligation of a Party to make payment under this Agreement, as a result of the calculation of time, falls on a Day other than a Business Day, such time for performance shall be extended to the next Business Day;

1.2.9 "certified" shall mean in the context of the Company, duly certified by the company secretary and in the context of the GoS Parties, duly certified by an authorised person;

1.2.10 "including" or "includes" shall be deemed to be qualified by a reference to "without limitation";

1.2.11 reference to "this Agreement" or any other agreement or document shall be construed as a reference to such agreement or document as amended, modified or supplemented and in effect from time to time and shall include a reference to any document which amends, modifies or supplements it, or is entered into, made or given pursuant to or in accordance with its terms;

1.2.12 the "face amount" of a letter of credit or guarantee, shall be construed as a reference to the remaining amount available for drawing under that letter of credit or guarantee;

1.2.13 neither the giving of any approval or consent, the review, knowledge or acknowledgement of the terms of any document by or on behalf of the GoS Parties or the Independent Appointees, nor the failure to do so, shall, unless expressly stated in this Agreement, relieve the Company of any of its obligations under this Agreement or of any duty which it may have under this Agreement to ensure the correctness, accuracy or suitability of the matter or thing which is the subject of the approval, consent, review, knowledge or acknowledgement;

1.2.14 the rule of construction, if any, that an agreement should be interpreted against the Party responsible for the drafting and preparation thereof shall not apply to this Agreement; and

1.2.15 the Parties acknowledge that liquidated damages for specific defaults prescribed under this Agreement are representative of the actual losses, liabilities, damages, costs, charges, or expenses that shall be suffered by the non-defaulting Party due to failure of the defaulting Party to perform its obligations in accordance with this Agreement and are not in the nature of a penalty.

2. CONCESSION AND TERM

2.1 Grant of Concession

2.1.1 In consideration of the Company's obligations contained in this Agreement and relying on the Company's representations, warranties and covenants contained herein,

KW&SB, subject to the terms of this Agreement, grants to the Company the right and authorizes it to:

2.1.1.1 carry out the Mobilisation Activities during the Mobilisation Period, the C&O Activities during the C&O Period, and the Operating Activities during the Operating Period, on a **DFBROMT** basis;

2.1.1.2 exercise and enjoy the rights, powers, benefits, privileges, authorizations, and entitlements as set forth in this Agreement,

(collectively referred to as the **"Concession"**).

2.1.2 The Company agrees and undertakes to implement the Project in accordance with the terms of this Agreement.

2.2 Concession

Unless otherwise stated, this Agreement shall become effective on the Effective Date. The Concession is granted to the Company and shall be effective in accordance with the terms of this Agreement.

2.3 Extension of Concession Period

The Concession Period may be extended for an additional period, if:

2.3.1 not less than eighteen (18) Months prior to the Term Expiry Date, the GoS Parties (acting jointly) provide a notice to the Company, or the Company provides a notice to the GoS Parties, requesting that the Parties enter into good faith negotiations to extend the Concession Period;

2.3.2 subject to the Parties having agreed to enter into good faith negotiations pursuant to clause 2.3.1, not later than twelve (12) Months prior to the Term Expiry Date, the Parties agree to the terms of such extension;

2.3.3 not later than six (6) months prior to the Term Expiry Date, the Parties enter into a binding agreement in writing, confirming the agreed terms of the extension (including any adjustments to the Service Payments); and

2.3.4 any requisite approval for the extension of the Concession Period (including any adjustments to the Service Payments) is obtained from the Competent Authorities in accordance with the Legal Requirements.

3. MOBILISATION AND COMMENCEMENT

3.1 Mobilisation Date

3.1.1 The rights and obligations of the Parties to undertake the Mobilisation Activities shall be conditional upon the issuance of the Mobilisation Certificate by the Independent Appointees, certifying in writing the satisfaction, deferral or irrevocable waiver by the relevant Party as provided in part 1 of appendix 4 of all the Mobilisation Conditions Precedent (the date of such certification being the **"Mobilisation Date"**). The

Mobilisation Certificate shall be issued within five (5) Business Days of the occurrence of such satisfaction, deferral, or waiver.

3.1.2 Each Party shall cause the Mobilisation Date to occur on or before the Scheduled Mobilisation Date.

3.2 Reports Prior to Mobilisation Date

On a regular (at least weekly) basis from the appointment of the Independent Appointees to the Mobilisation Date, the Company shall advise the Independent Appointees as to the status of the satisfaction of the Mobilisation Conditions Precedent for which the Company is responsible, provided that:

3.2.1 no review or approval by the Independent Appointees of any Mobilisation Conditions Precedent shall relieve the Company from any liability that it would otherwise have had in respect of such Mobilisation Conditions Precedent or failure to comply with the applicable Legal Requirements or this Agreement with respect thereto; and

3.2.2 neither the GoS Parties, the Independent Appointees, nor any of their representatives or any of their advisors shall be liable to the Company or any other person by reason of their review or approval of any Mobilisation Conditions Precedent.

3.3 Delay in Achieving the Mobilisation Date

3.3.1 If, the achievement of the Mobilisation Date has been delayed due to:

3.3.1.1 any delay or failure on the part of a GoS Party in the performance of its obligations under this Agreement, which is not otherwise attributable to the Sponsors, the Company or any of its Contractors;

3.3.1.2 any delay or failure on the part of KW&SB in the execution of, or the performance of its obligations under the License Agreement; or

3.3.1.3 the occurrence of a Political Force Majeure Event,

the Independent Appointees shall confer with the Parties with a view to equitably adjusting the Scheduled Mobilisation Date and the Implementation Schedule, taking into account:

3.3.1.4 the effect which the Company demonstrates is solely attributable to the GoS Parties' delay or failure and which would not have occurred but for such delay or failure;

3.3.1.5 the effect which the Company demonstrates is solely attributable to the occurrence of a Political Force Majeure Event and which would not have occurred but for such delay or failure; and

3.3.1.6 the ability of the Parties to reschedule their obligations to avoid or minimise the overall resulting delays and ensure that any such adjustment to the Scheduled Mobilisation Date and the Implementation Schedule is limited to that necessary and is a consequence of the delay or failure.

3.3.2 The remedies set out in this clause 3.3 shall be the Company's sole and exclusive remedies with respect to any delay in achieving the Mobilisation Date by the Scheduled Mobilisation Date due to any matter referred to in clause 3.3.1, provided that if the Company fails to achieve the Mobilisation Date by the Scheduled Mobilisation Date (as adjusted under clause 3.3.1), then, unless the Scheduled Mobilisation Date is extended in accordance with clause 3.3.3, either Commercial Party may exercise its right to terminate this Agreement pursuant to clause 21.2.

3.3.3 If, for reasons other than those specified under clause 3.3.1, the Company is unable to achieve the Mobilisation Date by the Scheduled Mobilisation Date then, subject to clause 3.3.4, the Scheduled Mobilisation Date shall be extended for a period not exceeding sixty (60) Days. No later than twenty (20) Days prior to the Scheduled Mobilisation Date, the Company shall provide written notice to the Independent Appointees of its expected inability to achieve the Mobilisation Date by the Scheduled Mobilisation Date (the **"Mobilisation Date Delay Notice"**).

3.3.4 The extension of the Scheduled Mobilisation Date pursuant to clause 3.3.3 shall be subject to each of the following conditions being fulfilled on or before the Scheduled Mobilisation Date as applicable prior to any such extension being granted:

3.3.4.1 the Financing Documents have been signed and are in full force and effect subject only to the satisfaction of conditions precedent to the first drawdown of funds thereunder;

3.3.4.2 the Company shall have:

(a) provided the Mobilisation Date Delay Notice; and

(b) executed the EPC Contract; and

3.3.4.3 the EPC Contractor shall have commenced work under the EPC Contract such that the Company will meet the Implementation Schedule.

3.3.5 The Company acknowledges that any adjustment to the Scheduled Mobilisation Date pursuant to clause 3.3.3 shall not entitle the Company to any adjustment to the Implementation Schedule or any Service Payments.

3.3.6 Within ten (10) Days after the Mobilisation Date, the Company shall deliver to the Independent Appointees and the GoS Parties, one (1) physical copy, each, of all Project Agreements, Financing Documents and all other documents related or incidental thereto, and a closing book on CD-ROM containing conformed copies thereof.

3.4 Commencement Date

3.4.1 The rights and obligations of the Parties to undertake the C&O Activities shall be conditional upon the issuance of the Commencement Certificate by the Independent Appointees certifying in writing the satisfaction, deferral, or irrevocable waiver by the relevant Party as provided in part 2 of appendix 4 of all the Commencement Conditions Precedent (the date of such certification being the **"Commencement Date"**). The Commencement Certificate shall be issued within five (5) Business Days of the occurrence of such satisfaction, deferral or waiver.

3.4.2 Each Party shall use its best endeavours to cause the Commencement Date to occur on or before the Scheduled Commencement Date.

3.5 Reports Prior to Commencement Date

On a regular (at least weekly) basis from the Mobilisation Date, the Company shall advise the Independent Appointees as to the status of the satisfaction of the Commencement Conditions Precedent for which the Company is responsible, provided that:

3.5.1 no review or approval by the Independent Appointees of any Commencement Conditions Precedent shall relieve the Company from any liability that it would otherwise have had in respect of such Commencement Conditions Precedent or failure to comply with the applicable Legal Requirements or this Agreement with respect thereto; and

3.5.2 neither the GoS Parties, the Independent Appointees nor any of their representatives or any of their advisors shall be liable to the Company or any other person by reason of their review or approval of any Commencement Conditions Precedent.

3.6 Delay in Achieving the Commencement Date

3.6.1 If, the achievement of the Commencement Date has been delayed due to:

3.6.1.1 any delay or failure on the part of a GoS Party in the performance of its obligations under this Agreement, which is not otherwise attributable to the Sponsors, the Company or any of its Contractors; or

3.6.1.2 the occurrence of a Force Majeure Event,

the Independent Appointees shall confer with the Parties with a view to equitably adjusting the Scheduled Commencement Date and the Implementation Schedule, taking into account:

3.6.1.3 the effect which the Company demonstrates is solely attributable to the GoS Parties' delay or failure and which would not have occurred but for such delay or failure;

3.6.1.4 the effect which the Company demonstrates is solely attributable to the occurrence of a Force Majeure Event and which would not have occurred but for such delay or failure; and

3.6.1.5 the ability of the Parties to reschedule their obligations to avoid or minimise the overall resulting delays and ensure that any such adjustment to the Scheduled Commencement Date and the Implementation Schedule is limited to that necessary and is a consequence of the delay or failure.

3.6.2 The remedies set out in this clause 3.6 shall be the Company's sole and exclusive remedies with respect to any delay in achieving the Commencement Date by the Scheduled Commencement Date due to any matter referred to in clause 3.6.1, provided that if the Company fails to achieve the Commencement Date by the Scheduled Commencement Date (as adjusted under clause 3.6.1), then, unless the Scheduled

Commencement Date is extended in accordance with clause 3.6.3, either Commercial Party may exercise its right to terminate this Agreement pursuant to clause 21.3.

3.6.3 If, for reasons other than those specified under clause 3.6.1, the Company is unable to achieve the Commencement Date by the Scheduled Commencement Date then, subject to clause 3.6.4, the Scheduled Commencement Date shall be extended for a period not exceeding sixty (60) Days. No later than twenty (20) Days prior to the Scheduled Commencement Date, the Company shall provide written notice to the Independent Appointees of its expected inability to achieve the Commencement Date by the Scheduled Commencement Date (the **"Commencement Date Delay Notice"**).

3.6.4 The extension of the Scheduled Commencement Date pursuant to clause 3.6.3 shall be subject to each of the following conditions being fulfilled on or before the Scheduled Commencement Date as applicable prior to any such extension being granted:

3.6.4.1 the Company shall have provided the Commencement Date Delay Notice;

3.6.4.2 submission of the Operating and Maintenance Procedures in accordance with clause 10.3;

3.6.4.3 submission of the Maintenance Schedule in accordance with clause 10.4;

3.6.4.4 submission of the construction manual and the operations and maintenance manuals; and

3.6.4.5 completion by the Company of all Mobilisation Activities as required under appendix 1 (other than procurement of Mobilisation Testing Acceptance Certificate).

3.6.5 The Company acknowledges that any adjustment to the Scheduled Commencement Date pursuant to clause 3.6.3 shall not entitle the Company to any adjustment to the Implementation Schedule or any Service Payments.

4. PROJECT IMPLEMENTATION

4.1 Company's Obligations

4.1.1 The Company shall deliver the C&O Performance Security to the GoS on or before the Effective Date and shall maintain the same in full force and effect until the expiry of a period of six (6) Months from the Project Commercial Operations Date (the **"C&O Performance Security Expiry Date"**). The Company shall notify the GoS of the impending expiry of the C&O Performance Security not more than three (3) and not less than two (2) Months prior to the date when it is due to expire. If the C&O Performance Security is not extended at least one (1) Month prior to the C&O Performance Security Expiry Date, the Parties acknowledge and agree that the GoS may encash the full amount of the C&O Performance Security.

4.1.2 The Company shall deliver the O&M Performance Security to the GoS on or before the Scheduled Project Commercial Operations Date and shall maintain the same in full force and effect until the later of: (a) expiry of a period of six (6) Months from the Final Expiry Date; and (b) the date determined in accordance with clause 21.10.3 (the **"O&M Performance Security Expiry Date"**). The Company shall notify GoS of the

impending expiry of the O&M Performance Security not more than three (3) and not less than two (2) Months prior to the date it is due to expire. If the O&M Performance Security is not extended at least one (1) Month prior to the O&M Performance Security Expiry Date, the Parties acknowledge and agree that GoS may encash the full amount of the O&M Performance Security.

4.1.3 The Performance Securities:

4.1.3.1 shall be issued and maintained without any recourse on the Company, its assets or properties and all costs, expenses, fees and other charges of any nature associated with the issuance, maintenance and encashment of the Performance Securities shall be borne by the Sponsors;

4.1.3.2 shall not be secured by the property or assets comprising of KWC or the Site; and

4.1.3.3 shall be encashed on demand in accordance with the terms of this Agreement.

4.1.4 The Company undertakes that no Encumbrance of any nature shall be created on the Site, or any immovable assets and immovable properties comprising of the KWC, unless the same have been constructed, procured, or rehabilitated by the Company.

4.1.5 The Company shall cause and be responsible for:

4.1.5.1 the due and proper application for all Approvals and all renewals thereof required to be obtained in the name of the Company in connection with the transactions contemplated by this Agreement, other Project Agreements and the Financing Documents, the diligent effort to obtain, the receipt of, and the maintenance of, all such Approvals until the Final Expiry Date;

4.1.5.2 preparation of, and compliance with the requirements of, the Environmental and Social Impact Assessment;

4.1.5.3 development, implementation, operation and maintenance of the Environmental and Social Management System;

4.1.5.4 the procurement and use of any temporary land identified by the Environmental and Social Impact Assessment as required by the Company for the Project Activities, in compliance with the Environmental and Social Requirements, including the IFC Performance Standards' requirements relating to temporary land acquisition, and any mitigation measures set out in the Environmental and Social Impact Assessment and subsequent Environmental and Social Management System;

4.1.5.5 the due and proper application for, the diligent effort to obtain, and the receipt of, any visas, work permits, employment permits, dependents' permits, licences and other permits required for all individuals involved in the Project on behalf of or pursuant to contracts with the Company;

4.1.5.6 executing all Project Agreements and Financing Documents to which it or a Sponsor is a party, in a timely manner;

4.1.5.7 co-operating with KW&SB in the identification of the applications to be made by KW&SB referred to in clause 4.2.3 and supporting such applications, including providing reasonable assistance in the preparation thereof, so as to expedite the consideration thereof by the appropriate Competent Authority, provided that such applications are in compliance with all applicable Legal Requirements and the terms and conditions of each Project Agreement in connection with which such application is made;

4.1.5.8 delivering to the Independent Appointees and the GoS Parties, each of the documents required to be delivered in accordance with parts 1 and 2 of appendix 4 not later than the time for delivery thereof set out therein;

4.1.5.9 achieving the Mobilisation Date on or before the Scheduled Mobilisation Date;

4.1.5.10 achieving the Commencement Date on or before the Scheduled Commencement Date; and

4.1.5.11 achieving the Project Commercial Operations Date on or before the Scheduled Project Commercial Operations Date.

4.2 KW&SB Obligations

KW&SB shall cause and be responsible for:

4.2.1 making available, or causing to be made available, to the Company, the Site in accordance with clause 5;

4.2.2 making available, or causing to be made available, to the Company, during the Concession Period (except for during Planned Outages or Unplanned Outages), water from the Head Regulator and K-III;

4.2.3 the due and proper application for, the diligent effort to obtain, and the receipt of, all Approvals and all renewals thereof that are required to be obtained in the name of KW&SB in connection with the transactions contemplated by this Agreement;

4.2.4 executing the Relevant Agreements to which it is a party in a timely manner; and

4.2.5 delivering to the Independent Appointees and the Company, each of the documents required to be delivered in accordance with parts 1 and 2 of appendix 4 not later than the time for delivery thereof set out therein.

4.3 GoS' Obligations

The GoS shall cause and be responsible for:

4.3.1 as reasonably requested by the Company, discussing the Project with and providing publicly available and/or non-confidential information about GoS Parties to financial institutions interested in providing financing for the Project, provided that the GoS Parties shall not be required to make any representations, warranties or undertakings or otherwise incur any liability in connection with any such discussion or in connection with the Financing Documents; and

4.3.2 executing the Relevant Agreements in a timely manner.

4.4 Sub-contractors

4.4.1 The appointment of the EPC Contractor or the O&M Contractor or any other contractor or supplier shall not relieve the Company of any of its obligations under this Agreement.

4.4.2 All references in this Agreement to any act, default, omission, breach or negligence of the Company shall be construed to include any such act, default, omission, breach or negligence of the Contractors or any other contractor or supplier of the Company or those of the Contractors.

4.4.3 The Company shall ensure that the EPC Contract and O&M Contract contain provisions required in terms of the appendix 12 and which further provide for such contracts to be, at the option of the GoS, novated or assigned to the GoS or its nominee without any further consent or approval from the Company or the Contractor, or entitle the GoS or its nominee to step into such contract, in substitution of the Company, if this Agreement is terminated prior to the Term Expiry Date, provided that the step-in rights of the GoS shall be subject to any substitution rights of the Financing Parties under the Concession and License Direct Agreement.

4.4.4 The Company shall at all times comply and shall procure that any third-party contractors and subcontractors comply, with the Environmental and Social Requirements, in relation to the performance of the Project Activities.

4.5 GoS and KW&SB Representatives

Each of the GoS Parties shall be entitled from time to time to appoint one or more representatives to support it or represent it in connection with the implementation of the Project. Each GoS Party shall notify the Company from time to time of its appointed representatives and their roles and responsibilities. Unless and to the extent specified by a GoS Party in writing to the contrary, no such representative shall have authority to act on a GoS Party's behalf for the purpose of giving any instruction or notice under this Agreement or otherwise taking any action binding on a GoS Party for any purpose in connection with this Agreement.

4.6 KW&SB Site Facilities

The Company shall ensure that office(s) and related facilities are provided at the Site for the use of KW&SB and its representative, in accordance with the requirements set out in appendix 1.

4.7 Biodiversity Action Plan

If a Biodiversity Action Plan has been prepared as a Commencement Conditions Precedent, the Company shall ensure compliance with the Biodiversity Action Plan throughout the Concession Period.

4.8 Water Access Connection Points

4.8.1 The Company shall:

4.8.1.1 maintain, throughout the Concession Period, the Water Access Connection Points for delivery of water to the Water Access Point Consumers; and

4.8.1.2 ensure that the volume of water made available at each of the Water Access Connection Points in any Day is equal to the volume stated in the Water Volume Notification.

4.8.2 KW&SB shall:

4.8.2.1 notify the Company in writing at least twenty (20) Days prior to the Commencement Date, the volume of water to be made available at each of the Water Access Connection Points in any Day of the Concession Period. KW&SB may from time to time revise the volume of water stated in such notification, provided that such revision shall come into effect seven (7) Days after the revised notification is received by the Company;

4.8.2.2 be responsible for the delivery of water to the relevant Stakeholders; and

4.8.2.3 coordinate with the Water Access Connection Point Consumers for filtration of water supplied under clause 4.8.2.1.

4.9 Human Resource Policies and Resources

4.9.1 The Company shall (and shall procure that each Contractor shall) develop and maintain written human resource policy and procedures in accordance with the Legal Requirements, including the E&S Standards (the **"HR Policy and Procedure"**). The HR Policy and Procedure shall be prepared and submitted to the Independent Engineer within two (2) Months following the Mobilisation Date.

4.9.2 The HR Policy and Procedures shall clearly describe, in relation to the Company, the working conditions, terms of employment, management of workers' relationship, grievance redress mechanism, and the roles and responsibilities of the Company and its employees.

4.9.3 The HR Policy and Procedures developed in terms of clause 4.9.1 shall be made available to the respective employees of the Company and each of the Contractors.

4.10 Stakeholder Engagement Plan

4.10.1 KW&SB shall engage with the Settlements in order to:

4.10.1.1 share information regarding the Project;

4.10.1.2 confirm the water needs of the Settlements and their willingness and/or ability to pay for the water delivered from the KWC;

4.10.1.3 assess the infrastructure needs of the Settlements and available water storage facilities at community and household levels; and

4.10.1.4 address any concerns over the portability of the water from KWC to the Settlements.

4.10.2 KW&SB, if required, shall also liaise with the Competent Authorities to ensure that the Settlements are delivered water from the KWC in accordance with the requirements of each Settlement.

4.10.3 KW&SB shall develop and implement in coordination with the Company a stakeholder engagement plan (the **"Stakeholder Engagement Plan"**) in compliance with the Legal Requirements and the E&S Standards and accounting for all consultations and engagements conducted pursuant to clauses 4.10.1 and 4.10.2. The Stakeholder Engagement Plan shall include the Grievance Redress Mechanism developed in accordance with clause 25.5.1.2.

4.11 Employee Redeployment Plan

4.11.1 KW&SB shall develop an employee redeployment plan prior to the Mobilisation Date in compliance with the Legal Requirements, including the E&S Standards, to manage the redeployment of its employees (the **"Employee Redeployment Plan"**).

4.11.2 The Employee Redeployment Plan shall include:

4.11.2.1 details of the number of staff to be redeployed within the GoS and the conditions for their redeployment;

4.11.2.2 documentation of the selection process for alternative projects;

4.11.2.3 timely consultation measures amongst KW&SB, its employees and their representatives to communicate the details of the redeployment and the alternative measures available to the employees in lieu of such redeployment; and

4.11.2.4 documentation of compliance with all Legal Requirements in terms of notice of dismissal, severance payments, payment of outstanding back pays and social security, pension benefits and contributions and other relevant considerations.

4.12 Temporary Land

4.12.1 The Company shall procure and use any temporary land identified by the Environmental and Social Impact Assessment as required by the Company for the Project Activities.

4.12.2 The procurement or use of any land in terms of clause 4.12.1 shall be subject to an Environmental and Social Impact Assessment conducted for such land and compliance with the Environmental and Social Requirements, including IFC Performance Standard 5.

4.13 Settlement Water Access

4.13.1 KW&SB will ensure that Settlements have continued access to water from the KWC through planning, construction, and operation.

4.13.2 KW&SB will be responsible for determining Settlement water requirements, with an assessment to be conducted every five (5) years (from the Commencement Date) to confirm whether supply levels are sufficient to meet Settlement needs.

5. SITE

5.1 Access

If the Company (or its Contractors) require access to the Site prior to execution of the License Agreement, for the purposes of conducting preliminary activities such as investigations of the geotechnical or hydrological conditions of the Site, KW&SB will support the Company in granting such access. If agreed, such access will be granted to the Company (or its Contractors) on the terms and conditions to be agreed and recorded in writing between the Company and KW&SB. If and when such access is granted, the indemnities set out in clause 23 shall become fully effective in respect of the access to and activity on the Site.

5.2 License Agreement

With effect from the Mobilisation Date, KW&SB shall procure that the Site is made available to the Company upon and subject to the terms of the License Agreement.

5.3 Access for GoS Parties and their Designees

The Company shall permit, and shall procure that its Contractors permit the GoS Parties, the Independent Appointees, and the GoS or KW&SB representatives and designees to enter upon the Site at any time:

5.3.1 to monitor, sample, or otherwise investigate the nature and volume of discharges or other emissions from the KWC;

5.3.2 to ensure that any interconnection to any utility system is not adversely affecting or will not adversely affect such system;

5.3.3 in response to a fire, explosion or any other like event at the Site, to preserve the safety or health of persons, materials or equipment at the KWC, or elsewhere on the Site;

5.3.4 to permit the GoS Parties, as may be required, to exercise their rights and comply with their obligations under this Agreement and the other Relevant Agreements;

5.3.5 to permit KW&SB to comply with any applicable Legal Requirements; or

5.3.6 in connection with an Archaeological Delay Event, for the purposes of liaising with any Competent Authority in connection with the removal of Archaeological Items from the Site.

5.4 Exercise of Access Rights

In exercising the right of access under clause 5.3, each GoS Party shall cause its representatives and designees to comply with all applicable Legal Requirements and the reasonable directions of the Company. Each GoS Party shall exercise its access rights for the purposes specified in clause 5.3 in a manner that does not interfere with, or increase the cost of, the Company's

activities on the Site and shall adhere to the reasonable safety rules and procedures of the Company that are consistent with Good International Industry Practices.

5.5 Access Routes and Transportation

5.5.1 The Company shall be responsible for the selection and usage of all transportation means, transportation routes, roads, bridges, highways and routes to and from the Site in respect of performance of its obligations under this Agreement, and the GoS Parties shall not be responsible for any claims attributable to Company in respect of the same.

5.5.2 The Company shall be responsible for obtaining and maintaining all necessary Approvals required for usage of routes and transportation means as contemplated in clause 5.5.1.

5.5.3 The Company shall at all times ensure that the access roads are adequate and suitable for the Project Activities and should be maintained in accordance with the Legal Requirements and in consultation with the Competent Authorities, each at the cost of the Company.

5.5.4 The Company shall develop and implement a plan, as part of the Environmental and Social Management System, to ensure the safe movement of traffic during the Project Activities, and to allow the Settlements safe access for crossing of KWC, as outlined in part 2 of appendix 12 (the **"Traffic and Pedestrian Safety Plan"**).

5.6 Site Risks

5.6.1 KW&SB has made available to the Company the information in KW&SB's possession in connection with the Site and the KWC as set out in appendix 1 (the **"Site Information"**).

5.6.2 The Company shall be deemed to have obtained all necessary information as to the risks, contingencies and other circumstances which may influence or affect the implementation of the Project at the Site.

5.6.3 The Company shall also be deemed to have inspected and examined the Site and its surroundings, analysed and verified the accuracy and reliability of the Site Information and to have satisfied itself as to all the relevant matters including:

5.6.3.1 the nature of the Site, including the subsurface, hydrological, climatic and general physical conditions of the Site;

5.6.3.2 the suitability of the Site for undertaking the Project Activities;

5.6.3.3 the extent, nature and availability of labour, material, transport, accommodation, storage facilities and other facilities and resources necessary to undertake the Project;

5.6.3.4 the nature of design, construction work and operations and maintenance services necessary for the performance of its obligations under this Agreement;

5.6.3.5 the Legal Requirements for undertaking the Project;

5.6.3.6 the risk of injury or damage to the Adjoining Property and to the occupiers thereof or any other risk;

5.6.3.7 the suitability and adequacy of any access roads to the Site and other utilities and facilities to be provided by the relevant Competent Authority; and

5.6.3.8 all other matters that may affect the performance of its obligations under this Agreement.

The Company acknowledges and agrees that except as otherwise provided in this Agreement, if any error or discrepancy is subsequently discovered in the data, including the Site Information, made available by KW&SB or any other person on its behalf, then, such error or discrepancy shall not entitle the Company to any change in the Implementation Schedule, and/or compensation for Increased Costs or any other costs it may incur. Further, any misinterpretation of the data, studies and reports provided by KW&SB or any other person on its behalf shall not relieve the Company from the performance of its obligations under this Agreement.

5.7 Disclaimer

5.7.1 The Company acknowledges that it has, after a complete and careful examination, made an independent evaluation of the RFP, the scope of the Project, this Agreement, the Site, the Site Information, existing structures, local conditions and all information provided by KW&SB (or any other person on its behalf) or obtained, procured or gathered otherwise and has determined to its satisfaction the accuracy or otherwise thereof and the nature and extent of difficulties, risks and hazards as are likely to arise or may be faced by it in the course of performance of its obligations hereunder. The GoS Parties make no representations whatsoever, express, implicit or otherwise, regarding the accuracy, adequacy, correctness, reliability and/or completeness of any assessment, assumptions, statement or information provided by either GoS Party and the Company confirms that it shall have no claim whatsoever against either GoS Party in this regard.

5.7.2 The Company acknowledges and hereby accepts the risk of any inadequacy, mistake or error in or relating to any of the matters specified in clause 5.7.1 and hereby acknowledges and agrees that the GoS Parties shall not be liable for the same in any manner whatsoever to the Company or any person claiming through or under any of them.

5.7.3 Any mistake or error in or relating to any of the matters specified in clause 5.7.1 shall not vitiate this Agreement or render it voidable.

5.7.4 In the event that either Technical Party becomes aware of any mistake or error relating to any of the matters specified in clause 5.7.1, that Technical Party shall immediately notify the other Technical Party, specifying the mistake or error; provided, however, that a failure on part of KW&SB to give any notice pursuant to this clause 5.7.4 shall not prejudice the disclaimer contained in clause 5.7.1 and shall not in any manner reallocate to the GoS Parties any risks, obligations or liabilities assumed by the Company pursuant to this Agreement.

5.7.5 Except as otherwise provided in this Agreement, all risks relating to the Project shall be borne by the Company and the GoS Parties shall not be liable in any manner for such risks or the consequences thereof.

5.8 Site Security

5.8.1 From the Commencement Date, the Company shall be responsible for making all necessary arrangements to secure the Site, and all persons, and moveable and immoveable properties present at or forming part of the Site.

5.8.2 The KW&SB shall provide reasonable security outside the Site premises during the C&O Period, as and when requested by the Company, provided that the Company makes a written request fifteen (15) Days prior to when the support from KW&SB is required and furnish reasonable details in the request as to the nature, time, and location where such security is to be provided.

5.8.3 The Company shall ensure that employment of direct or contracted workers to provide security for the Site will be undertaken following an assessment of risks posed by its security arrangements to those within and outside the Site.

5.8.4 All security arrangements shall be guided by the principles of proportionality and Good International Industry Practice, including the requirements set out under IFC Performance Standard 4.

6. CONSTRUCTION AND REHABILITATION

6.1 Construction Documents

6.1.1 The Company shall be responsible for preparing the Construction Documents in a manner consistent with the requirements of appendix 1 and other provisions of this Agreement, Good International Industry Practices, the Environmental and Social Requirements and in accordance with any other relevant Legal Requirements.

6.1.2 The Construction Documents shall be prepared in English language.

6.1.3 Within five (5) Months of the Effective Date, the Company shall prepare, and submit to the Independent Engineer (with a copy to the GoS Parties) for its approval, the proposed Detailed Engineering Design and the proposed Construction Drawings (the **"Proposed Construction Documents"**). Within thirty (30) Days of receipt thereof, the Independent Engineer shall review the Proposed Construction Documents, and (following consultation with the GoS Parties), either approve the Proposed Construction Documents or reject the Proposed Construction Documents and convey comments/observations (if any) relating to the same, to the Company, provided, that the Independent Engineer may only refuse to approve the Proposed Construction Documents if the same fail to comply with the requirements of clause 6.1.1.

6.1.4 The Company shall (at its own cost and expense) re-submit the revised Proposed Construction Documents no later than five (5) Days from receipt of the rejection and/or comments/observations under clause 6.1.3, and the approval process under this clause 6.1 shall be repeated until all comments/observations are addressed and the Proposed Construction Documents have been approved.

6.1.5 If any errors, omission, ambiguities, inconsistencies, inadequacies, or other defects are found in the Construction Documents, such Construction Documents and any resultant error in the construction and rehabilitation of KWC shall be corrected at the Company's cost, notwithstanding any consent or approval under this clause 6.1.

6.1.6 Unless the Independent Engineer (after consulting the GoS Parties) permits, the Company shall not commence any construction or rehabilitation activities for the KWC until the Proposed Construction Documents have been approved in terms of this clause 6.1.

6.2 Construction and Rehabilitation of KWC

6.2.1 The Company shall undertake the C&O Activities in accordance with the parameters set out in appendix 1 and appendix 5 such that the KWC is:

6.2.1.1 free from all defects in design, materials, and workmanship;

6.2.1.2 safe, reliable and fit for purpose; and

6.2.1.3 capable of supplying water up to the Contracted Availability.

6.2.2 All obligations of the Company to be undertaken during the C&O Period shall be consistent with the Construction Documents, Good International Industry Practices, Environmental and Social Requirements, and in accordance with any relevant Approvals, the Legal Requirements and the Accounting Principles.

6.2.3 The Company shall rectify any defects and/or deficiencies in the KWC, including any defects and/or deficiencies identified by the Independent Engineer or KW&SB and shall bear all costs of remedying such defects and deficiencies and retesting the relevant part of the KWC and shall not be entitled to any extension of time or additional costs for remedying such defects or deficiencies or for retesting the relevant part of the KWC.

6.2.4 The Company shall ensure that an adequate number of suitably skilled and experienced contractors, architects, workmen and other personnel are engaged to undertake the Project. The Company shall be solely responsible for the work performed by any staff and labour engaged by it to execute the Project and for payment of all applicable labour charges, fees, and cess payable in accordance with the Legal Requirements (including labour welfare legislations). The Company shall ensure that its Contractors provide all necessary amenities and welfare facilities for the staff and labour engaged by them at the Site and comply with all applicable labour laws. The Company shall indemnify and hold harmless the GoS Parties from and against all claims, liabilities, expenses, costs and losses suffered or incurred by each of the GoS Parties due to the Company's or any Contractor's failure to comply with any Legal Requirements (including labour welfare legislations).

6.2.5 The Independent Appointees and KW&SB (and its representatives) shall have the right, at all times, to attend and be present at the Site and to observe the progress of the C&O Activities.

6.3 Change in Scope

6.3.1 Any Party, following the Effective Date, may propose a Change in Scope, provided that, no Party shall propose a Change in Scope which would, if implemented:

6.3.1.1 materially and adversely affect the health and safety of any person;

6.3.1.2 infringe any Legal Requirement;

6.3.1.3 be a departure from Good International Industry Practices;

6.3.1.4 cause any Approval to be revoked or become unobtainable;

6.3.1.5 require a new Approval which will not be obtainable by the Company despite it using all reasonable endeavours; or

6.3.1.6 materially affect the Project Activities in a manner that cannot be compensated for under this Agreement.

6.3.2 Within fifteen (15) Days of receipt of a request for Change in Scope from the GoS Parties, the Company shall submit a proposal to the GoS Parties and the Independent Appointees setting out in sufficient detail the implications of the proposed Change in Scope, including any implications on the Implementation Schedule and the Scheduled Project Commercial Operations Date, any additional costs, including any increase in the Financing Due, incurred in undertaking the Change in Scope, or any Savings resulting from the Change in Scope.

6.3.3 Based on their review of the proposal submitted by the Company, the GoS Parties may, at their sole discretion: (a) accept the proposal and the corresponding adjustment to the Implementation Schedule and/or the additional costs or reduction in the costs for undertaking the Change in Scope; (b) provide comments on the proposal seeking amendments and/or justification for the implications put forth by the Company; or (c) reject the proposal submitted by the Company and withdraw the proposed Change in Scope, within fifteen (15) days from the date of receipt of the Company's proposal under clause 6.3.2.

6.3.4 To the extent the GoS Parties or the Independent Appointees seek amendments and/or justification in the proposal submitted by the Company, the Company shall incorporate or address, in writing, such comments and submit a revised proposal.

6.3.5 On approval of the proposal or the revised proposal, as the case may be, by the GoS Parties, the GoS Parties shall issue a Change in Scope Order and the Company shall proceed with the Change in Scope in accordance with the Change in Scope Order.

6.3.6 If the Parties are unable to agree on the implications of a Change in Scope proposed by the GoS Parties, which in the GoS Parties' view is necessary or desirable for the Project, as determined by the Independent Appointees, the GoS Parties shall have the right to require the Company to carry out the proposed Change in Scope at the cost determined by the Independent Appointees. Any Dispute on the terms of the Change in Scope (including the method of payment and funding or application of Savings or reductions) will be resolved in accordance with clause 27.

6.3.7 On implementation of a Change in Scope Order, the Company shall be entitled to the agreed adjustment to the Implementation Schedule and the Scheduled Project Commercial Operations Date, payment of additional amounts, and/or any adjustment to the permissible Financing Due, if any, set out in the Change in Scope Order. The economic benefit of any reduction or Savings in the cost arising from a Change in Scope shall be shared by the Commercial Parties in the ratio and manner agreed by the Commercial Parties.

6.3.8 The method of payment for and funding of any additional costs that become payable by the GoS or the application of reduction or Savings in the costs, in relation to a Change in Scope Order, shall be agreed by the Commercial Parties and included in the Change in Scope Order.

6.3.9 If, after the Effective Date, the Company wishes to effect any Change in Scope, the Company shall obtain the prior written approval of the GoS Parties, such approval not to be unreasonably withheld or delayed. On approval by the GoS Parties, the GoS Parties shall issue a Change in Scope Order and the Company shall proceed with the Change in Scope in accordance with the Change in Scope Order. Any such change will be effected at the Company's own risk and cost.

6.3.10 Notwithstanding anything to the contrary in this clause 6.3, the Company shall be bound to implement any Change in Scope that is necessitated by a Change in Law and any consequent adjustment to the Implementation Schedule, and Increased Costs or Savings shall be determined in accordance with clause 20.

6.3.11 No Change in Scope shall invalidate this Agreement.

6.4 Drawings, Test Results, Documentation

6.4.1 The Company shall obtain and maintain at the Site in an orderly manner and in accordance with the Operating and Maintenance Procedures and Good International Industry Practices, complete and up to date copies of all:

6.4.1.1 operation and maintenance manuals and other technical documentation (including electronic files) for all items of equipment incorporated into the KWC as identified in appendix 1;

6.4.1.2 test results (including electronic files) for tests performed on the KWC in accordance with:

(a) this Agreement;

(b) the EPC Contract; and

(c) the O&M Contract,

6.4.1.3 as-built drawings (including electronic files) for the KWC, including for the civil and architectural works; and

6.4.1.4 detailed technical documents (including electronic files) related to the design, engineering, construction, rehabilitation, operation and maintenance of the KWC.

7. IMPLEMENTATION SCHEDULE AND DELAYS

7.1 Compliance with Implementation Schedule

The Company shall achieve the timely implementation of the Project in accordance with the Implementation Schedule. The Company shall promptly inform the Independent Appointees and each of the GoS Parties of any actual or anticipated material deviations from the dates stipulated in the Implementation Schedule. Without prejudice to the Parties' rights and obligations under clauses 7.2, 7.3 or 7.4, as the case may be, the Company shall provide the Independent Appointees and each GoS Party with a remedial programme setting out the actions to be taken by the Company to mitigate the adverse effect of any such deviation on its ability to undertake the Project in accordance with the Implementation Schedule.

7.2 Adjustment of Implementation Schedule

7.2.1 If a Relief Event causes a delay that has, or is reasonably likely to have, the effect of delaying the achievement of the Commencement Date by the Scheduled Commencement Date or the Project Commercial Operations Date by the Scheduled Project Commercial Operations Date (as applicable), then, subject to clause 7.2.2, the Scheduled Commencement Date or the Scheduled Project Commercial Operations Date (as applicable) and the Implementation Schedule shall be adjusted equitably by the Independent Engineer to take into account the ability of the Company to re-schedule its activities to minimise the delay and the effect of such Relief Event on the ability of the Company to achieve the relevant milestone by the respective scheduled date, provided that such scheduled date shall not be extended to the extent that such delay would have nevertheless been experienced had such Relief Event not occurred.

7.2.2 The Company must notify the Independent Appointees and the GoS Parties in writing promptly (and in any event within fourteen (14) Days) after becoming aware of the occurrence of a Relief Event, and together with such notice or as soon as possible (and in any event within fourteen (14) Days) following such notice), the Company shall provide full details of the Relief Event and its consequences including sufficient details to confirm the existence of a Relief Event and its impact on the Scheduled Commencement Date or the Scheduled Project Commercial Operations Date (as applicable) and the Implementation Schedule. As soon as practicable (and in any event within fourteen (14) Days after receiving the Company's detailed information and justification), the Independent Appointees shall confirm whether (and to what extent) they agree to adjust the Scheduled Commencement Date or the Scheduled Project Commercial Operations Date (as applicable) and the Implementation Schedule.

7.2.3 If the Company does not deliver the notices as required by clause 7.2.2 in accordance with the terms thereof, the Company shall not be entitled to invoke the benefits of clause 7.2.1 or deemed commissioning under clause 8.4 in respect of the relevant Relief Event.

7.2.4 If a Force Majeure Event causes a delay that has, or is reasonably likely to have, the effect of delaying:

7.2.4.1 the achievement of the Commencement Date, then the provisions of clause 3.6 shall apply; or

7.2.4.2 the achievement of the Project Commercial Operations Date, then the provisions of clause 19.7 shall apply.

7.3 Company Liquidated Damages for Delay

7.3.1 The Company acknowledges that the GoS Parties will each suffer actual damages if, for any reason not otherwise excused under this Agreement, the Company fails to achieve the Project Commercial Operations Date by the Scheduled Project Commercial Operations Date. In that event, and without prejudice to the GoS Parties' rights under clause 21, the Company shall pay liquidated damages to the GoS for each Day (or any part thereof) of delay at a rate of Pakistani Rupees five million only (PKR 5,000,000/-) per Day, for each Day of delay, commencing from the Scheduled Project Commercial Operations Date until the earlier of:

7.3.1.1 the Project Commercial Operations Date; and

7.3.1.2 the Long Stop Date.

7.3.2 Any liquidated damages payable pursuant to this clause 7.3 shall be paid by the Company within fifteen (15) Days of the date of the Company's receipt of an invoice from GoS setting out the amount of liquidated damages which are then due and payable by the Company. If the Company fails to pay such liquidated damages when due, the GoS shall be entitled to claim such amounts under the C&O Performance Security, plus interest at the Late Payment Rate, accruing from the due date of such payment until the GoS is actually paid such amounts. To the extent that the Company's liability for liquidated damages under clause 7.3.1 exceeds the then current balance of the C&O Performance Security, the GoS shall be entitled to take steps to recover such amounts (plus any applicable interest) as a debt due from the Company to GoS (including by way of set-off against any amounts due to the Company from GoS or KW&SB) under any Relevant Agreement.

7.3.3 In addition, if the Company fails to achieve the Scheduled Project Commercial Operations Date by the Long Stop Date, the GoS shall be entitled to encash the C&O Performance Security up to the face amount.

7.3.4 The Parties agree that:

7.3.4.1 the delay liquidated damages payable pursuant to this clause 7.3 represent the actual losses, liabilities, damages, costs, charges or expenses that the GoS Parties will suffer as a result of the failure of the Company to achieve the Project Commercial Operations Date by the Scheduled Project Commercial Operations Date;

7.3.4.2 there is, in any event, a commercial justification and legitimate interest in imposing such liquidated damages as a payment for the failure of the Company to achieve the Project Commercial Operations Date by the Scheduled Project Commercial Operations Date which would not be satisfied by a right to recover damages on an unliquidated basis for such default; and

7.3.4.3 the payment or deduction of delay liquidated damages payable pursuant to this clause 7.3 shall not relieve the Company from its obligations to complete the

C&O Activities, or from any of its other duties, obligations, or responsibilities under this Agreement. The Company shall use and continue to use its best endeavours to avoid or reduce further delay in completing the C&O Activities.

7.4 Company Liquidated Damages for Abandonment

7.4.1 If Abandonment occurs, in addition to any rights or remedies that the GoS may have pursuant to clause 21, the Company shall pay to the GoS as liquidated damages the following amount:

7.4.1.1 in case of Abandonment prior to the Project Commercial Operations Date, an amount equal to the face amount of the C&O Performance Security as at the date Abandonment occurs, after any amounts paid or payable under clause 7.3 have been paid; and

7.4.1.2 in case of Abandonment on or following to the Project Commercial Operations Date, an amount equal to the face amount of the O&M Performance Security as at the date Abandonment occurs.

7.4.2 Any liquidated damages payable pursuant to this clause 7.4 shall be paid by the Company within fifteen (15) Days of the date of the Company's receipt of an invoice from the GoS setting out the amount of liquidated damages which are then due and payable by the Company. If the Company fails to pay such liquidated damages when due, the GoS shall be entitled to claim such amounts under the Performance Securities or to take steps to recover such amounts as a debt due from the Company to the GoS, plus interest at the Late Payment Rate, accruing from the due date of such payment until the GoS is actually paid such amounts. To the extent that the Company's liability for liquidated damages under clause 7.4.1 exceeds the face amount of the Performance Securities, at the date of issue of a demand thereunder, the GoS shall be entitled to take steps to recover such amounts (plus any applicable interest) as a debt due from the Company to GoS (including by way of set-off against any amounts due to the Company from GoS or KW&SB) under any Relevant Agreement.

7.4.3 The Parties agree that:

7.4.3.1 the liquidated damages payable pursuant to this clause 7.4 represent the actual losses, liabilities, damages, costs, charges or expenses that the GoS Parties will suffer as a result of Abandonment by the Company; and

7.4.3.2 there is in any event a commercial justification and legitimate interest in imposing such liquidated damages as a payment for Abandonment by the Company which would not be satisfied by a right to recover damages on an unliquidated basis for such default.

7.5 General Damages

7.5.1 If either of clauses 7.3.1 or 7.4.1 is found for any reason to be void, invalid or otherwise inoperative so as to disentitle GoS from claiming liquidated damages under such clause(s), the GoS is entitled to claim against the Company for general damages at law for the Company's failure to achieve the Project Commercial Operations Date by the Scheduled Project Commercial Operations Date or for Abandonment, subject to the

limitation that such damages must not exceed the amounts set out in clause 7.3.1 for any Day of delay or clause 7.4.1 for Abandonment, as the case may be.

8. MOBILISATION, START-UP AND COMMERCIAL OPERATION

8.1 Test Procedures

8.1.1 The Company shall be responsible for the development and implementation of detailed testing procedures for each test during the mobilisation, construction, rehabilitation, inspection, start-up and commissioning, including performance testing, reliability testing and capacity demonstration, of the KWC, in accordance with appendix 5 (the **"Test Procedures"**) and shall notify the Independent Appointees and each GoS Party in advance of all such testing and carry out all Test Procedures in accordance with appendix 5.

8.1.2 The Independent Appointees and designees of each GoS Party shall be entitled to be present at any such testing as provided in appendix 5.

8.2 Issuance of Mobilisation Testing Acceptance Certificate

8.2.1 The Company shall carry out the Mobilisation Testing in accordance with the procedure set out in appendix 5. The Mobilisation Testing Acceptance Certificate shall be issued by the Independent Engineer in accordance with the procedure set out in appendix 5.

8.2.2 During any testing conducted pursuant to this clause 8.2, upon at least three (3) Days' prior notice by the Company, KW&SB shall arrange for such quantity of water to be delivered at each Input Water Connection Point to allow the Company to be able to conduct such tests (as determined by the Independent Engineer). If, despite compliance with the foregoing, KW&SB fails to deliver water as foresaid, in accordance with the Test Procedures and appendices 1 and 5, and such failure causes a delay in achieving the Commencement Date by the Scheduled Commencement Date, the provisions of clause 7.2.1 shall apply mutatis mutandis.

8.3 Project Commercial Operations Testing

8.3.1 The commercial operations date for the KWC (the **"Project Commercial Operations Date"**) shall occur on the Day following the date on which the Independent Engineer issues to the Company the Project Commercial Operations Certificate, in accordance with the procedure set out in appendix 5.

8.3.2 During any testing conducted pursuant to this clause 8.3, upon at least three (3) Days' prior notice by the Company, KW&SB shall arrange for such quantity of water to be delivered at each Input Water Connection Point to allow the Company to be able to conduct such tests (as determined by the Independent Engineer). If, despite compliance with the foregoing, KW&SB fails to deliver water as foresaid, in accordance with the Test Procedures and appendices 1 and 5, and such failure causes a delay in achieving the Project Commercial Operation Date by the Scheduled Project Commercial Operation Date, the provisions of clause 7.2.1 and clause 8.4 shall apply mutatis mutandis.

8.4 Deemed Project Commercial Operations Date

8.4.1 If, due to a Relief Event or a Political Force Majeure Event (each a **"Deemed Commissioning Event"**), the Company is unable to conduct or conclude Project Commercial Operations Testing for the KWC on the date selected therefor in accordance with appendix 5, then provided that the Company shall have made all reasonable efforts, as determined by the Independent Engineer, to prevent and/or mitigate the effect of such Deemed Commissioning Event, on and from the date on which the Company would have been able to achieve the Project Commercial Operations Date but for such event until the date the Project Commercial Operations Date is actually achieved:

8.4.1.1 subject to clause 8.4.2, the Project Commercial Operations Date shall be deemed to have been achieved; and

8.4.1.2 the KWC shall be deemed to be providing water equivalent to Contracted Availability (subject to deduction for Outages determined by the Independent Appointees) and GoS shall compensate the Company for the consideration set out in appendix 8 for such deemed Contracted Availability.

8.4.2 If the Project Commercial Operations Date shall have been deemed to be achieved pursuant to clause 8.4.1, and thereafter:

8.4.2.1 when the Test Procedures are conducted in accordance with appendix 5, the KWC does not attain the minimum criteria required under appendix 5 for the achievement of the Project Commercial Operations Date, then:

(a) the KWC shall cease to be deemed commissioned and (if the Scheduled Project Commercial Operations Date has passed) the Company shall be in breach of its obligation to achieve the Project Commercial Operations Date by the Scheduled Project Commercial Operations Date and, if the Long Stop Date has passed, clause 21.5.1 shall also apply;

(b) the GoS shall have no further obligation to make payments under clause 8.4.1.2;

(c) the Company shall be obliged to repay the GoS the Availability Payments paid by GoS under clause 8.4.1.2 together with commission accrued thereon at the Late Payment Rate, and the GoS shall have the right to deduct such amounts from future payments to be made pursuant to appendix 8 in the immediately following Billing Period(s) until the full amount shall have been deducted, or recover such amounts from the C&O Performance Security or the O&M Performance Security ; and

(d) the GoS shall have the right to pursue any other remedy available to it under this Agreement or under the Law.

8.4.3 The Parties shall undertake all reasonable measures to ensure that any Project Commercial Operations Testing that is delayed due to any of the circumstances

described in clause 8.4.1 shall be undertaken as soon as possible after the circumstances that resulted in such delay are no longer in effect.

8.4.4 The Company shall not be entitled to the benefit of clause 8.4.1 where, and to the extent that a Deemed Commissioning Event, results (in whole or in part) from a delay or default by the Company or the Sponsors or is concurrent with a delay or default by the Company or the Sponsors of an obligation of the Company or the Sponsor under any Project Agreement.

9. ELECTRICITY AND OTHER UTILITIES

9.1 Utilities

9.1.1 The Company shall be responsible for:

9.1.1.1 procuring, at its risk and cost, all electricity and other utilities and any fuel required for (a) the Project Activities; and (b) the reinstatement of the Site in accordance with the Handover Conditions following the Final Expiry Date in accordance with clause 21.10; and

9.1.1.2 coordinating with the relevant utility provider to relocate any utility infrastructure under or over the Site, and the cost of such relocation shall be borne by the Company.

9.1.2 Electricity required for the operation and maintenance of the KWC shall either be procured from the Electricity Supplier or generated by the Solar Plant. Electricity shall not be procured or generated from any other source.

9.1.3 During the Concession Period, the Company shall be responsible for securing all supplies of telecommunication and all waste disposal services required for the Project, either from its own resources or from the applicable authorities at published tariffs and in accordance with the standard terms and conditions of supply and pay for such supplies in accordance with such terms and conditions.

9.1.4 KW&SB will use its best endeavours to assist the Company in the relocation of existing utilities required for the Project, at the risk and cost of the Company.

9.2 Actual Electricity Consumption

9.2.1 The Company shall provide access to the Independent Engineer and KW&SB from time to time to inspect the electricity meters installed to measure the supply of Electricity to the KWC and to read or attend any reading of such meters. The Company shall supply details of all readings of such meters within two (2) Business Days after such readings are carried out.

9.2.2 The Company shall procure that the Independent Engineer and KW&SB are notified of and invited to attend any reading of the electricity meters.

9.2.3 The Company shall take all reasonable commercial measures to ensure that the Electricity supplied to the KWC is accurately measured and shall, if so required by the Independent Engineer or KW&SB, exercise any rights in order to achieve the foregoing.

9.3 Electricity Price

The Company shall notify the Independent Appointees and each GoS Party as soon as possible (and in any event within seven (7) Days) after it becomes aware of any change in the Electricity Price and shall provide the Independent Appointees and each GoS Party with full details of the change and the dates when it became or will become effective.

10. OPERATION AND MAINTENANCE

10.1 O&M Obligations

The Company shall:

10.1.1 ensure that the KWC is, at all times, capable of transmitting the Contracted Availability to the Output Water Connection Point;

10.1.2 carry out all O&M Activities in a manner consistent with this Agreement, Good International Industry Practices, Environmental and Social Requirements, and in accordance with any relevant Approvals, applicable Legal Requirements, Accounting Principles, and the Operating and Maintenance Procedures;

10.1.3 employ in and at the KWC all safety devices and safety practices required by applicable Legal Requirements, the requirements of appendix 1, all Insurance Policies, and Good International Industry Practices;

10.1.4 undertake the Project Activities in accordance with the parameters set out in appendix 1 and appendix 5 such that the KWC is:

10.1.4.1 free from all defects in design, materials, and workmanship;

10.1.4.2 safe, reliable and fit for purpose; and

10.1.4.3 capable of supplying water up to its Contracted Availability;

10.1.5 operate and maintain the KWC so as to prevent the release or leaching of any Hazardous Substances affecting the Site or surrounding environs (including the soil, subsoil, surface water, or groundwater);

10.1.6 as soon as reasonably practicable, inform the GoS Parties of any instances of fire, explosion or any other like event at the Site;

10.1.7 to the extent consistent with Good International Industry Practice, keep accurate and up to date records of any accidents or other occurrences at the Site that result in injury to persons or damage to property for a minimum period of ten (10) years from the occurrence of such event, and shall provide to the Independent Engineer and KW&SB reasonable access to such records, subject to requirements of confidentiality;

10.1.8 ensure that its personnel are on duty at the KWC at all times (twenty-four (24) hours a Day and seven (7) Days a week) during the Concession Period;

10.1.9 promptly provide KW&SB with accurate Unavailability Notice(s), by 11:00 am on the Day prior to Planned Outages or Unplanned Outages, and issue superseding

Unavailability Notice(s) as soon as it is known that a previously issued Unavailability Notice(s) must be updated;

10.1.10 if and when requested by KW&SB in exceptional circumstances, use its best endeavours to deliver water in excess of the Contracted Availability; and

10.1.11 ensure that the debt-to-equity ratio of the Company (as determined on the basis of Accounting Principles and confirmed by the Independent Auditor) shall not exceed 80:20.

10.2 Co-ordination

The Company shall:

10.2.1 promptly inform the Independent Appointees and each GoS Party of any material issues with the KWC;

10.2.2 where required by the Independent Appointees and KW&SB, promptly and in any event within ten (10) days after being so requested, submit a remediation programme setting out the actions to be taken by the Company to mitigate the adverse effect of any material issues notified in accordance with clause 10.2.1 and abide by such remediation programme once instructed by the Independent Appointees and KW&SB, provided that the submission of any remediation programme and instructions issued by the Independent Appointees and KW&SB shall in no way relieve the Company of any liability that would have otherwise accrued;

10.2.3 maintain operating communications between the KWC and KW&SB in accordance with the Operating and Maintenance Procedures; and

10.2.4 keep a daily operations log for the KWC, which shall include information known to it on the KWC, and any outages or de-ratings, and circuit breaker trip operations requiring a manual reset, and any significant events related to the foregoing. The Independent Engineer and KW&SB shall have the right to review logs not in their possession at all reasonable times and upon reasonable notice to the Company.

10.3 Operating and Maintenance Procedures

10.3.1 The Company shall, at its own costs and expense, develop written operating and maintenance procedures for the KWC in accordance with this clause 10.3 (the **"Operating and Maintenance Procedures"**).

10.3.2 The Operating and Maintenance Procedures shall:

10.3.2.1 be based on the design parameters of the KWC and other requirements specified in appendix 1;

10.3.2.2 incorporate Operating and Maintenance Procedures specified or recommended by the KWC equipment suppliers and manufacturers in their operators' manuals;

10.3.2.3 provide a comprehensive procedure for sampling and testing of water at specified locations along the KWC by third-party laboratories (as approved by the GoS in consultation with the Independent Engineer);

10.3.2.4 provide for coordination with KW&SB for release of water from the KIII Conduit;

10.3.2.5 be consistent with Good International Industry Practice; and

10.3.2.6 provide comprehensive procedures for all operational interfaces between (i) KW&SB, the Pakistan Water and Power Development Authority, and (ii) the Company, including in relation to the delivery of Electricity prior and subsequent to the Project Commercial Operations Date.

10.3.3 The Company shall submit a draft of the Operating and Maintenance Procedures to the Independent Engineer and KW&SB no later than sixty (60) Days prior to the Scheduled Commencement Date and no later than ninety (90) Days prior to the Scheduled Project Commercial Operations Date.

10.3.4 Within sixty (60) Days after its receipt thereof, the Independent Engineer and KW&SB shall have the right to provide comments on the draft Operating and Maintenance Procedures.

10.3.5 If, within such sixty (60) Day period, the Independent Engineer and KW&SB do not provide any comments, the draft proposed by the Company shall become the Operating and Maintenance Procedures.

10.3.6 If the Independent Engineer or KW&SB provide comments on the draft Operating and Maintenance Procedures within such sixty (60) Day period, the Company shall, within thirty (30) Days of its receipt of such comments, either incorporate the requested changes to the draft Operating and Maintenance Procedures or request a meeting with the Independent Engineer or KW&SB to discuss any outstanding requested changes. Any Dispute over the requested changes still not resolved within ten (10) Days following any such meeting shall be referred for resolution pursuant to clause 27.

10.3.7 The Company acknowledges and agrees that no review or approval by the Independent Engineer or KW&SB of the Operating and Maintenance Procedures shall relieve the Company from any liability it would otherwise have under this Agreement, and that neither the Independent Engineer nor the GoS Parties nor any of their representatives shall be liable to the Company or any other person by reason of their review or approval of the Operating and Maintenance Procedures.

10.4 Scheduled Maintenance

10.4.1 The Company shall undertake all scheduled KWC maintenance in accordance with this Agreement, Good International Industry Practice, Environmental and Social Requirements, and in accordance with any relevant Approvals, applicable Legal Requirements, Accounting Principles, Operating and Maintenance Procedures, and the maintenance appendices (each, a **"Maintenance Schedule"**) developed pursuant to this clause 10.4.

10.4.2 The Company shall submit to the Independent Engineer and KW&SB the proposed Maintenance Schedule for the KWC at least forty-five (45) Days prior to:

10.4.2.1 the Scheduled Commencement Date, in respect of the first Contract Year; and

10.4.2.2 the commencement of each subsequent Contract Year, in respect of such Contract Year,

in each case, setting out:

(a) its Planned Outages; and

(b) a forecast of the Net Water Output that could be delivered to the Output Water Connection Point on each Day in the forthcoming Contract Year.

10.4.3 The Company shall:

10.4.3.1 plan its Maintenance Schedule so as to minimise interruptions of the supply of Net Water Output; and

10.4.3.2 not undertake scheduled KWC maintenance resulting in an outage of the KWC during the Summer Period.

10.4.4 Within thirty (30) Days of receipt of the proposed Maintenance Schedule, the Independent Engineer and KW&SB shall notify the Company whether the proposed Maintenance Schedule is acceptable.

10.4.5 If Independent Engineer and KW&SB do not, within such thirty (30) Day period, accept the proposed Maintenance Schedule in whole or in part, the Independent Engineer and KW&SB shall advise the Company of a period or periods when the maintenance can be rescheduled, provided that the Independent Engineer and KW&SB shall seek to make such rescheduled period or periods as close as reasonably practicable to the Maintenance Schedule proposed by the Company and, provided further, that the rescheduled period or periods shall be of equal duration to the period or periods proposed by the Company. In the event that the Independent Engineer and KW&SB fail to provide such advice within the time period stipulated in this clause 10.4, KW&SB shall be deemed to have accepted the proposed Maintenance Schedule.

10.4.6 With respect to each Planned Outage, the Company shall (in addition to the requirement to issue an Unavailability Notice pursuant to clause 10.1.9):

10.4.6.1 confirm ninety (90) Days; and

10.4.6.2 reconfirm thirty (30) Days,

prior to the planned date for such outage.

10.4.7 KW&SB may, upon sixty (60) Days prior written notice, request the Company to re-schedule a Planned Outage and the Company shall use its best efforts to accommodate such requested rescheduling. The Company shall notify KW&SB within fifteen (15)

Days of its receipt of a request for rescheduling of a Planned Outage whether the Company is able to comply with such request.

10.4.8 If the Company is unable to comply with the request for rescheduling of a Planned Outage, it shall provide KW&SB with the reasons therefor and provide alternative periods in which the Planned Outage may be rescheduled. In such event, KW&SB shall advise the Company whether it would prefer that the Planned Outage occur on the initial date or on a rescheduled date.

10.4.9 The Company shall, within thirty (30) Days of the end of each Planned Outage, provide to KW&SB a report detailing the activities carried out during the Planned Outage and the results for any tests carried out during such Planned Outage.

10.5 Maintenance during Unplanned Outages

10.5.1 The Company, during any Unplanned Outage, shall undertake KWC maintenance in a manner consistent with this Agreement, Good International Industry Practices, Environmental and Social Requirements, and in accordance with any relevant Approvals, applicable Legal Requirements, Accounting Principles, and Operating and Maintenance Procedures.

10.5.2 The Company shall (in addition to the requirement to issue an Unavailability Notice pursuant to clause 10.1.9), promptly inform the Independent Engineer and KW&SB of the need for any Unplanned Outage as soon as it becomes aware thereof, detailing the reason for the Unplanned Outage and each component of the KWC that is affected, and submit to the Independent Engineer (with a copy to KW&SB) a program detailing:

10.5.2.1 the start date and duration of the Unplanned Outage; and

10.5.2.2 the activities, and tests (if any) to be carried out during the Unplanned Outage (the **"Unplanned Outage Maintenance Program"**).

10.5.3 The Independent Engineer, keeping in consideration the scheduled start date for the Unplanned Outage, as soon as reasonably practicable:

10.5.3.1 shall notify the Company whether the Unplanned Outage Maintenance Program is acceptable; or

10.5.3.2 may prescribe changes to the Unplanned Outage Maintenance Program.

10.5.4 If the Independent Engineer prescribes any changes to the Unplanned Outage Maintenance Program under clause 10.5.3.2, the Company shall be obligated to carry out the KWC maintenance during the Unplanned Outage in accordance with the changes prescribed.

10.5.5 In preparation of the Unplanned Outage Maintenance Program and the execution of the maintenance works during the Unplanned Outage, the Company shall endeavour to reduce the duration of the Unplanned Outage and the costs associated with the maintenance works, to the extent possible, without adversely impacting the integrity of the maintenance works.

10.5.6 The Company shall, within thirty (30) Days of the end of each Unplanned Outage, provide to KW&SB a report detailing the activities carried out during the Unplanned Outage and the results for any tests carried out during such Unplanned Outage.

10.6 Test Procedures – Post Project Commercial Operations Date

The Company and KW&SB shall develop and implement the Test Procedures for testing the KWC after the Project Commercial Operations Date in accordance with the requirements of appendix 5.

10.7 Reservoir

The Company undertakes to provide water from the Reservoir that meets the Output Water Quality Specifications for up to three (3) hours in any day to be used as back-up in the event of non-supply of water from the Head Regulator or K-III.

11. SALE AND PURCHASE

11.1 Contracted Availability and Output

11.1.1 During the C&O Period, in consideration of the Company undertaking the operation and maintenance activities and delivering the Net Water Output to KW&SB, the GoS shall make payments in accordance with appendix 8.

11.1.2 During the Operating Period, in consideration of the Company:

11.1.2.1 maintaining the Contracted Availability;

11.1.2.2 delivering the Net Water Output to KW&SB; and

11.1.2.3 performing the O&M Activities,

the GoS shall make payments in accordance with appendix 8.

11.2 Risk of Loss

The risk of loss on any Net Water Output shall pass from the Company to KW&SB, at the Output Water Connection Point.

11.3 Effect of Relief Event

Subject to clause 11.4, if a Relief Event:

11.3.1 affects the ability of the Company to meet the Contracted Availability, the GoS shall, for the RE Period, continue to pay:

11.3.1.1 during the Operating Period, the Availability Payments in respect of the Deemed Availability (without applying the Deduction for Reduced Water Availability); and

11.3.1.2 during the Concession Period, the Output Payments in respect of the Net Water Output; or

11.3.2 does not affect the ability of the Company to meet the Contracted Availability, but affects the ability of the Company to deliver Net Water Output, the GoS shall, for the RE Period, continue to pay:

11.3.2.1 during the Operating Period, the Availability Payments; and

11.3.2.2 during the Concession Period, the Output Payments in respect of the Net Water Output.

11.4 Notice of Relief Event

11.4.1 If a Relief Event occurs after the Commencement Date, the Company must notify the Independent Appointees and the GoS Parties in writing promptly (and in any event within fourteen (14) Days) after becoming aware of the occurrence of a Relief Event. Together with such notice or as soon as possible (and in any event within fourteen (14) Days) following such notice, the Company shall provide full details of the Relief Event and its consequences including sufficient details to confirm the existence of a Relief Event and its impact on the ability of the Company to meet the Contracted Availability or deliver Net Water Output.

11.4.2 As soon as practicable (and in any event within fourteen (14) Days after receiving the Company's detailed information and justification) pursuant to clause 11.4.1, the Independent Appointees shall confirm whether or not (and if so, to what extent) they agree that a Relief Event has occurred and the extent of its impact on the ability of the Company to meet the Contracted Availability or deliver Net Water Output.

11.4.3 Any Dispute as to whether or not a Relief Event has occurred, or the extent of its impact, may be referred by any Party for resolution pursuant to clause 27.

11.4.4 If the Company does not deliver a notice as required by clause 11.4.1 in accordance with the terms thereof, the Company shall not be entitled to invoke the benefits of clause 11.3 in respect of the relevant Relief Event.

12. PAYMENT ACCOUNTS AND SBP DEBIT AUTHORITY

12.1 Establishment and GoS Funding of Payments Accounts

12.1.1 The GoS shall establish and maintain the GoS Payment Account until the Final Expiry Date in accordance with and subject to, the terms of this Agreement.

12.1.2 The Independent Appointees shall determine the GoS Payment Account Required Balance within thirty-five (35) Days prior to each GoS Account Funding Date and notify the Commercial Parties thereof (the **"GoS Payment Account Certificate"**).

12.1.3 Subject to clause 12.1.9, on each GoS Account Funding Date that falls prior to the Final Expiry Date, the GoS shall procure that the balance standing to the credit of the GoS Payment Account is equal to the GoS Payment Account Required Balance.

12.1.4 The GoS Payment Account shall be operated in accordance with the GoS Payment Account Standing Instructions.

12.1.5 Upon establishing the GoS Payment Account, the GoS shall issue the GoS Payment Account Standing Instructions containing instructions to the GoS Payment Account Bank to debit the GoS Payment Account on each Payment Date for an amount equal to the amount set out in the Payment Certificate as payable on such Payment Date.

12.1.6 Subject to clause 12.1.7, the GoS Payment Account Standing Instructions issued by the GoS shall remain effective, in each case, until the Final Expiry Date.

12.1.7 Prior to the Final Expiry Date, the GoS Payment Account Standing Instructions issued by the GoS may be revoked pursuant to a written revocation notice duly executed and confirmed by:

12.1.7.1 the authorized representatives of the Commercial Parties;

12.1.7.2 the GoS, if this Agreement is terminated under clause 21 and the Termination Payments have been made; or

12.1.7.3 the GoS, if the GoS exercises its option to establish the GoS Service Payment Account SBLC in terms of clauses 12.1.9, 12.1.10 and 12.1.11.

12.1.8 The GoS Payment Account Standing Instructions may be amended at any time pursuant to a notice issued by the GoS to the GoS Payment Account Bank instructing amendment of the GoS Payment Account Standing Instructions (or any part thereof) and the same shall be confirmed and acknowledged by the GoS Payment Account Bank, provided, that such notice shall only be effective if the same is also duly signed by the authorized representatives of the Commercial Parties.

12.1.9 At any time, the GoS shall have the option of replacing the amount in the GoS Payment Account with a GoS Service Payment SBLC provided that at all times:

12.1.9.1 the balance standing to the credit of the GoS Payment Account shall not fall below an amount equal to one-quarter (1/4) of the GoS Payment Account Required Balance; and

12.1.9.2 the sum of the balance standing to the credit of the GoS Payment Account and the face amount of the GoS Service Payment SBLC is equal to the GoS Payment Account Required Balance.

12.1.10 The provisions applicable to withdrawals of funds from the GoS Payment Account shall apply *mutatis mutandis* to encashment of the GoS Service Payment SBLC.

12.1.11 Without prejudice to the requirements stated in clauses 12.1.9 and 12.1.10, the Commercial Parties may agree to additional terms relating to the GoS Service Payments SBLC.

12.2 SBP Debit Authority

12.2.1 The GoS shall issue to the SBP (with a copy to the Company), in terms of paragraph 6.1 of part 2 of appendix 4, a debit authority (the **"SBP Debit Authority"**) authorising the SBP to debit the GoS Account One with an amount equal to the lower of (a) the Unpaid Termination Payment Amount (as stated in the Unpaid Termination Payment Amount Certificate) and (b) the GoS Termination Secured Amount, on demand from

the Company, provided the demand is made in writing, duly signed by an authorised representative of the Company and a copy of the Unpaid Termination Payment Amount Certificate or the certificate of the Independent Auditor certifying the GoS Termination Secured Amount (as applicable), is attached thereto (the **"Company Demand"**). The SBP Debit Authority shall remain valid and effective until the Financing Termination Date.

12.2.2 At any time, the GoS shall have the option of replacing the SBP Debit Authority with the GoS Termination SBLC. The GoS Termination SBLC should be maintained until the Financing Termination Date in accordance with and subject to, the terms of this Agreement.

12.2.3 The GoS Termination SBLC shall be fully secured by the GoS as a principal debtor and not as surety, without any recourse to the Company, its assets or properties. All costs, expenses, fees and other charges of any nature associated with the issuance and maintenance of the GoS Termination SBLC shall be borne by the GoS.

12.2.4 The GoS Termination SBLC shall be unconditional and irrevocable and shall be payable on first written demand without any prior notice, reference or recourse to the GoS or any other entity.

12.2.5 The GoS Termination SBLC shall only be encashed in the following circumstances:

12.2.5.1 pursuant to clause 12.2.8; and

12.2.5.2 pursuant to clause 12.2.9.2.

12.2.6 Where the GoS elects to establish the GoS Termination SBLC (in place of the SBP Debit Authority), at least five (5) Days prior to the start of each Contract Year (the **"GoS Termination SBLC Renewal Date"**), the Independent Auditor shall issue a certificate to the GoS (with a copy to the Company) setting out the GoS Termination SBLC Amount (the **"GoS Termination SBLC Certificate"**).

12.2.7 On each GoS Termination SBLC Renewal Date, the GoS shall adjust the face amount of the GoS Termination SBLC such that it equals the GoS Termination SBLC Amount as set out in the applicable GoS Termination SBLC Certificate.

12.2.8 Each GoS Termination SBLC shall be valid for at least twelve (12) Months from issuance thereof (the **"GoS Termination SBLC Validity Period"**). Within thirty (30) Days prior to expiry of a GoS Termination SBLC, the GoS shall extend the validity of the GoS Termination SBLC, so as to keep it valid for the GoS Termination SBLC Validity Period. In the event of failure by the GoS to extend the validity of a GoS Termination SBLC in accordance with this clause 12.2.8, as certified by the Independent Auditor in its certificate (the **"GoS Termination SBLC Failure Certificate"**), the Company shall have the right, upon issuance of its first written demand (together with the GoS Termination SBLC Failure Certificate) to encash the GoS Termination SBLC to its full outstanding value (the **"Encashed Sums"**). The Company shall, within three (3) Days, return the Encashed Sums to the GoS on the GoS re-establishing the GoS Termination SBLC for the GoS Termination SBLC Validity Period, with a face amount equal to the GoS Termination SBLC Amount. Any

failure to return the Encashed Sums to the GoS as aforesaid, shall constitute a Company Event of Default.

12.2.9 In the event of termination of this Agreement pursuant to clause 21 and to the extent Financing Due (or part thereof) is due and payable and remains outstanding (the **"Unpaid Termination Payment Amount"**) on the Termination Payment Date as certified in writing by the Independent Auditor (the **"Unpaid Termination Payment Amount Certificate"**), the Company shall be entitled to:

12.2.9.1 issue the Company Demand in accordance with clause 12.2.1; or

12.2.9.2 where the GoS Termination SBLC is established, encash the GoS Termination SBLC for an amount that is the lower of: (a) the Unpaid Termination Payment Amount; and (b) the face amount of the GoS Termination SBLC.

13. INVOICING AND PAYMENT

13.1 Invoices Issued by the Company

Within ten (10) Business Days of the end of each Billing Period, the Company shall issue to the Independent Appointees and the GoS itemised invoices together with all supporting data necessary to verify and calculate the Service Payments (including any applicable Deductions) payable in any given Billing Period, in accordance with appendix 8. The Independent Appointees and the GoS may request for any additional information reasonably necessary to verify and calculate such amounts.

13.2 Invoices Issued by GoS

Save as otherwise provided in this Agreement, GoS shall issue an itemised invoice to the Company in relation to any amounts due and payable by the Company under this Agreement within thirty (30) Days of the end of a Billing Period in which any such amounts accrue. Such invoices shall be accompanied by supporting documents.

13.3 Payment Date

Save as otherwise provided in this Agreement, each invoice issued pursuant to this Agreement shall be due and payable within thirty (30) Days after the date on which it is received by the receiving Party (each such date, a **"Payment Date"**).

13.4 Method of Payment

13.4.1 All amounts payable by the GoS against invoices for the Service Payments, as set out in the Payment Certificates, shall be paid by GoS, on or before the Payment Date, by debiting the GoS Payment Account and crediting the Company Payment Account in terms of the GoS Payment Account Standing Instructions.

13.4.2 All amounts payable by the Company against invoices issued by GoS pursuant to clause 13.2 shall be paid by the Company on or before the Payment Date, by wire transfer of

immediately available funds to such account or accounts specified by the GoS for such purpose.

13.5 Payment Certificate

13.5.1 On submission by the Company of its invoices for Service Payments (including supporting data) in terms of clause 13.1, the Independent Appointees shall review and verify the same and issue a certificate to the Commercial Parties setting out the amount of Service Payment that is payable by the GoS to the Company (the **"Payment Certificate"**), no later than five (5) Business Days prior to the Payment Date.

13.5.2 Notwithstanding anything to the contrary in this Agreement, the Independent Appointees shall have no obligation to issue a Payment Certificate if:

13.5.2.1 any of the Performance Securities is not valid and in effect;

13.5.2.2 the insurances to be obtained by the Company in accordance with clause 18 are not valid and in effect;

13.5.2.3 the required Approvals are not in full force and effect, unless the withdrawal or cancellation of any Approval is not attributable to the Company's failure to comply with the Legal Requirements; and

13.5.2.4 if there is a subsisting Company Event of Default.

13.6 Disputed Payments

13.6.1 If a Commercial Party receiving an invoice or a Payment Certificate (the **"Receiving Party"**) Disputes any portion or amount of such invoice or Payment Certificate, then the Receiving Party shall:

13.6.1.1 inform the other Commercial Party (the **"Invoicing Party"**) and the Independent Appointees of the reason for the Dispute, specifying the amount(s) disputed; and

13.6.1.2 pay to the Invoicing Party the undisputed amounts contained in such invoice or Payment Certificate on or before the relevant Payment Date, provided that in the case of invoices relating to Service Payments, the Independent Appointees shall issue the Payment Certificate setting out such amount that is not disputed.

Each Commercial Party agrees that the invoices rendered by the other Commercial Party may only be disputed on bona fide grounds.

13.6.2 No previously undisputed invoice, Payment Certificate, or payment may be disputed by:

13.6.2.1 the Company, more than sixty (60) Days after the applicable Payment Date; or

13.6.2.2 the GoS, more than three hundred and sixty-five (365) Days after the applicable Payment Date.

13.6.3 The Commercial Parties shall use their reasonable endeavours to resolve the payment Dispute by amicable negotiation, provided that if the Commercial Parties are unable to resolve the Dispute within ten (10) Days of the Payment Date, then either Commercial Party may refer the Dispute for resolution pursuant to clause 27.

13.6.4 If it is agreed or determined that a Commercial Party has:

13.6.4.1 underpaid an invoice, such Commercial Party shall pay to the other Commercial Party the full amount of the underpayment, together with the commission thereon at the Late Payment Rate accrued from, but excluding, the relevant Payment Date to, and including, the Day on which such underpayment is paid; or

13.6.4.2 overpaid an invoice, the Commercial Party who has received the overpayment shall be obliged to repay the other Commercial Party the full amount of such overpayment, together with commission thereon at the Late Payment Rate accrued from, but excluding, the Day the amount of such overpayment was originally paid to, and including, the Day on which the amount of such overpayment is fully repaid. If agreed or determined that GoS has overpaid an invoice, GoS shall have the right to deduct the amount of such overpayment from future payments in the immediately following Billing Period(s) until the full amount of the overpayment shall have been deducted.

13.7 Late Payments

Any amount under any invoice that is not paid in accordance with this clause 13 on or before the Payment Date therefor shall bear commission at the Late Payment Rate accrued from, but excluding, the relevant Payment Date, and including the Day on which such payment is made.

13.8 Set-Off

The GoS shall be entitled to set off against any sum payable by the GoS to the Company under this Agreement or any other Relevant Agreement, any debt or other moneys due and owing (other than any amounts (including any liquidated damages) that are the subject of an on-going Dispute) from the Company to GoS under or in accordance with this Agreement or any other Relevant Agreement.

13.9 Taxes and Royalties

13.9.1 The Service Payments are inclusive of all Taxes.

13.9.2 The GoS may deduct from the Service Payments and any other amounts due to the Company, any income tax or withholding tax that is required to be deducted at source in accordance with the Legal Requirements.

13.9.3 The Company shall be responsible for the payment of all applicable Taxes and complying with all procedural requirements related to the payment of Taxes pursuant to this Agreement and shall be solely responsible for any proceedings initiated by any Competent Authority in respect of any non-payment or short payment of Taxes.

13.9.4 The Company shall be responsible for payment of all applicable royalties on any fine and coarse aggregate, core sand, fine sand, grit and any other minerals extracted and/or used by the Company or any Contractor and furnish proof of payment of such royalties to the GoS along with the invoices for the Service Payments, as the case may be.

13.9.5 Upon a request from the Company, the GoS will provide all relevant certificates and information it has on record to enable the Company to obtain any Tax exemptions available in relation to the Project. It is clarified that the GoS shall not be responsible in any manner for ensuring that any applicable Tax exemptions are available to the Company.

13.9.6 The Company shall indemnify the GoS Parties from and against any cost or liability that may arise due to the Company's failure to pay all applicable Taxes, in connection with the Project.

13.9.7 Any Taxes payable in relation to the Site shall be borne by KW&SB.

14. METERING SYSTEMS AND MONITORING SYSTEMS

14.1 Electricity Metering Systems

14.1.1 The Metering Systems and associated equipment to measure the delivery of electrical energy to the KWC that exists as of the Effective Date shall continue to be operated and maintained by the Electricity Supplier.

14.1.2 The Company shall, at its own expense, procure, install, test, commission, complete, own, operate and maintain, at the Electricity Connection Point, Back Up Metering Systems and associated equipment in accordance with the Legal Requirements to measure the delivery of electrical energy to the KWC.

14.2 Water Output Metering and Monitoring Systems

The Company shall, at its own expense:

14.2.1 procure, install, operate and maintain at the HD Water Connection Point, one or more electronic metering systems and associated equipment to measure the volume of water entering the WAPDA Canal from the Hub Dam in accordance with appendix 1 (the **"HD Input Water Metering System"**);

14.2.2 procure and install immediately upstream of the Input HD Water Connection Point, one or more electronic metering systems and associated equipment to measure the volume of water entering the KWC from the WAPDA Canal in accordance with appendix 1 (the **"Primary HD Input Water Metering System"**);

14.2.3 procure, install, own, operate and maintain immediately downstream of the Input HD Water Connection Point, one or more electronic back-up metering systems and associated equipment to measure the volume of water entering the KWC from the WAPDA Canal in accordance with appendix 1 (the **"Back-up HD Input Water Metering System"**);

14.2.4 procure, install, own, operate and maintain at Input HD Water Connection Point, one or more electronic metering systems and associated equipment to measure the quality

of water entering the KWC from the WAPDA Canal in accordance with appendix 1 (the **"HD Input Online Quality Monitoring System"**);

14.2.5 procure and install immediately upstream of Input KIII Water Connection Point, one or more electronic metering systems and associated equipment to measure the volume of water entering KWC from the KIII Conduit in accordance with appendix 1 (the **"Primary KIII Input Water Metering System"**);

14.2.6 procure, install, own, operate and maintain immediately downstream of Input KIII Water Connection Point, one or more electronic Back-Up Metering Systems and associated equipment to measure the volume of water entering KWC from the KIII Conduit in accordance with appendix 1 (the **"Back-up KIII Input Water Metering System"**);

14.2.7 procure, install, own, operate and maintain at Input KIII Water Connection Point, one or more electronic metering systems and associated equipment to measure the quality of water entering the KWC from the KIII Conduit in accordance with appendix 1 (the **"KIII Input Online Quality Monitoring System"**);

14.2.8 procure and install immediately downstream of each Water Access Point, an electronic metering system and associated equipment to measure the volume of water supplied to each Water Access Point in accordance with appendix 1 (each, the **"Primary Water Access Point Metering System"**);

14.2.9 procure, install, own, operate and maintain immediately upstream of each Water Access Point, one or more electronic Back-Up Metering Systems and associated equipment to measure the volume of water supplied to each Water Access Point in accordance with appendix 1 (each, the **"Back-up Water Access Point Metering System"**);

14.2.10 procure, install, own, operate and maintain immediately upstream of the Pumping Station, one or more electronic metering systems and associated equipment to measure the volume of water reaching the Pumping Station (before mixing with water from the KIII Conduit) in accordance with appendix 1 (the **"Pumping Station Metering System"**);

14.2.11 procure, install, own, operate and maintain immediately upstream of the Pumping Station, one or more electronic metering systems and associated equipment to measure the quality of water reaching the Pumping Station (before mixing with water from the KIII Conduit) in accordance with appendix 1 (the **"Pumping Station Online Quality Monitoring System"**);

14.2.12 procure, install, own, operate and maintain at the Mixed Water Monitoring Point, one or more electronic metering systems and associated equipment to measure the volume of mixed water from the Hub Dam and the KIII Conduit entering the KWC in accordance with appendix 1 (the **"Mixed Water Metering System"**);

14.2.13 procure, install, own, operate and maintain at the Mixed Water Monitoring Point, one or more electronic metering systems and associated equipment to measure the quality of mixed water from the Hub Dam and the KIII Conduit entering the KWC in accordance with appendix 1 (the **"Mixed Online Quality Monitoring System"**);

14.2.14 procure, install, own, operate and maintain immediately upstream of the Reservoir, one or more electronic metering systems and associated equipment to measure the volume of water reaching the Reservoir in accordance with appendix 1 (the **"Reservoir Water Metering System"**);

14.2.15 procure, install, own, operate and maintain immediately upstream of the Reservoir, one or more electronic monitoring systems and associated equipment to measure the quality of water reaching the Reservoir in accordance with appendix 1 (the **"Reservoir Online Quality Monitoring System"**);

14.2.16 procure and install downstream of the last Bypass Water Connection Point, one or more electronic metering systems and associated equipment to measure the Bypass Water Output in accordance with appendix 1 (the **"Primary Bypass Output Water Metering System"**);

14.2.17 procure, install, own, operate and maintain upstream of the last Bypass Water Connection Point, one or more electronic back-up metering systems and associated equipment to measure the Bypass Water Output in accordance with appendix 1 (the **"Back-up Bypass Output Water Metering System"**);

14.2.18 procure and install immediately downstream of the Output Water Connection Point, one or more electronic metering systems and associated equipment to measure Net Water Output in accordance with appendix 1 (the **"Primary Output Metering System"**);

14.2.19 procure, install, own, operate and maintain immediately upstream of the Output Water Connection Point, one or more electronic back-up metering systems and associated equipment to measure Net Water Output in accordance with appendix 1 (the **"Back-up Output Metering System"**); and

14.2.20 procure, install, own, operate and maintain at the Output Water Connection Point, one or more electronic monitoring systems and associated equipment to measure the quality of Net Water Output in accordance with appendix 1 (the **"Online Output Quality Monitoring System"**).

14.3 General

14.3.1 Each of the Metering Systems and the Monitoring Systems shall be jointly sealed by the Technical Parties (in the presence of the Independent Engineer).

14.3.2 The Company shall ensure that the procurement, installation, operation, and maintenance of the Back-up Metering Systems shall not interfere with the operations and maintenance of the Primary Metering Systems and the Online Output Quality Monitoring System, and physical testing and analysis of water samples required to be conducted in terms of the Operating and Maintenance Procedures.

14.3.3 Upon installation, the Company shall transfer each of the Primary Metering Systems (together with any related warranties or guarantees) at no cost to KW&SB, and following such transfer, KW&SB shall be responsible for the ownership, operation and maintenance of the same.

14.4 Reading of Meters

14.4.1 The Independent Engineer shall read each of the Primary Metering Systems at 23:59 hours on the last Day of each Month for the purpose of determining the Net Water Output managed by the Company up to the Output Water Connection Point since the last meter reading. The Company shall be entitled to have a representative present during any such reading.

14.4.2 The Independent Engineer shall make all records derived from the Metering Systems, Monitoring Systems, and the physical testing facilities, available to the Parties upon reasonable request for inspection and verification.

14.4.3 The metered data derived from the Primary Metering Systems and the Online Output Quality Monitoring System shall be telemetered to the distribution control system within the KWC, and, subject to clause 14.5.1, shall be used as the binding measurement of the Net Water Output delivered at the Output Water Connection Point.

14.4.4 The Company shall maintain and calibrate the Metering Systems and Monitoring Systems in accordance with the requirements of appendix 1.

14.5 Defective Metering Events and Corrections

14.5.1 If there is a Defective Metering Event in relation to any of the Primary Metering Systems, then subject to clause 14.5.2, the binding measurements referred to in clause 14.5.3 shall be provided by the readings of the respective Back-up Metering Systems.

14.5.2 If there is a Defective Metering Event in relation to both the Primary HD Input Water Metering System and the Back-up HD Input Water Metering System, the Primary KIII Input Water Metering System and the Back-up KIII Input Water Metering System, the Primary Water Access Point Metering System and the Back-up Water Access Point Metering System, the Primary Bypass Output Water Metering System and the Back-up Bypass Output Water Metering System, or the Primary Output Metering System and the Back-up Output Metering System, then any error in the readings from the relevant Primary Metering System shall be corrected in accordance with the following:

14.5.2.1 if the Independent Engineer is able to determine the amount of the error, if any, then all measurements made by the relevant Primary Metering System shall be corrected by such amount; or

14.5.2.2 if the Independent Engineer is unable to determine the amount of the error, if any, then the percentage error for which the relevant Primary Metering System is to be corrected, for the period determined in accordance with clause 14.5.3, shall be determined if:

(a) the percentage of error is ascertainable, by calibration, tests, or mathematical calculation; or

(b) the percentage of error is not ascertainable, on the basis of the readings taken under similar conditions during the period before the last test.

14.5.3 If a correction is to be made pursuant to clause 14.5.2.2, then such correction shall be made to the readings given by the relevant Metering System from the period commencing on:

14.5.3.1 the Day of the Defective Metering Event, if such Day can be established by the Independent Engineer; or

14.5.3.2 if the Day of the Defective Metering Event cannot be established by the Independent Engineer, the Day which is halfway between the Day of the immediately preceding test of such metering device and the Day the Defective Metering Event was discovered.

14.5.4 If, as a result of any corrections pursuant to clause 14.5.2:

14.5.4.1 it is determined that the GoS is required to pay any additional amounts to the Company, then the Company shall include such additional amounts in the next invoice to be delivered by the Company in accordance with clause 13.1; or

14.5.4.2 it is determined that GoS has overpaid the Company, the Company shall be obliged to repay such overpaid amount, and the GoS shall have the right to deduct the amount of such overpayment from future payments in the immediately following Billing Period(s) until the full amount of the overpayment shall have been deducted.

14.6 Repair, Replacement and Recalibration

14.6.1 If a Defective Metering Event occurs, or a Metering System is otherwise found to be functioning improperly in accordance with the design and equipment parameters, the Independent Engineer shall instruct the Technical Party owning such Metering System to promptly recalibrate, repair or replace such system at the relevant Technical Party's expense.

14.6.2 A Technical Party wishing to recalibrate, repair or replace a Metering System shall notify the other Technical Party and the Independent Engineer so that any recalibration, repair or replacement of a Metering System may be witnessed by the Technical Party not owning such Metering System (and the Independent Engineer) and, upon completion of any such recalibration, repair or replacement, such Metering System shall be jointly sealed by the Technical Parties (in the presence of the Independent Engineer).

14.7 Testing and Access

14.7.1 Either Technical Party shall be entitled to request at any time a test of any component of a Metering System. The Technical Party calling for such test shall be responsible for all costs associated with such test unless such test discloses that the accuracy of the tested component is outside the Metering Tolerance, in which case, the Technical Party that owns such component shall bear all such costs and shall repair, replace or recalibrate such component as necessary.

14.7.2 Each Technical Party or its representatives or designees shall be entitled to be present at, and to receive reasonable advance notice of, any test, inspection, maintenance and replacement of any part of any Metering System owned by the other Technical Party.

14.7.3 The Independent Engineer and KW&SB and its designees shall have the right to enter upon the Site or enter the KWC at such times as may reasonably be required to enjoy its rights or perform its obligations pursuant to this clause 14 and for the purposes of maintaining any equipment on the Site owned or operated by it. When so doing, KW&SB and the Independent Engineer shall (and shall ensure that any of its designees shall) act in accordance with Good International Industry Practices and the Company's reasonable safety regulations and procedures.

14.8 Water Quality

14.8.1 The Company shall perform water quality tests on a continuous basis by means of:

14.8.1.1 the Monitoring Systems; and

14.8.1.2 physical testing and analysis of water samples by an authorised third party approved by the GoS Parties in writing at least once a day;

each in accordance with appendix 1 and the Operating and Maintenance Procedures.

14.8.2 For the purposes of calculating the Deduction for Off-Spec Output Water and determination of Bypass Input Water, Bypass Off-Spec Mixed Water, Off-Spec Mixed Water, Off-Spec Input Water, Off-Spec Output Water, and Within Spec Input Water, the results obtained through physical testing and analysis of water samples by an authorised third party approved by the GoS Parties in writing in accordance with the Operating and Maintenance Procedures, shall apply. All payments to be made to such third party shall be borne by the Company.

14.8.3 The Company warrants that no Bypass Input Water or Bypass Off-Spec Mixed Water shall be delivered to KW&SB at the Output Water Connection Point. Determination of whether water constitutes Bypass Input Water or Bypass Off-Spec Mixed Water shall be made in accordance with appendix 1.

14.8.4 If water delivered or proposed to be delivered to the Output Water Connection Point does not conform to the Output Water Quality Specifications, the Independent Engineer shall give notice to the Company, as soon as practicable upon becoming aware of such failure, confirming whether, such water is to be accepted or rejected. If the Independent Engineer rejects any water that does not conform to the Output Water Quality Specifications, the provisions of clause 14.8.5 shall apply. If the Independent Engineer accepts any water that does not conform to the Output Water Quality Specifications, the provisions of appendix 8 shall apply to determine the extent to which the Company is compensated for such supply.

14.8.5 The Company shall ensure that all Bypass Input Water, Bypass Off-Spec Mixed Water and water rejected in terms of clause 14.8.4 is discharged to the Bypass Water Connection Point.

15. RECORDS, REPORTING AND AUDIT

15.1 Monitoring Rights

15.1.1 The Independent Appointees and the GoS Parties and their duly appointed representatives shall have the right to:

15.1.1.1 monitor the Project; and

15.1.1.2 review and make copies of all materials required to be obtained and retained by the Company pursuant to clause 6.4 and all materials pertinent to the exercise of audit rights pursuant to clause 15.2.

15.1.2 The purpose of such monitoring and review shall be to determine:

15.1.2.1 in the case of C&O Activities, whether the KWC is (or is being) designed, engineered, manufactured, supplied, procured, transported, erected, constructed, rehabilitated, installed, tested and commissioned in accordance with the design and equipment parameters set out in appendix 1, and to observe the progress of the Mobilisation Activities and the C&O Activities; and

15.1.2.2 in the case of O&M Activities, to determine whether the KWC is being operated and maintained in accordance with the terms of this Agreement.

15.1.3 The Company shall permit the Independent Engineer and KW&SB and their duly appointed representatives to conduct such monitoring and review at any time and, following the Project Commercial Operations Date, during normal operating hours, in each case, upon reasonable notice to the Company.

15.1.4 Such monitoring and review shall be conducted in the presence of and, in the case of inquiries addressed to the Company's employees and contractors, through suitably qualified, appropriate representative(s) of the Company designated by the Company for this purpose.

15.1.5 The Company agrees to designate such a representative or representatives and to make such representative(s) available for all such monitoring and review. In the case of monitoring of equipment or supplies, the Independent Engineer and KW&SB shall have the right to conduct such monitoring with the prior approval of the Company, which shall not be unreasonably withheld or delayed, in the presence of a representative of the Company, at any and all locations inside or outside Pakistan at which such equipment and supplies are designed, manufactured, assembled or tested.

15.1.6 The Company shall ensure that the EPC Contract and the O&M Contract provide for such rights and shall require the EPC Contractor and the O&M Contractor to require that their contracts with subcontractors and suppliers provide for such rights.

15.1.7 The foregoing provisions shall be without prejudice to the Independent Engineer's and KW&SB's inspection, monitoring and review rights with respect to the KWC (or any part thereof) in connection with testing pursuant to appendix 5 or as otherwise provided in this Agreement.

15.1.8 The Company shall provide to the Independent Appointees and the GoS Parties, promptly, and in any event within seven (7) Days of becoming aware, a report describing the occurrence of any act or condition materially affecting the Project or the Company's ability to perform any of its obligations under this Agreement and any other Project Agreements to which the Company is a party.

15.1.9 The Company hereby agrees that:

15.1.9.1 any monitoring or review by any of the Independent Appointees or the GoS Parties (or their representatives) pursuant to this clause 15.1 is solely for information, and by conducting any such monitoring or review, neither the Independent Appointees nor the GoS Parties (or their representatives) make (or shall be construed to make) any endorsement of the design, or representation or warranty of the safety, durability, or reliability of the KWC or any part thereof; and

15.1.9.2 it shall in no way represent to any third party that, as a result of any monitoring or review by Independent Appointees and the GoS Parties (or their representatives) pursuant to clause 15.1, the Independent Appointees and the GoS Parties (or their representatives) are in any way responsible for the engineering, design or construction soundness of the KWC.

15.2 Books and Records and Audit Rights

15.2.1 The Company shall comply with the Accounting Principles and maintain proper books, data and records in accordance with the Law and this Agreement.

15.2.2 The Independent Appointees and the GoS Parties (and their duly appointed representatives) may at reasonable times, and at their expense, audit the Company's books, data and records in relation to testing, metering, invoicing, payments, Claims, claims for Increased Costs, termination payments, reimbursements and any other charges to GoS, in all such cases for the purpose of determining whether the Company's charges to GoS have been computed in accordance with this Agreement.

15.2.3 The Independent Appointees and the GoS Parties shall have the right, upon reasonable prior notice to the Company, to examine and/or make copies of the books, data and records referred to in clause 15.2.2 during normal office hours during the period such books, data and records are required to be maintained pursuant to clause 15.2.4.

15.2.4 All books, data and records referred to in this clause 15.2 shall be maintained by the Company until the Final Expiry Date. The Company shall provide a notice to KW&SB thirty (30) Days prior to the Final Expiry Date for handing over custody of such books, data and records to KW&SB, and KW&SB shall be entitled to take custody of the same within twenty (20) Days of the date of receipt of the notice provided by the Company hereunder.

15.2.5 The Company shall provide to the Independent Appointees and the GoS Parties, such information concerning the operational and financial performance of the Project and the Company, as the Independent Appointees and the GoS Parties may reasonably require.

15.2.6 The Company hereby agrees that:

15.2.6.1 any receipt, review or audit by any of the Independent Appointees or the GoS Parties (or their representatives) of any books, data, records or other documentation or information pursuant to this clause 15.2 is solely for information purposes and by such receipt, review or audit, neither the Independent Appointees nor the GoS Parties (or their representatives) make (or shall be construed to make) any endorsement as to the accuracy and completeness of any books, data or records; and

15.2.6.2 it shall in no way represent to any third party that, as a result of any receipt, review or audit by the Independent Appointees and the GoS Parties (or their representatives) of any books, data or records pursuant to this clause 15.2, the Independent Appointees and the GoS Parties (or their representatives) are in any way responsible for accuracy and completeness of any such books, data or records.

15.2.7 The Company shall provide to the Independent Appointees and the GoS Parties an updated financial model within three (3) Business Days after any update to the financial model is made following a reasonable request by any of the Independent Appointees or the GoS Parties.

16. COVENANTS

16.1 Licences, Permits and Consents

The Company shall, as soon as reasonably practicable and in any event within seven (7) days of request, deliver to the Independent Appointees and KW&SB copies of all Approvals that have been issued to the Company and not previously delivered to the Independent Appointees and KW&SB.

16.2 Other Business

The Company shall not:

16.2.1 engage in any business activity other than as reasonably required to perform its obligations and enjoy its rights under this Agreement;

16.2.2 use the water from the KWC for any purpose other than the Project;

16.2.3 enter into any agreement of merger, consolidation or amalgamation with any entity; or

16.2.4 substantially amend or alter its memorandum of association and/or articles of association without the prior written approval of the Independent Appointees and the GoS.

16.3 Project Agreements, Financing Documents and Refinancing

16.3.1 Drafts of the EPC Contract and O&M Contract to be entered into by the Company shall be provided to the Independent Engineer (with a copy to the GoS) for review at least thirty (30) Days prior to the Scheduled Mobilisation Date. The GoS shall, within ten (10) Business Days of its receipt of the proposed EPC Contract and the O&M Contract,

provide its comments or observation on the same, if any, to the Independent Engineer. The Independent Engineer shall within fifteen (15) days of the delivery of the proposed EPC Contract and O&M Contract, provide its comments on the same, in consultation with the GoS after addressing any objection by the GoS. Prior to execution of the EPC Contract or the O&M Contract, the Company shall address any comments made by the Independent Engineer. In the event the Independent Engineer fails to provide its comments on the proposed EPC Contract or O&M Contract within fifteen (15) days of the delivery of the same by the Company, the EPC Contract or O&M Contract (as the case maybe) shall be deemed to have been approved by the Independent Engineer. Promptly following the execution and delivery of the EPC Contract and the O&M Contract, the Company shall deliver copies to the Independent Engineer and the GoS Parties.

16.3.2 The Company shall ensure that the Financing Documents conform to the debt financing term sheet of the Financing Parties submitted as part of the Proposal, unless otherwise approved in writing by the Independent Auditor and the GoS. Promptly following the execution and delivery of the Financing Documents, the Company shall deliver copies thereof to the Independent Appointees and the GoS Parties.

16.3.3 The Company may not enter into:

16.3.3.1 any material amendments, modifications or supplements to, or waivers under any of the Project Agreements; or

16.3.3.2 any material amendments, modifications or supplements to, or waivers under any of the Financing Documents; or

16.3.3.3 any material new contracts after the Commencement Date, including any new construction contract for construction activities on the Site,

without first giving the Independent Appointees and the GoS thirty (30) Days' notice (or sixty (60) Days' notice where clause 16.3.5 applies) of such matter and obtaining the prior written approval of the Independent Engineer and the GoS), which approvals shall not be unreasonably withheld or delayed and which shall be deemed to have been granted if the Independent Engineer and the GoS do not object to such matter within thirty (30) Days of receiving notice thereof, provided that:

(i) no approval shall be deemed to have been granted by the Independent Appointees or the GoS if: (a) the Company shall have failed to provide such information as the Independent Appointees or the GoS may reasonably request to evaluate the matter proposed, or (b) the GoS Parties or the Independent Appointees consider that the substitute EPC Contractor or the O&M Contractor does not meet (at minimum) the relevant criteria provided for in the RFP relating to the relevant Contractor; and

(ii) in relation to any proposed Refinancing, the GoS or the Independent Appointees may withhold approval at their absolute discretion if such changes adversely affect the GoS' rights or obligations under any Relevant Agreement (including giving rise to any increase in the GoS' financial obligations (whether actual or contingent) at any point in time

under any Relevant Agreement) or the Company's or any Sponsor's ability to perform its obligations under any Project Agreement.

16.3.4 Promptly following the execution and delivery of any items referred to in clauses 16.3.3.1 to 16.3.3.3 (inclusive), the Company shall deliver a copy of all relevant documents to the Independent Appointees and the GoS Parties.

16.3.5 Not later than sixty (60) Days prior to the execution by the Company of any amendments, modifications or supplements to, or consent to any change of any provision of, or waiver under:

16.3.5.1 the EPC Contract or the O&M Contract that would result in:

(a) a change of the EPC Contractor or the O&M Contractor;

(b) a material change to the scope of work of the EPC Contractor or the O&M Contractor;

(c) a material change to the performance standards to which the EPC Contractor or the O&M Contractor is subject; or

(d) a change, in the case of the EPC Contract only, to:

(i) the critical path schedule under the EPC Contract, to the extent such change could affect the ability of the Company to meet the Implementation Schedule; or

(ii) a major piece of equipment as to either its manufacturer or country of origin; or

16.3.5.2 the Financing Documents that would result in a Refinancing,

the Company shall deliver to the Independent Appointees and the GoS Parties a notice executed by a duly authorised officer, setting out the terms of any of the foregoing in reasonable detail including calculations for consideration by the Independent Auditor for determination of any Refinancing Gains.

16.3.6 The Company acknowledges and agrees that no review or approval (actual or deemed) by the Independent Appointees or the GoS Parties of any amendments, modifications, supplements, waivers or new contracts pursuant to clause 16.3.3 shall in any way relieve the Company from any liability it would otherwise have under this Agreement, and that neither the Independent Appointees nor the GoS Parties (or any of their representatives shall be liable to the Company, the relevant Contractor or the Financing Parties by reason of their review or approval of the amendments, modifications, supplements, waivers or new contracts.

16.3.7 The Company acknowledges and agrees that sixty percent (60%) of any economic benefit arising out of a Refinancing shall be shared with the GoS (the **"Refinancing Gain"**). The Refinancing Gain shall be determined by the Independent Auditor based on the calculations provided by the Company in respect of the proposed Refinancing and such other information and calculations as may be reasonably required by the Independent Auditor from the Company. The GoS shall select the mechanism for

applying the Refinancing Gain (in the aforesaid ratio), through (one or a combination of the following):

16.3.7.1 upfront or staggered payments to the GoS;

16.3.7.2 reduction in Service Payments; or

16.3.7.3 any other mechanism agreeable to the Commercial Parties, which in each case, shall take effect from the date when the Refinancing Gain is realised.

16.3.8 The Company shall not introduce any form of balloon loan or balloon structure, in each case whether or not such balloon loan or balloon structure is supported by letters of credit or letters of guarantee of any form.

16.3.9 The Company shall pay, on behalf of the GoS, all reasonable costs and fees of external advisers appointed by the GoS for the purposes of considering any approval or review of any documents (including amendments, modifications or supplements to, or waivers pursuant to, any Financing Document or Project Agreement) as contemplated in this clause 16.3.

16.4 Compliance with Applicable Legal Requirements

Each Party agrees that all applicable Legal Requirements shall govern their performance of this Agreement, and each shall respectively comply in all material respects with the applicable Legal Requirements and shall keep in full force and effect all Approvals required to be in their respective names for the performance of their respective obligations under this Agreement and the other Project Agreements to which it is a party. Without limiting the generality of the foregoing, the Company specifically acknowledges that the applicable Legal Requirements may from time to time prohibit the import of goods or services manufactured, supplied, or performed from or by any Adverse Person and undertakes not to import any such goods or services. The Company, in addition to the foregoing, agrees to fully comply with the Asian Development Bank's Anticorruption Policy, 1998, as amended from time to time.

16.5 Site Related Undertakings

The Company agrees and undertakes that:

16.5.1 it shall take all necessary measures to confine the Project Activities, its personnel and equipment to the Site and not encroach on any Adjoining Property;

16.5.2 it shall make good any damage to any roads, footpaths, conduits, and other works on any Adjoining Property, which is caused by the Company or its Contractors or employees; and

16.5.3 it shall use all reasonable endeavours not to do or permit to be done anything which might:

(a) cause destruction, scarring or defacing of natural surroundings in the vicinity of the Site;

(b) be or become a danger or nuisance or give rise to liability in tort to any owners or occupiers of the Adjoining Property or to members of the public; or

(c) cause any contamination or damage to any Adjoining Property.

17. INDEPENDENT APPOINTEES

17.1 Selection of Independent Engineer

17.1.1 Within ten (10) Days from the Effective Date, the Company shall provide the GoS Parties with a list of three (3) reputable firms of engineers for appointment of the Independent Engineer (the **"First IE List"**). In the event the proposed Independent Engineer is a consortium of engineers then: (a) a lead consortium member shall serve as the lead Independent Engineer and shall be fully responsible for the overall management, coordination and implementation of the services under the Independent Engineer Contract; and (b) the consortium members shall be jointly and severally liable for the services under the Independent Engineer Contract.

17.1.2 Within seven (7) Days of receipt by the GoS Parties of the First IE List, the GoS Parties shall (subject to one (1) of the firms in the First IE List being acceptable to the GoS) select a firm of engineers from First IE List and the Parties shall finalise and execute the Independent Engineer Contract.

17.1.3 If the firms of engineers identified in the First IE List are not acceptable to the GoS Parties, the Parties shall select as the Independent Engineer a firm acceptable to them and the Parties shall finalise and execute the Independent Engineer Contract.

17.1.4 The Independent Engineer Contract shall be executed within thirty (30) Days from the Effective Date.

17.1.5 The Independent Engineer shall provide the services set out in the Independent Engineer Contact, which shall be in accordance with the Indicative Independent Engineer Terms of Reference, provided, however, upon execution of the Independent Engineer Contract, the terms and conditions including scope of work under the Independent Engineer Contract shall supersede.

17.2 Term of Appointment of the Independent Engineer

17.2.1 The appointment of the Independent Engineer shall initially be for a term not less than the C&O Period (the **"Independent Engineer Initial Term"**).

17.2.2 The Company shall ensure that until the Final Expiry Date, an Independent Engineer is retained for the purposes of carrying out the functions of the Independent Engineer under this Agreement.

17.2.3 Prior to the expiry of the Independent Engineer Initial Term, the Company, the Sponsors and the GoS shall have the option to extend the Independent Engineer Contract (on terms and conditions agreeable to the Company, the Sponsors, the GoS and the Independent Engineer) or appoint a new independent engineer (such appointment to be effective upon expiry of the Independent Engineer Initial Term). In the event a new Independent Engineer is to be appointed, the Parties shall follow the process set out in clause 17.1, *mutatis mutandis*, for appointment of a new independent engineer so as to ensure that at all times until the Final Expiry Date an Independent Engineer is retained.

17.2.4 The Parties shall have the right to terminate the Independent Engineer Contract in accordance with its terms, provided, however, that prior to such termination and subject to clause 17.5, the Commercial Parties shall endeavour to select and appoint a replacement Independent Engineer and execute (with KW&SB), the Independent Engineer Contract.

17.2.5 The Company shall ensure that all provisions of this Agreement pertaining to the Independent Engineer and its responsibilities in respect of the matters set out herein are duly incorporated in the Independent Engineer Contract.

17.3 Independent Engineer Authorized Signatories

17.3.1. The Parties shall require the Independent Engineer to designate and notify, suitably qualified and appropriate representatives, authorized to represent the Independent Engineer in all matters relating to this Agreement and sign for and on behalf of the Independent Engineer any communication or document required to be signed by the Independent Engineer (the **"Independent Engineer Authorized Representative(s)"**). Any document shall be valid and effective only if it is signed by such Independent Engineer Authorized Representative. The Independent Engineer, may by prior notice in writing to the Parties, substitute the Independent Engineer Authorized Representative.

17.4 Decision of Independent Engineer & Dispute Resolution

17.4.1 Subject to clause 17.4.2, any advice, instruction, certification, approval or determination of the Independent Engineer shall be binding on the Parties.

17.4.2 In the event the GoS, KW&SB, the Sponsors or the Company disagree with any decision of the Independent Engineer, then it will be deemed as a Dispute under this Agreement and shall be resolved in accordance with clause 27.

17.4.3 The Company shall be responsible for procuring from the Independent Engineer any approval, consent, determination, certificate or other document or decision required or contemplated under any Relevant Agreement within the necessary timelines stated herein and any delay in the procurement of the same shall not give raise to any claim for extension in the Scheduled Mobilisation Date, Scheduled Commencement Date or Scheduled Project Commercial Operations Date, adjustment in the Implementation Schedule or any additional payments (including Increased Costs).

17.5 Independent Engineer Remuneration

17.5.1. Subject to funding in accordance with clause 17.5.2, the Company (and, until the Commencement Date, the Sponsors) shall be solely responsible for the payment of fees and expenses due to the Independent Engineer under the Independent Engineer Contract (the **"Independent Engineer Payments"**). In the event the Independent Engineer terminates the Independent Engineer Contract due to the Independent Engineer Payments not being paid, the GoS (without prejudice to its rights under clause 21) shall be entitled to appoint a third party to carry out the functions of the Independent Engineer (the **"GoS Appointed IE"**) and all fees and expenses relating to the same shall be payable on demand of the GoS by the Sponsors or the Company (as the case maybe). The GoS shall be entitled to encash the Performance Securities (to the extent

demanded) or deduct such amounts from payments due by the GoS to the Company, in case the Sponsors or the Company fail to provide the necessary funds demanded by GoS to pay the GoS Appointed IE. Where a GoS Appointed IE is appointed by the GoS, all references to Independent Engineer herein shall be considered as a reference to the GoS Appointed IE.

17.5.2. The Independent Engineer Payments shall be funded by the:

17.5.2.1 Sponsors from the date of signing of the Independent Engineer Contract until the Commencement Date; and

17.5.2.2 Company from the Commencement Date until the Final Expiry Date.

17.6 Independent Engineer Payment Account

17.6.1 The Company shall establish and maintain the Independent Engineer Payment Account from the date of signing of the Independent Engineer Contract until the Final Expiry Date.

17.6.2 The Company shall issue standing instructions (that may be suspended, amended or revoked only with the consent of the Parties) to the Independent Engineer Payment Account Bank (the **"Independent Engineer Payment Account Standing Instructions"**) for making payments to the Independent Engineer in accordance with the Independent Engineer Contract.

17.7 Selection of Independent Auditor

17.7.1 Within ten (10) Days from the Effective Date, the Company shall provide the GoS with a list of three (3) reputable firms of auditors for appointment of the Independent Auditor (the **"First IA List"**). In the event the proposed Independent Auditor is a consortium of auditors then: (a) a lead consortium member shall serve as the lead Independent Auditor and shall be fully responsible for the overall management, coordination and implementation of the services under the Independent Auditor Contract; and (b) the consortium members shall be jointly and severally liable for the services under the Independent Auditor Contract.

17.7.2 Within seven (7) Days of receipt by the GoS of the First IA List, the GoS shall (subject to one (1) of the firms in the First IA List being acceptable to the GoS) select a firm of auditors from First IA List and the Parties shall finalise and execute the Independent Auditor Contract.

17.7.3 If the firms of auditors identified in the First IA List are not acceptable to the GoS, the Commercial Parties shall select as the Independent Auditor a firm acceptable to them and the Parties shall finalise and execute the Independent Auditor Contract.

17.7.4 The Independent Auditor Contract shall be executed within thirty (30) Days from the Effective Date.

17.7.5 The Independent Auditor shall provide the services set out in the Independent Auditor Contact which shall be in accordance with the Indicative Independent Auditor Terms of Reference, provided, however, upon execution of the Independent Auditor Contract,

the terms and conditions including scope of work under the Independent Auditor Contract shall supersede.

17.8 Term of Appointment of the Independent Auditor

17.8.1 The appointment of the Independent Auditor shall initially be for a term not less than the C&O Period (the **"Independent Auditor Initial Term"**).

17.8.2 The Company shall ensure that until the Final Expiry Date, an Independent Auditor is retained, for the purposes of carrying out the functions of the Independent Auditor under this Agreement.

17.8.3 Prior to the expiry of the Independent Auditor Initial Term, the Company, the Sponsors and GoS shall have the option to extend the Independent Auditor Contract (on terms and conditions agreeable to the Company, the Sponsors, GoS and the Independent Auditor) or appoint a new independent auditor (such appointment to be effective upon expiry of the Independent Auditor Initial Term). In the event a new Independent Auditor is to be appointed, the Commercial Parties shall follow process set out in clause 17.7, *mutatis mutandis*, for appointment of a new independent auditor so as to ensure that at all times until the Final Expiry Date, an Independent Auditor is retained.

17.8.4 The Commercial Parties shall have the right to terminate the Independent Auditor Contract in accordance with its terms provided, however, that prior to such termination and subject to clause 17.11, the Commercial Parties shall endeavour to select and appoint a replacement Independent Auditor and execute (with KW&SB), the Independent Auditor Contract.

17.8.5 The Company shall ensure that all provisions of this Agreement pertaining to the Independent Auditor and its responsibilities in respect of the matters set out herein are duly incorporated in the Independent Auditor Contract.

17.9 Independent Auditor Authorized Signatories

17.9.1 The Parties shall require the Independent Auditor to designate and notify, suitably qualified and appropriate representatives, authorized to represent the Independent Auditor in all matters relating to this Agreement and sign for and on behalf of the Independent Auditor any communication or document required to be signed by the Independent Auditor (the **"Independent Auditor Authorized Representative(s)"**). Any document shall be valid and effective only if is signed by such Independent Auditor Authorized Representative. The Independent Auditor may, by prior notice in writing to the Parties, substitute the Independent Auditor Authorized Representative.

17.10 Decision of Independent Auditor & Dispute Resolution

17.10.1 Subject to clause 17.10.2, any advice, instruction, certification, approval or determination of the Independent Auditor shall be binding on the Parties.

17.10.2 In the event the GoS, KW&SB, the Sponsors or the Company disagree with any decision of the Independent Auditor, then it will be deemed as a Dispute under this Agreement and shall be resolved in accordance with clause 27.

17.10.3 The Company shall be responsible for procuring from the Independent Auditor any approval, consent, determination, certificate or other document or decision required or contemplated under any Relevant Agreement within the necessary timelines stated herein and any delay in the procurement of the same shall not give raise to any claim for extension in the Scheduled Mobilisation Date, Scheduled Commencement Date or Scheduled Project Commercial Operations Date, adjustment in the Implementation Schedule or any additional payments (including Increased Costs).

17.11 Independent Auditor Remuneration

17.11.1 Subject to funding in accordance with clause 17.11.2, the Company (and, until the Commencement Date, the Sponsors) shall be solely responsible for the payment of fees and expenses due to the Independent Auditor under the Independent Auditor Contract (the **"Independent Auditor Payments"**). In the event the Independent Auditor terminates the Independent Auditor Contract due to the Independent Auditor Payments not being paid, the GoS (without prejudice to its rights under clause 21) shall be entitled to appoint a third party to carry out the functions of the Independent Auditor (the **"GoS Appointed IA"**) and all fees and expenses relating to the same shall be payable on demand of the GoS by the Sponsors or the Company (as the case maybe). The GoS shall be entitled to encash the Performance Securities (to the extent demanded) or deduct such amounts from payments due by the GoS to the Company, in case the Sponsors or the Company fail to provide the necessary funds demanded by GoS to pay the GoS Appointed IA. Where a GoS Appointed IA is appointed by the GoS, all references to Independent Auditor herein shall be considered as a reference to the GoS Appointed IA.

17.11.2 The Independent Auditor Payments shall be funded by the:

17.11.2.1 Sponsors from the date of signing of the Independent Auditor Contract until the Commencement Date; and

17.11.2.2 Company from Commencement Date until the Final Expiry Date.

17.12 Independent Auditor Payment Account

17.12.1 The Company shall establish and maintain the Independent Auditor Payment Account from the date of signing of the Independent Auditor Contract until the Final Expiry Date.

17.12.2 The Company shall issue standing instructions (that may be suspended, amended and/or revoked only with the consent of the Commercial Parties) to the Independent Auditor Payment Account Bank (the **"Independent Auditor Payment Account Standing Instructions"**) for making payments to the Independent Auditor in accordance with the Independent Auditor Contract.

18. INSURANCE

18.1 Insurance Policies

18.1.1 The Company, at its sole cost and expense, shall obtain and maintain in effect such Insurance Policies and coverage as is required by the Legal Requirements, the

Financing Documents, Good International Industry Practices, appendix 3 and this clause 18 (the **"Insurance Policies"**), provided that such coverage may be changed from time to time with the prior written consent of the GoS Parties (in consultation with the Independent Appointees), which consent shall not be unreasonably withheld or delayed. Nothing under this clause 18.1 shall prevent the Company, at its sole cost and expense, from procuring insurance cover in addition to those required under this clause 18.1.

18.1.2 Subject to clause 18.4 and compliance with the Legal Requirements, any Insurance Policies or cover placed by the Company shall:

18.1.2.1 be placed through a competitive process; and

18.1.2.2 subject to compliance with other applicable Laws, include reinsurance to the extent of ninety-five percent (95%) of one hundred percent (100%) of sum insured with reputable underwriters having not less than Standard & Poor's A-/AM Best A- or equivalent rating.

18.2 Policy Endorsements

18.2.1 The Company shall cause the insurers to provide the following endorsement items in the Company's 'Third-Party Liability' Insurance Policy (as provided in appendix 3) and, if applicable, umbrella or excess liability Insurance Policies, relating to the ownership, construction, rehabilitation, operation and maintenance of the KWC:

18.2.1.1 the GoS Parties and the Independent Appointees shall each receive at least thirty (30) Days prior notice of any cancellation of the Insurance Policies except in the event of non-payment of premium, in which case the prior notice of cancellation period shall be ten (10) Days and any such notice shall be delivered by facsimile and confirmed in writing delivered by first class mail or, if sent from an office outside Pakistan, by international courier;

18.2.1.2 the insurance shall be primary with respect to the interest of each GoS Party and any other insurance maintained by it is excess and not contributory with such Insurance Policies; and

18.2.1.3 a cross-liability clause shall be made a part of the policy to provide that in the event of claims being made by reason of:

(a) personal or bodily injuries suffered by any employee of one insured thereunder for which another insured thereunder is or may be liable; or

(b) damage to property belonging to any insured thereunder for which another insured thereunder is or may be liable,

then the policy shall cover such insured against whom a claim is made or may be made in the same manner as if separate policies had been issued to each insured thereunder, except with respect to the limits of insurance.

18.2.2 The Company shall cause its insurers to waive all rights of subrogation against the GoS Parties (and their employees and contractors) and the Company (and its employees and Contractors) in respect of a claim arising under its Insurance Policies.

18.2.3 The Company shall be responsible for all deductibles under all policies.

18.3 Evidence of Cover

18.3.1 Not later than thirty (30) Days after the date any of the Insurance Policies and coverage required to be in effect in accordance with this clause 18 are issued, or renewed in accordance with their terms, the Company shall cause its insurers or agents to provide the GoS Parties and the Independent Appointees with such Insurance Policies, and where the Insurance Policies are being renewed, provide Insurance Policies evidencing the same terms and conditions as the expiring policies and coverage.

18.3.2 The Company shall provide the GoS Parties and the Independent Appointees with copies of receipts or statements from the Company's insurers evidencing payment by the Company of the premiums in respect of such Insurance Policies, reinsurance policies and cover.

18.4 Compliance with Insurance Obligations

18.4.1 With regard to clauses 18.1 to 18.3, to the extent that the Company is in compliance with insurance obligations under the Financing Documents which provide wider coverage, terms more favourable to the Company and include the policy endorsements set out in clause 18.2, the Company shall be deemed to be in compliance with its obligations under clauses 18.1 to 18.3.

18.4.2 Failure by the Company to obtain the insurance coverage or Insurance Policies required by clauses 18.1 or 18.3, respectively, shall not relieve the Company of its obligations under this clause 18 or in any way relieve or limit the Company's obligations and liabilities under any other provision of this Agreement.

18.4.3 If the Company fails to procure or maintain any insurance required pursuant to this clause 18, then the GoS Parties shall have the right to procure such insurance at the Company's expense, provided that the GoS Parties shall provide a twenty (20) Days prior notice to the Company of their intention to exercise such right, unless such intention arises from the Company's non-payment of premiums for existing insurance, in which case the GoS Parties shall provide at least five (5) Days' prior notice of such intention.

18.4.4 If the Company fails to reimburse the GoS Parties for such premiums within seven (7) Days of being notified to so do, the GoS Parties shall be entitled to payment of such amount(s) under the Performance Securities or by deducting such amount(s) from any payments due to the GoS Parties by the Company.

18.5 Application of Proceeds

Subject to clause 19.10, the Company shall apply any and all insurance proceeds received in connection with the damage to or loss of the KWC, toward the repair, reconstruction or replacement of the KWC, in accordance with the provisions of this Agreement.

19. FORCE MAJEURE

19.1 Force Majeure Event

A **"Force Majeure Event"** means any circumstance, event or condition (or combination thereof) beyond the reasonable control, directly or indirectly, of the Affected Party but only to the extent that:

19.1.1 such circumstance, event or condition, despite the exercise of diligence, cannot be prevented, avoided or overcome by the Affected Party;

19.1.2 such circumstance, event or condition prevents the performance by the Affected Party of its obligations under or pursuant to this Agreement (save for payment obligations);

19.1.3 such circumstance, event or condition was not foreseeable, or if foreseeable, could not have been prevented or avoided or overcome by the Affected Party having taken all reasonable precautions and due care;

19.1.4 the Affected Party has taken all reasonable precautions, due care and measures to prevent, avoid or overcome the effect of such circumstance, event or condition on its ability to perform its obligations under this Agreement and to mitigate its consequences;

19.1.5 such circumstance, event or condition is not the direct or indirect result of a breach or failure by the Affected Party to perform any of its obligations under this Agreement or any other Project Agreement (as the case may be);

19.1.6 such circumstance, event or condition is without fault or negligence of the Affected Party; and

19.1.7 the Affected Party has given the other Party notice in accordance with clause 19.5.1,

and shall consist of "Natural Force Majeure Events" and "Political Force Majeure Events".

19.2 Natural Force Majeure Event

A **"Natural Force Majeure Event"** means a Force Majeure Event which is not a Political Force Majeure Event, including:

19.2.1 lightning, fire, earthquake, unusual flood, storm, cyclone, tornado, tsunami, typhoon or other natural disaster or act of God;

19.2.2 pandemic, epidemic or plague;

19.2.3 accident, explosion or chemical contamination;

19.2.4 strikes, works to rule or go-slows (other than solely by employees of the Affected Party or its Affiliates);

19.2.5 the discovery of hydrocarbons on, under or within the Site; and

19.2.6 the discovery of unexploded bombs or munitions on or within the Site.

19.3 Political Force Majeure Event

A **"Political Force Majeure Event"** means:

19.3.1 acts of war (whether declared or not), invasion, armed conflict, act of foreign enemy or blockade in each case occurring within Pakistan or directly involving Pakistan;

19.3.2 acts of rebellion, riot, civil commotion, strikes of a political nature, act or campaign of terrorism, or sabotage of a political nature, in each case, occurring within Pakistan;

19.3.3 any boycott, sanction, embargo penalty or other restriction imposed directly on Pakistan by the government of [***insert main equipment and materials countries of origin***] during the period up to and including the latest of the Project Commercial Operations Date or the expiry of the relevant warranty period stipulated in the EPC Contract;

19.3.4 any action or failure to act by a Competent Authority, including any action or failure that results in any Approval:

19.3.4.1 ceasing to remain in full force and effect; or

19.3.4.2 not being issued or renewed in a timely manner upon due application having been made,

provided that the proper exercise of any rights of a Competent Authority in response to a Company default under or breach of the terms of any Approval, or any breach of any Legal Requirements by the Company, shall not constitute a Political Force Majeure Event; and

19.3.5 a Change in Law.

19.4 Certain Events Not Force Majeure Events

Notwithstanding that a Force Majeure Event may otherwise exist, the provisions of this clause 19 shall not excuse:

19.4.1 failure to make a payment of money in accordance with the Party's obligations under this Agreement;

19.4.2 any failure by the Company or its Contractors to obtain or maintain any Approval due to negligence or default by the Company or such Contractor;

19.4.3 any failure to research, consider, plan for or take into account reasonably foreseeable ground and weather conditions at the Site;

19.4.4 any failure by a Contractor which results in the failure or inability of the Company to perform its obligations under this Agreement where the cause of such failure by the Contractor would not otherwise constitute a Force Majeure Event pursuant to this Agreement;

19.4.5 late performance by the Company or any Contractor, caused by the failure of the Company or such Contractor for any reason, including failure to engage qualified sub-

contractors and suppliers, failure to hire an adequate number of personnel or labour, or any failure of sub-contractors hired by the Company to perform their respective obligations;

19.4.6 late delivery of equipment, machinery, plant or materials caused by default, negligent acts or omissions on part of the Company or any Contractor;

19.4.7 inability to obtain or maintain adequate funding for the Project;

19.4.8 mechanical or electrical breakdown or failure of equipment, machinery or plant owned or operated by any Party due to the manner in which the equipment, machinery or plant has been operated or maintained;

19.4.9 delays resulting from reasonably foreseeable unfavourable weather (including monsoon) or sea conditions or other similar reasonably foreseeable adverse conditions;

19.4.10 delay or non-performance of any Project Activities as a result of SARS-CoV-2, except where the Company is restricted from undertaking Project Activities at the Site due to measures imposed by a Competent Authority; and

19.4.11 submission of documents and/or drawings for approval by the GoS Parties or the Independent Appointees at a time which does not leave sufficient time for review thereof by the GoS Parties or the Independent Appointees within the time periods provided therefor in this Agreement.

19.5 Obligations

19.5.1 If a Party (the **"Affected Party"**) desires to invoke a Force Majeure Event as a cause for delay or failure in performance of any of its obligations under this Agreement (other than payment of money), it shall:

19.5.1.1 as soon as reasonably practicable (and in any event no later than ten (10) Days) after the Affected Party first had knowledge of the occurrence of a Force Majeure Event, as a condition precedent to its entitlement under this clause 19, give notice to the other Parties and the Independent Appointees of the circumstance, event or condition which it alleges constitutes the Force Majeure Event and an estimate of its likely duration. If the Affected Party does not deliver such notice in accordance with the terms hereof, such Affected Party shall not be entitled to invoke the benefits of clauses 3.3.1, 3.6.1, 8.4.1, 19 or 20 of this Agreement in respect of the relevant Force Majeure Event;

19.5.1.2 within ten (10) Days of the date of a notice issued pursuant to clause 19.5.1.1, provide a written report identifying the Force Majeure Event and the Affected Party's understanding of its effects, including particulars of the circumstance, event or condition, a general description of the obligations likely to be affected, an estimate of its likely duration and a statement of the actions to be taken in order to comply with its obligations under this clause 19. If the Affected Party does not deliver such report in accordance with the terms hereof, such Affected Party shall not be entitled to invoke the

benefits of clauses 3.3.1, 3.6.1, 8.4.1, 20 or 21 of this Agreement in respect of the relevant Force Majeure Event; and

19.5.1.3 from time to time, at reasonable intervals, and upon any reasonable request from any other Party, provide updates as to the matters set out in clause 19.5.1.2.

19.5.2 The Affected Party shall:

19.5.2.1 make all reasonable efforts to prevent and reduce to a minimum and mitigate the effect of any Force Majeure Event, including recourse to alternate sources of services, equipment and materials, provided that, if there occurs a Force Majeure Event, the effects of which cannot be mitigated by the Company, and results in the KWC not delivering (wholly or partially) Net Water Output, the GoS Parties shall have the right to take such actions as are necessary to resume delivery of Net Water Output to ensure water is provided to end-consumers;

19.5.2.2 as soon as reasonably possible, and in accordance with Good International Industry Practice, ensure the resumption of normal performance of this Agreement after the cessation of any Force Majeure Event or its effects and shall otherwise perform its obligations under this Agreement to the extent not excused under this clause 19; and

19.5.2.3 within three (3) Days following the cessation of any Force Majeure Event, submit to the other Parties reasonable proof of the nature of such delay and its effect upon the performance of its obligations under this Agreement.

19.5.3 With respect to the Company only, if a Force Majeure Event occurs that affects the Company, such event may only be invoked with respect to the part of the Project affected by such event and not with respect to any other part of the Project not so affected, provided that, with respect to the operation of any part of the Project not so affected, such part of the Project is capable of independent or partial operation in accordance with Good International Industry Practice.

19.6 Effects of a Force Majeure Event Generally

The Affected Party shall not be liable for any delay or failure in performing its obligations under this Agreement due to a Force Majeure Event, provided that no relief shall be granted to the Affected Party pursuant to this clause 19 to the extent that such failure or delay:

19.6.1 would have nevertheless been experienced by the Affected Party had the Force Majeure Event not occurred; or

19.6.2 was caused by the failure of the Affected Party to comply with its obligations under clause 19.5.1.

19.7 Effects of a Force Majeure Event during C&O Period

If, during the C&O Period, a Force Majeure Event occurs which results in material damage to or loss of the KWC (while in the custody, care and control of the Company) or a delay in

achieving the Project Commercial Operations Date, in addition to any remedies the Company may have under clause 8.4 or clause 20:

19.7.1 the Parties and the Independent Appointees shall consult with one another as soon as practicable after the giving of a notice as provided in clause 19.5.1.1 concerning the effect of such Force Majeure Event upon the Implementation Schedule, and the Implementation Schedule shall be adjusted equitably taking into account the effect which the Affected Party reasonably demonstrates is properly attributable to such Force Majeure Event and the ability of such Party to re-schedule its activities to minimise the overall delays to the Implementation Schedule resulting from such event;

19.7.2 if the Parties and the Independent Appointees are unable to agree upon the equitable adjustment to the Implementation Schedule within a period of sixty (60) Days from the date the notice referred to in clause 19.7.1 is received, the Dispute shall be referred for resolution pursuant to clause 27 for the determination of the adjustment to the Implementation Schedule; and

19.7.3 the GoS shall, during the C&O Period, continue to make Output Payments in respect of Net Water Output.

19.8 Effects of a Force Majeure Event After Project Commercial Operations Date

19.8.1 On and from the Project Commercial Operations Date:

19.8.1.1 if a Natural Force Majeure Event affects the ability of:

(a) the Company to meet the Contracted Availability; or

(b) KW&SB to perform its obligations under this Agreement,

GoS shall, during the NFME Period, continue to make:

(i) Availability Payments based on the extent the KWC is capable of delivering Net Water Output as determined by the Independent Engineer (regardless of whether KW&SB is able to take delivery of Net Water Output at the Output Water Connection Point and without applying the Deduction for Reduced Water Availability); and

(ii) Output Payments, in respect of Net Water Output;

19.8.1.2 if a Political Force Majeure Event affects the ability of the Company to meet the Contracted Availability, the GoS shall, during the PFME Period, continue to make:

(a) Availability Payments in respect of Deemed Availability (without applying the Deduction for Reduced Water Availability); and

(b) Output Payments in respect of Net Water Output;

19.8.1.3 If a Political Force Majeure Event does not affect the ability of the Company to meet the Contracted Availability, but affects the ability of the Company

to deliver Net Water Output to KW&SB, the GoS shall, during the PFME Period, continue to make:

(a) Availability Payments; and

(b) Output Payments in respect of Net Water Output; and

19.8.1.4 if a Political Force Majeure Event affects the performance of KW&SB's obligations under this Agreement, GoS shall, during the PFME Period, continue to make:

(a) Availability Payments; and

(b) Output Payments in respect of the Net Water Output.

19.8.2 If the Company has incurred or suffered any Increased Cost as a result of a Political Force Majeure Event, the provisions of clause 20 shall apply.

19.9 Extension of Term

19.9.1 Without prejudice to the foregoing, if on or after the Project Commercial Operations Date:

19.9.1.1 there occurs a Natural Force Majeure Event affecting the Company, the Concession Period shall be extended by the period equivalent to the period during which the Contracted Availability (subject to deduction for Outages determined by the Independent Appointees) cannot be met (such extension to be reduced proportionately to the extent the KWC is partially Available and/or to the extent the Company receives insurance proceeds in respect of loss of revenue, compensating it for such Unavailability); and

19.9.1.2 there occurs a Political Force Majeure Event, the Concession Period may, at the GoS Parties' option, be extended by a period equivalent to any period of relief for a Political Force Majeure Event during which GoS has continued to pay the Availability Payments, provided that during any such extension period, GoS shall be obliged to pay only Component BW of the Availability Payment (determined pursuant to appendix 8) in respect of Contracted Availability, respectively.

19.9.2 Any extension period under clause 19.9.1.2 shall run successively with any extension granted under clause 19.9.1.1.

19.10 Reinstatement of the KWC

19.10.1 If a Force Majeure Event causes an Event of Loss, the Company shall rebuild, repair and/or restore the KWC, using all insurance proceeds or other amounts actually received on account of the Event of Loss, except proceeds from delay in start-up or business interruption insurance (collectively, **"Casualty Proceeds"**), together with any other amounts that are available to the Company for such rebuilding, repair and/or restoration, in accordance with this clause 19.10.

19.10.2 All Casualty Proceeds received by the Company shall be deposited by the Company into a restoration account segregated from all other funds of the Company (the **"Restoration Account"**) to be applied as provided in clause 19.10.5. The Company:

19.10.2.1 shall diligently pursue all of its rights to compensation against any person with respect to such Event of Loss;

19.10.2.2 may, in the reasonable judgement of the Company, compromise or settle any claim against any person with respect to such Event of Loss; and

19.10.2.3 shall hold all amounts of Casualty Proceeds (including financial instruments) received by the Company in respect of any Event of Loss (after deducting all reasonable expenses incurred by the Company in litigating, arbitrating, compromising or settling any claims) in the Restoration Account.

19.10.3 As soon as reasonably practicable but no later than the date of receipt by the Company of any Casualty Proceeds, the Company shall make a good faith determination as to whether:

19.10.3.1 the KWC or such portion thereof that has been affected by the Event of Loss can be rebuilt, repaired, or restored to permit operations of the KWC or such portion thereof on a commercially feasible basis; and

19.10.3.2 the Casualty Proceeds, together with any other amounts that are available to the Company for such rebuilding, repair and/or restoration, are sufficient to permit such rebuilding, repair and/or restoration of the KWC or such portion thereof.

19.10.4 The determination of the Company under clause 19.10.3 shall be evidenced by a certificate of a responsible officer of the Company to be delivered to the Independent Appointees and the GoS Parties which, in the event the Company determines that the KWC or such portion thereof can be rebuilt, repaired and/or restored to permit operation thereof on a commercially feasible basis, shall also set out a reasonable good faith estimate by the Company of the total cost of such rebuilding, repair and/or restoration.

19.10.5 If the Parties agree or the Independent Appointees determine under clause 19.10.3 that:

19.10.5.1 the KWC cannot be rebuilt, repaired and/or restored to permit operations on a commercially feasible basis or that the Casualty Proceeds, together with any other amounts that are available to the Company for such rebuilding, repair and/or restoration, are not sufficient to permit such rebuilding, repair and/or restoration, then any Commercial Party may elect to terminate this Agreement in accordance with clause 21.8.3 and all of the Casualty Proceeds shall be distributed in the following order of priority:

(a) first, to the payment of costs and expenses actually incurred and duly evidenced by the Company in the performance of its obligations under clause 19.10.7 and not already compensated for by way of payments otherwise received by the Company;

(b) second, to the payment of any amount due to the GoS Parties under the Project Agreements; and

(c) third, to the Company or to whomever may be lawfully entitled to receive the same or as a court of competent jurisdiction may direct, any surplus then remaining from such proceeds;

19.10.5.2 only a portion of the KWC can be rebuilt, repaired and/or restored to permit operations on a commercially feasible basis and that the Casualty Proceeds, together with any other amounts that are available to the Company for such rebuilding, repair and/or restoration, are sufficient to permit such rebuilding, repair and/or restoration, then GoS may elect to terminate this Agreement in accordance with clause 21.8.3 and all of the Casualty Proceeds shall be distributed in the following order of priority:

(a) first, to the payment of costs and expenses actually incurred and duly evidenced by the Company in the performance of its obligations under clause 19.10.7 and not already compensated for by way of payments otherwise received by the Company;

(b) second, to the payment of any amount due to the GoS Parties under the Project Agreements; and

(c) third, to the Company or to whomever may be lawfully entitled to receive the same or as a court of competent jurisdiction may direct, any surplus then remaining from such proceeds;

or, if the GoS is not entitled to or does not elect to terminate this Agreement:

(a) the amount equal to the estimate of the total cost of such rebuilding, repair and/or restoration agreed by the Parties or determined by the Independent Appointees shall be deposited in the Restoration Account to be applied towards the costs of rebuilding, repairing and/or restoring such portion of the KWC; and

(b) the amount, if any, by which all of the Casualty Proceeds exceed the estimate of the total cost shall be distributed in the following order of priority:

(i) first, to the payment of any amount due to the GoS Parties under the Project Agreements; and

(ii) second, to the Company or to whomever may be lawfully entitled to receive the same or as a court of competent jurisdiction may direct, any surplus then remaining from such proceeds; or

19.10.5.3 the KWC (if applicable) can be rebuilt, repaired and/or restored to permit operation on a commercially feasible basis and the Casualty Proceeds, together with any other amounts that are available to the Company for such

rebuilding, repair and/or restoration, are sufficient to permit such rebuilding, repair and/or restoration, then all of the Casualty Proceeds, together with such other amounts as are available to the Company for such rebuilding, repair and/or restoration, shall be deposited in the Restoration Account to be applied toward the costs of rebuilding, repairing and/or restoring the KWC.

19.10.6 It is agreed that the Company shall not be required to deposit any Availability Payments payable by GoS under this Agreement, including in relation to:

19.10.6.1 Availability Payments under clause 8.4;

19.10.6.2 Contracted Availability under clause 19.8.1.1; and

19.10.6.3 Deemed Availability under clause 19.8.1.2,

into the Restoration Account or otherwise apply such Availability Payments to the rebuilding, repairing and/or restoring of the KWC or any part thereof pursuant to this clause 19.10.6 in an Event of Loss.

19.10.7 Upon the occurrence of an Event of Loss, the Company shall immediately take all necessary action, consistent with applicable Legal Requirements, to secure and make safe the KWC and the Site.

19.10.8 If the Company is required to restore the KWC, the Company shall promptly commence any restoration work and shall diligently pursue the same to completion, subject to a reasonable allowance for the time needed to adjust any insurance claims. Before the Company shall commence any such restoration, and at all times during the course of such restoration, the Company shall pay the GoS Parties all amounts due to the GoS Parties under the Project Agreements. In addition, at all times, the Company shall continue to perform and observe all of the terms, covenants, conditions, agreements and obligations of the Company to be performed under this Agreement and the other Project Agreements notwithstanding any Event of Loss.

19.10.9 If, at any time during restoration pursuant to clause 19.10.8, the Independent Engineer believes that the Company is not diligently pursuing the restoration activities, the Independent Engineer will specify a reasonable restoration timetable and if the Company subsequently fails to adhere to such timetable, the Company shall not be entitled to receive Availability Payments with respect to Deemed Availability pursuant to clause 19.8 until such time as restoration is complete and the Company has resumed normal performance of this Agreement in accordance with clause 19.5.2.2.

19.10.10 For the avoidance of doubt, in the event that only a part of the KWC is rebuilt, repaired and/or restored to allow operation on a commercially feasible basis as referred to in clause 19.10.5.2, the GoS shall continue to make Availability Payments under clause 19.8.1.2 in respect of the portion of the KWC that was unable to be rebuilt, repaired and/or restored, subject to clause 21.8.2.2.

20. INCREASED COSTS OR SAVINGS

20.1 Claim for Increased Costs or Savings

20.1.1 If:

20.1.1.1 any Party believes that:

(a) a Political Force Majeure Event (other than a Change in Law) has occurred; or

(b) a Change in Law has occurred;

that has resulted in Increased Costs or Savings; or

20.1.1.2 the Company believes that:

(a) a failure to achieve the Commencement Date by the Scheduled Commencement Date (under the circumstances described in, and prior to any adjustment pursuant to, clause 3.6.1); or

(b) a Relief Event;

has resulted in an Increased Cost,

then such Party shall promptly (and in any event within ten (10) Days after the affected Party first had knowledge of the relevant event or circumstance) and as a condition precedent to its entitlement to recover Increased Costs or Savings under this clause 20, issue a notice to the Independent Appointees, specifying:

20.1.1.3 the details of such Increased Costs or Savings;

20.1.1.4 details of the event or occurrence which gave or gives rise to such Increased Costs or Savings, providing reasonable evidence of the economic impact thereof which resulted in such Increased Costs or Savings; and

20.1.1.5 any other details required by this clause 20.1.

Such notification obligations shall be in addition to any notice or other requirements under clause 7 or clause 19 and shall be a condition precedent to a Party's entitlement to recover Increased Costs or Savings under this clause 20.

20.1.2 The Party that has made a claim for Increased Costs or Savings under clause 20.1.1 may thereafter, from time to time, deliver to the Independent Appointees additional notices identifying further Increased Costs or Savings that have resulted or are reasonably expected to result from the same circumstances, provided that any such additional notice shall be given not later than sixty (60) Days after the Party giving such notice, knew of, or should have known of, such additional Increased Costs or Savings.

20.1.3 The Company shall, acting in accordance with Good International Industry Practice, use all reasonable efforts to minimise any Increased Costs and maximise any Savings.

20.1.4 If the Parties are unable to agree with the Independent Appointees on contents of the notice(s) delivered pursuant to clause 20.1.1 or 20.1.2 within sixty (60) Days of receipt thereof, then the Dispute shall be referred for resolution pursuant to clause 27.

20.1.5 To the extent that a claim for Increased Costs or Savings under clauses 20.1.1 or 20.1.2 has been allowed by the Independent Appointees, or otherwise allowed under clause 27:

20.1.5.1 with respect to an Increased Cost, if the Increased Cost occurs:

(a) prior to the Project Commercial Operations Date, the Company shall, to the extent available and permissible under the terms of the Financing Documents, draw on any funds under the Financing Documents, to fund such Increased Costs and/or request for injection of additional equity by the Shareholders; or

(b) during the Operating Period, the Company shall use its best efforts to raise additional capital to fund such Increased Costs; and

20.1.5.2 the GoS shall (in consultation with the Independent Appointees) propose to the Company:

(a) a mechanism to adjust (upward or downwards) either or both of the Availability Payments or Output Payments, as appropriate;

(b) a mechanism to compensate the Company or the GoS (as applicable) through the payment of a lump-sum amount or staggered payments; and/or

(c) an extension to the Concession Period,

which takes account of all relevant circumstances and is structured so as to put the Company into a neutral financial position which results in it deriving neither gain nor loss as a consequence of the relevant event giving rise to the claim under this clause 20.

20.1.6 Notwithstanding the foregoing, any:

20.1.6.1 Political Force Majeure Event; or

20.1.6.2 Relief Event;

that results in Increased Costs shall be funded:

(a) by the Company drawing on any funds available under the Financing Documents or injection of additional equity by the Shareholders;

(b) thereafter, by means of a lump-sum payment by the GoS under clause 20.1.5.2(b); and

(c) in the event that the Company draws on any funds under the Financing Documents pursuant to clause 20.1.5.1(a), the GoS shall propose a mechanism to adjust (at the GoS' discretion) the Availability or Output Payments, as appropriate, as referred to in clause 20.1.5.2(a) to put the Company into a neutral financial position which results in it deriving neither gain nor loss as a consequence of the relevant event giving rise to the claim under this clause 20.

20.1.7 The Parties shall use reasonable endeavours to agree upon the appropriate adjustment or reimbursement mechanism within thirty (30) Days of the Company's receipt of the GoS' proposal under clause 20.1.5.2(b), failing which, the Dispute shall be referred for resolution pursuant to clause 27.2.

20.2 Claims in Aggregate

No Party shall be entitled to assert any claim for Increased Costs or Savings under this clause 20 until:

20.2.1 in the case of any claim for Increased Costs or Savings, asserted prior to the Project Commercial Operations Date, the earlier of: (a) the date thirty (30) Days after the end of the Construction Contract Year in which the relevant event or circumstance entitling the Party to claim Increased Costs or Savings occurred; and (b) the date on which the aggregate of all accrued and outstanding claims of such Party under this clause 20 exceeds the equivalent of Pakistani Rupees one hundred fifty million only (PKR 150,000,000/-); or

20.2.2 in the case of any claim for Increased Costs or Savings, asserted after the Project Commercial Operations Date, the earlier of: (a) the date thirty (30) Days after the end of the Operating Contract Year in which the relevant event or circumstance entitling the Party to claim Increased Costs or Savings occurred; and (b) the date on which the aggregate of all accrued and outstanding claims of such Party under this clause 20 exceeds the equivalent of Pakistani Rupees one hundred fifty million only (PKR 150,000,000/-),

at which time all accrued and outstanding claims of such Party may be asserted, provided that once such claims have been asserted, no future claims may be asserted until such time as all future claims again exceed such threshold, or the next annual deadline is reached.

21. TERMINATION

21.1 Expiry of the Term

Unless terminated earlier in accordance with this clause 21, this Agreement shall expire on the Term Expiry Date.

21.2 Termination due to Non-occurrence of the Mobilisation Date

21.2.1 If the Mobilisation Date is not achieved by the Scheduled Mobilisation Date (as may be extended pursuant to clause 3.3.3) then, provided that the Parties have first used their reasonable endeavours to adjust the Scheduled Mobilisation Date in accordance

with clause 3.3.1, any Commercial Party may terminate this Agreement by issuing a notice of termination to the other Parties, whereupon this Agreement shall terminate on the date of termination specified therein, or such later date as the Commercial Parties may agree in writing and, thereafter no Party shall have any liability to the other, provided that if such failure is due to reasons solely attributable to the Company, the Parties acknowledge and agree that GoS may draw upon and retain the full amount of the C&O Performance Security as payment of liquidated damages for such termination.

21.2.2 The Parties agree that:

21.2.1.1 the full amount of the C&O Performance Security are the actual losses that the GoS Parties will suffer in the event this Agreement is terminated for reasons solely attributable to the Company as set out in this clause 21.2; and

21.2.1.2 there is in any event a commercial justification and legitimate interest in imposing such liquidated damages as a payment for the termination of this Agreement for reasons set out in this clause 21.2 which would not be satisfied by a right to recover damages on an unliquidated basis for such default.

21.3 Termination due to Non-occurrence of the Commencement Date

21.3.1 If the Commencement Date is not achieved by the Scheduled Commencement Date (as may be extended pursuant to clause 3.6.3) then, provided that the Parties have first used their reasonable endeavours to adjust the Scheduled Commencement Date in accordance with clause 3.6.1, either Commercial Party may terminate this Agreement by issuing a notice of termination to the other Parties, whereupon this Agreement shall terminate on the date of termination specified therein, or such later date as the Commercial Parties may agree in writing and, thereafter no Party shall have any liability to the other except for any amounts payable by the GoS in terms of clause 2.3.2 of the EFU Agreement (the **"Value D"**) and provided that if such failure is due to reasons solely attributable to the Company, the Parties acknowledge and agree that the GoS may draw upon and retain the full amount of the C&O Performance Security as payment of liquidated damages for such termination. On payment by the GoS of Value D to the Company, all the Company's right, title and interest in the Project shall stand transferred to the GoS (or its nominee).

21.3.2 The Parties agree that:

21.3.2.1 the full amount of the C&O Performance Security are the actual losses that the GoS Parties will suffer in the event that this Agreement is terminated for reasons solely attributable to the Company as set out in this clause 21.3; and

21.3.2.2 there is in any event a commercial justification and legitimate interest in imposing such liquidated damages as a payment for the termination of this Agreement for reasons set out in this clause 21.3 which would not be satisfied by a right to recover damages on an unliquidated basis for such default.

21.4 Termination for Convenience

21.4.1 The GoS may at its absolute discretion and at any time, terminate this Agreement for convenience by giving at least two (2) Months' notice to the Company, whereupon this Agreement shall terminate on the date of termination specified therein.

21.4.2 If the GoS exercises its right to terminate this Agreement for convenience pursuant to clause 21.4.1, prior to the Commencement Date, the Company shall sell, and the GoS shall purchase (on behalf of KW&SB), the Company's right, title and interest in the Project for Value D.

21.4.3 If the GoS exercises its right to terminate this Agreement for convenience pursuant to clause 21.4.1, after the Commencement Date, the Company shall sell, and the GoS shall purchase (on behalf of KW&SB), the Company's right, title and interest in the Project for Value A.

21.5 Company Event of Default

Except where the relevant event occurs as a consequence of a Relief Event or a GoS Event of Default, each of the following events shall constitute a **"Company Event of Default"**:

21.5.1 a failure by the Company to achieve the Project Commercial Operations Date on or before the Long Stop Date;

21.5.2 a failure by the Company to ensure that the Net Water Output meets the Output Water Quality Specifications, and such failure continues for ten (10) consecutive Days or for thirty (30) Days in a Billing Period;

21.5.3 in the C&O Period, the Actual NRW exceeds thirty-five percent (35%) during any four (4) consecutive Days period;

21.5.4 in the Operating Period, the Actual NRW exceeds fifteen percent (15%) during any four (4) consecutive Days period;

21.5.5 during the C&O Period, the Actual Loss of Water Output exceeds the Projected Losses of Net Water Output by six million eight hundred nineteen thousand one hundred thirty-five (6,819,135) m^3 in any Billing Period or by one million seven hundred four thousand seven hundred eight three point seven five (1,704,783.75) m^3 for five (5) consecutive Days;

21.5.6 during the Operating Period, the Actual Loss of Water Output exceeds the Projected Losses of Net Water Output by six million eight hundred nineteen thousand one hundred thirty-five (6,819,135) m^3 in any Billing Period or by two million two hundred seventy-three thousand forty-five (2,273,045) m^3 for five (5) consecutive Days;

21.5.7 in any Billing Period falling in the C&O Period, Deductions in such Billing Period exceed the Service Payment due in such period (before applying Deductions);

21.5.8 in any Billing Period falling in the Operating Period, Deductions in such Billing Period exceed the Availability Payment due in such period (before applying Deductions);

21.5.9 a failure by the Company to obtain and maintain any Approvals required under the Legal Requirements or by a Competent Authority in order for it to perform its obligations pursuant to this Agreement where the Company has failed to use all reasonable endeavours to obtain or renew such Approvals;

21.5.10 a failure by the Company to pay any undisputed liquidated damages within the time periods specified therefor under clauses 7.3 or 7.4, as applicable, or a failure by the Company to pay any other amount due under this Agreement within sixty (60) Days after such amount has become due and payable;

21.5.11 Abandonment;

21.5.12 a material breach by the Company of its obligations under this Agreement, which is not remedied within sixty (60) Days after notice from a GoS Party to the Company stating that a breach has occurred, identifying the breach and demanding remedy thereof provided that, notwithstanding the exercise of reasonable efforts by the Company, if such breach cannot be cured within the sixty (60) Days following the notice from the GoS Party, the Company shall be afforded a further period of sixty (60) Days within which to cure such breach, provided always that the Company shall throughout such further sixty (60) Days period, exercise reasonable continuous efforts to cure the breach;

21.5.13 a material breach by the Company of the License Agreement;

21.5.14 a material breach by any Sponsor under the EFU Agreement;

21.5.15 termination of the Independent Engineer Contract by the Independent Engineer due to non-payment by the Company or the Sponsors, as applicable;

21.5.16 termination of the Independent Auditor Contract by the Independent Auditor due to non-payment by the Company or the Sponsors, as applicable;

21.5.17 the voluntary filing by the Company of a petition of bankruptcy, moratorium, winding up, or other similar relief and/or the passing of a resolution for the bankruptcy, insolvency, winding up, liquidation or other similar proceeding relating to the Company;

21.5.18 the appointment of a liquidator, custodian or similar person in respect of the Company in a proceeding referred to in clause 21.5.17, which appointment has not been stayed or set aside within sixty (60) Days of such appointment;

21.5.19 the making by a Competent Authority of an order for the winding up or otherwise confirming the bankruptcy or insolvency of the Company, which order has not been set aside or stayed within sixty (60) Days of such making;

21.5.20 a failure of the Company to return the Encashed Sums to the GoS in accordance with clause 12.2.8;

21.5.21 a failure of the Company to comply with its obligation to obtain and maintain the required insurances in accordance with clause 18;

21.5.22 a failure of the Company to establish, keep valid and maintain either of the Performance Securities in accordance with the terms of this Agreement;

21.5.23 a failure of the Company to increase the face amount of the O&M Performance Security by the Estimated Remedial Cost or extend the validity thereof, in each case, in accordance with the clause 21.10.3;

21.5.24 an event of default (howsoever described) has occurred under the Financing Documents;

21.5.25 any conditions to disbursement of debt by the Financing Parties under the Financing Documents have not been satisfied (unless waived in terms thereof);

21.5.26 termination of the Agreement in terms of clause 25.2.2; and

21.5.27 any event constituting a Company Event of Default under a Relevant Agreement.

21.6 GoS Event of Default

Except where the relevant event occurs as a consequence of a failure or delay on the part of the Company or a Company Event of Default, each of the following events shall constitute a **"GoS Event of Default"**:

21.6.1 a failure by the GoS to pay any undisputed Service Payments within thirty (30) Days from the due date therefor;

21.6.2 a failure by the GoS to make any undisputed payment under this Agreement, other than a Service Payment, within ninety (90) Days from the due date therefor;

21.6.3 the termination of the License Agreement due to a breach or default by KW&SB;

21.6.4 the termination of the EFU Agreement due to a breach or default by GoS;

21.6.5 the expropriation, nationalisation or compulsory acquisition of any material asset of the Company or any shares or other interest in the Company by any Competent Authority;

21.6.6 a material breach by a GoS Party of its obligations under this Agreement which is not remedied within sixty (60) Days after notice from the Company to the GoS Parties stating that a breach has occurred, identifying the breach and demanding remedy thereof provided that, notwithstanding the exercise of reasonable efforts by the relevant GoS Party, if such breach cannot be cured within sixty (60) Days following the notice from the Company, the GoS Party shall be afforded a further period of sixty (60) Days within which to cure such breach, provided always that the GoS Party shall throughout such further sixty (60) Days period, exercise reasonable continuous efforts to cure the breach;

21.6.7 a failure of the GoS to keep valid and maintain the GoS Payment Account in accordance with the terms of this Agreement;

21.6.8 a failure of the GoS to keep valid and maintain the GoS Service Payment SBLC (if applicable) in accordance with the terms of this Agreement;

21.6.9 prior the Financing Termination Date, the SBP Debit Authority is no longer valid and effective *unless* replaced with the GoS Termination SBLC in accordance with the terms of this Agreement;

21.6.10 where the GoS has established the GoS Termination SBLC, a failure of the GoS to keep valid and maintain the GoS Termination SBLC in accordance with the terms of this Agreement; and

21.6.11 the occurrence of an Unenforceability Event.

21.7 Termination due to an Event of Default

21.7.1 Upon the occurrence of a GoS Event of Default, the Company may give notice (the **"Company Notice of Intent to Terminate"**) to the GoS specifying in reasonable detail the relevant GoS Event of Default giving rise to such notice and the date upon which the Company proposes to terminate this Agreement, which date shall not be less than thirty (30) Days after the date of the Company Notice of Intent to Terminate or such longer period as specified in this Agreement (the **"GoS Cure Period"**).

21.7.2 Upon the occurrence of a Company Event of Default, the GoS may give notice (the **"GoS Notice of Intent to Terminate"**) to the Company specifying in reasonable detail the relevant Company Event of Default giving rise to such notice and the date upon which the GoS proposes to terminate this Agreement, which date shall not be less than thirty (30) Days after the date of the GoS Notice of Intent to Terminate or such longer period as specified in this Agreement (the **"Company Cure Period"**), provided that upon the occurrence of any of the Company Events of Default under clauses 21.5.17, 21.5.18, or 21.5.19, the GoS may terminate this Agreement immediately.

21.7.3 During the Cure Period, the Commercial Parties shall consult as to what steps shall be taken, and the Defaulting Party shall use its reasonable efforts, to mitigate the consequences of, and cure, the relevant Event of Default.

21.7.4 If, upon the expiry of the Cure Period, the relevant Event of Default has not been cured, unless the Commercial Parties have otherwise agreed, the GoS or the Company (as the case maybe) may issue a notice of termination to the Defaulting Party whereupon this Agreement shall terminate on the date specified therein or such later date as the Commercial Parties may agree in writing.

21.7.5 If this Agreement is terminated by the GoS due to a Company Event of Default:

21.7.5.1 the GoS shall have the right to encash the Performance Securities to their full outstanding value; and

21.7.5.2 the GoS shall have the right, but not the obligation, to purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value D where termination occurs prior to the Commencement Date and for Value B where termination occurs after the Commencement Date, and if the GoS exercises such right, it shall do so by giving notice to the Company.

21.7.6 If this Agreement is terminated by the Company due to a GoS Event of Default, the Company shall require the GoS to purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value D where termination occurs prior to the Commencement Date and for Value A where termination occurs after the Commencement Date, and it shall do so by giving notice to the GoS, and the GoS shall

be obliged to purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for such Value.

21.7.7 In the event that the circumstances giving rise to a Company Event of Default pursuant to clause 21.5.12 constitute a delay which directly impacts the Implementation Schedule and would, following the passage of time if not remedied, give rise to a Company Event of Default pursuant to clause 21.5.1, the GoS undertakes and agrees that it shall not terminate this Agreement with respect to such circumstances other than pursuant to clause 21.5.1 thereof.

21.8 Termination for a Prolonged Force Majeure Event

21.8.1 Subject to clause 21.8.4, the Company shall have the right to terminate this Agreement if a Political Force Majeure Event prevents KW&SB from performing any of its obligations under this Agreement for a continuous period of one hundred twenty (120) Days, provided that, if the GoS elects in such event to continue paying the Availability Payments in respect of Deemed Availability beyond such one hundred twenty (120) Day period, the Company shall not have the right to terminate this Agreement pursuant to this clause 21.8.1.

21.8.2 Subject to clause 21.8.4, the GoS shall have the right to terminate this Agreement if:

21.8.2.1 a Political Force Majeure Event prevents KW&SB from performing any of its obligations under this Agreement for a continuous period of one hundred twenty (120) Days;

21.8.2.2 a Political Force Majeure Event prevents the Company from performing any of its obligations under this Agreement for a continuous period of one hundred twenty (120) Days;

21.8.2.3 one or more Political Force Majeure Events or a combination thereof, results in the GoS incurring Increased Costs; or

21.8.2.4 a Natural Force Majeure Event prevents KW&SB or the Company from performing any of its obligations under this Agreement for a continuous period of one hundred twenty (120) Days.

21.8.3 Subject to clause 21.8.4, either Commercial Party shall have the right to terminate this Agreement if it is agreed, or determined that the KWC cannot be rebuilt, repaired and/or restored pursuant to clause 19.10.5.1, and the GoS shall have the right to terminate this Agreement if it is agreed, or determined that the KWC can only be partially rebuilt, repaired and/or restored pursuant to clause 19.10.5.2, in either case following an Event of Loss caused by a Force Majeure Event.

21.8.4 If a Commercial Party wishes to exercise its right to terminate this Agreement pursuant to clauses 21.8.1, 21.8.2 or 21.8.3, it shall issue a notice of termination to the other Parties specifying the date on which the Party giving such notice proposes to terminate this Agreement, which date shall not be less than sixty (60) Days from the date of such notice. Upon the occurrence of such date, provided that the event giving rise to such notice of termination is continuing, unless the Commercial Parties otherwise agree in writing, this Agreement shall terminate.

21.8.5 If this Agreement is terminated after the Commencement Date by:

21.8.5.1 the Company pursuant to clause 21.8.1, the Company shall have the right to require the GoS to purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value A, and it shall do so by giving notice to the GoS, and the GoS shall be obliged to purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for such Value;

21.8.5.2 the GoS pursuant to clause 21.8.2.1, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value A;

21.8.5.3 the GoS pursuant to clause 21.8.2.2, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value A;

21.8.5.4 the GoS pursuant to clause 21.8.2.3, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value A;

21.8.5.5 the GoS pursuant to clause 21.8.2.4 with respect to a prolonged Natural Force Majeure Event affecting the Company, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value C;

21.8.5.6 the GoS pursuant to clause 21.8.2.4 with respect to a prolonged Natural Force Majeure Event affecting KW&SB, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value C;

21.8.5.7 either Commercial Party pursuant to clause 21.8.3 with respect to an Event of Loss caused by a Political Force Majeure Event that prevents the Company from rebuilding, repairing and / or restoring the KWC (in whole) pursuant to clause 19.10.5.1, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value A;

21.8.5.8 the GoS pursuant to clause 21.8.3 with respect to an Event of Loss caused by a Political Force Majeure Event that prevents the Company from rebuilding, repairing and / or restoring the KWC (in part) pursuant to clause 19.10.5.2, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value A;

21.8.5.9 either Commercial Party pursuant to clause 21.8.3 with respect to an Event of Loss caused by a Natural Force Majeure Event that prevents the Company from rebuilding, repairing and / or restoring the KWC (in whole) pursuant to clause 19.10.5.1, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value C; or

21.8.5.10 the GoS pursuant to clause 21.8.3 with respect to an Event of Loss caused by a Natural Force Majeure Event that prevents the Company from rebuilding, repairing and / or restoring the KWC (in part) pursuant to clause 19.10.5.2, the GoS shall purchase (on behalf of KW&SB) the Company's right, title and interest in the Project for Value C.

21.9 Payments on Termination

All amounts payable pursuant to this clause 21 shall be paid in Pakistani Rupees in immediately available funds as follows:

21.9.1 with respect to any amounts payable by the Company, immediately on the date of termination of this Agreement, by way of credit directly to a bank account designated therefor, in writing, by the GoS; and

21.9.2 subject to clause 21.10.5, with respect to Termination Payments payable by the GoS, by the Termination Payment Date, by way of credit directly to a bank account in Pakistan designated therefor by the Company and advised to the GoS in writing.

The obligations of the GoS under this clause 21.9 shall survive termination of this Agreement until such time as all amounts due and owing by the GoS hereunder have been paid.

21.10 Transfer of the Project

21.10.1 Within one (1) year prior to the Term Expiry Date or within one (1) Month following the Termination Date (as applicable), the Independent Appointees shall carry out such tests and inspections as set out in appendix 5 to determine if the KWC satisfies the Handover Conditions.

21.10.2 If, in the opinion of the Independent Appointees:

21.10.2.1 the KWC meets the Handover Conditions, making allowances for any Force Majeure Event or a GoS Event of Default that may have affected the KWC and for which the Company shall not be responsible, then the Independent Appointees shall issue a Handover Certificate, together with such inspection reports, tests and other data reasonably adequate to substantiate the conclusions reached in the Handover Certificate; or

21.10.2.2 the KWC does not meet the Handover Conditions, making allowances for any Force Majeure Event or a GoS Event of Default that may have affected the KWC and for which the Company shall not be responsible, then as soon as reasonably practicable, and in any event within six (6) Months prior to the Term Expiry Date or within two (2) Months following the Termination Date (as applicable), the Independent Appointees shall issue a report (the **"Remedial Report"**) providing to the Parties (a) a list of the works and services required to be undertaken by the Company to meet the Handover Conditions (the **"Remedial Works"**), (b) a remediation plan, including the time period, for completing the Remedial Works (the **"Remedial Plan"**), and (c) an estimate of the costs of carrying out the Remedial Works (the **"Estimated Remedial Costs"**).

21.10.3 Immediately upon the issuance of a Remedial Report, the Company shall increase the face amount of the O&M Performance Security by the Estimated Remedial Costs and extend the validity thereof to the date falling six (6) Months following the estimated date stated in the Remedial Report for completion of the Remedial Works.

21.10.4 The Company shall complete all Remedial Works in accordance with the Remedial Plan at its own costs and expense. Upon completion of the Remedial Works in accordance with the Remedial Plan, as determined by the Independent Appointees, the Independent Appointees shall issue a Handover Certificate, together with such inspection reports, tests and other data reasonably adequate to substantiate the conclusions reached in the Handover Certificate. Where the Remedial Plan has been prepared following issuance of a Termination Notice, the Termination Payment Date shall be extended (by such period as determined by the Independent Appointees) to account for the timelines stated in the Remedial Plan.

21.10.5 Any Termination Payment due to the Company shall be made by the GoS subject to the issuance of the Handover Certificate.

21.10.6 If the Company fails to comply with the Remedial Plan, unless the Parties agree otherwise, the GoS shall have the option to:

21.10.6.1 encash the O&M Performance Security to the extent of the Estimated Remedial Costs; or

21.10.6.2 deduct the Estimated Remedial Costs from any payments due to the Company from the GoS in terms of this Agreement,

following which (and subject to full recovery of the Estimated Remedial Costs by the GoS), the Handover Certificate shall be deemed as issued.

21.10.7 Upon issuance or deemed issuance (in terms of clause 21.10.6) of the Handover Certificate and (if applicable) payment by the GoS of the Termination Payments under clause 21.9.2, or immediately following the Term Expiry Date, the Company shall transfer to KW&SB, free and clear of all liens and Encumbrances, at no cost to the GoS (other than payment of the Termination Payments, if applicable), all of the Company's right, title and interest in the Project, including insofar as they are a part of or used in the Project, all of the Company's right, title and interest in:

21.10.7.1 all raw materials, consumables and spare parts;

21.10.7.2 all tangible personal property;

21.10.7.3 all intangible personal property, including any Intellectual Property Rights;

21.10.7.4 all buildings and fixtures;

21.10.7.5 computerised and non-computerised records, reports, data, files, and information;

21.10.7.6 all drawings, test results, and documents relating to the Project;

21.10.7.7 all warranties of equipment, materials and work;

21.10.7.8 all contract rights and Insurance Policies;

21.10.7.9 all work in progress under contracts with vendors, suppliers, contractors and subcontractors; and

21.10.7.10 all rights with respect to any insurance proceeds payable to or for the account of the Company, but unpaid at the date of termination of the Agreement, in respect of the Company's right, title and interest in the Project.

21.11 Other Remedies

21.11.1 Except as otherwise expressly provided in this Agreement, upon termination of this Agreement, the Parties shall have no further obligations or liabilities hereunder, save those obligations or liabilities that arose on or before the date, or as a result of termination, shall survive until satisfied in full.

21.11.2 This clause 21 sets out the sole and exclusive grounds upon which this Agreement may be terminated, provided that upon the breach by any Party of any covenant or warranty hereunder, the Party damaged by any such default or breach may, in its sole discretion, in addition to exercising any other remedies provided for hereunder, proceed in accordance with clause 27 to protect and enforce its rights, to recover any damages to which it may be entitled (including all costs and expenses reasonably incurred in the exercise of its remedy), or to seek specific performance by the other Party of such breaching Party's obligations under this Agreement and the other Project Agreements (as the case may be).

21.12 Survival

The provisions of clauses 12, 13, 14.5.4, 21, 22, 26, 27, and 29 shall survive the termination of this Agreement.

22. REINSTATEMENT

The Company shall reinstate the Site if and to the extent that it is required in accordance with the Remedial Report.

23. INDEMNITIES

23.1 Indemnification by the Company

The Company shall indemnify, defend and hold harmless the GoS Parties (and their Affiliates and contractors and respective shareholders, directors, officers, employees, agents or representatives (collectively the **"GoS Indemnified Parties"**)), from and against all Claims made against or suffered by any of the GoS Indemnified Parties in relation to:

23.1.1 any loss of or damage to property or death or injury to persons (except for workers' compensation claims), resulting from any negligent act or omission of the Company or any of the Company Indemnified Parties, or that arising out of or in any manner connected with the performance of this Agreement, except to the extent that such loss, damage, injury or death is attributable to the negligence or misconduct of the GoS Indemnified Parties, or breach of this Agreement by the GoS Indemnified Parties, or the failure of the GoS Indemnified Parties, as applicable, to take reasonable steps in mitigation of the foregoing;

23.1.2 the violation of any Environmental and Social Requirements by any of the Company Indemnified Parties occurring at the Site or in any way related to the KWC, except to the extent that such Claim results from or arises out of:

23.1.2.1 the condition of the affected Site existing prior to the effective date of the License Agreement; or

23.1.2.2 any discharge, release or leaching of any Hazardous Substance on, in, over, under or otherwise affecting the Site (including the soil, subsoil, surface water or ground water on or beneath the Site and the air above the same) caused by a person other than the Company or any of the Company Indemnified Parties;

23.1.3 any use, presence, suspected presence, disposal, discharge, storage, treatment, transportation, handling, generation, leaching, release, or threatened release of any Hazardous Substance on, in, over, under or otherwise affecting the Site and their respective neighbouring properties (including the soil, subsoil, surface water or ground water on or beneath the Site and the surrounding environs and the air above the same):

23.1.3.1 caused by the Company or any of the Company Indemnified Parties;

23.1.3.2 originating from the Site after the Effective Date or, if earlier, the date of issue of the limited notice to proceed under the EPC Contract (if any); or

23.1.3.3 in any way related to the KWC;

23.1.4 the violation of any Legal Requirements arising out of the Company's performance of the Project Activities, including the design, construction, testing, commissioning, operation or maintenance of the KWC;

23.1.5 the performance or non-performance by the Company or the Contractors of their obligations under any of the Project Agreements; and

23.1.6 the presence of the Company Indemnified Parties on the Site.

23.2 Indemnification by GoS

The GoS shall indemnify, defend and hold harmless the Company (and its Affiliates and Contractors and its or their respective shareholders, directors, officers, employees, agents or representatives (collectively the **"Company Indemnified Parties"**), from and against all Claims made against or suffered by the Company or any of the Company Indemnified Parties in relation to any loss of or damage to property or death or injury to persons (except for workers' compensation claims), resulting from any negligent act or omission of the GoS Parties or otherwise that arises out of or is in any manner connected with the performance of this Agreement, except to the extent such loss, damage, injury or death is attributable to the negligence or misconduct of the Company or any Company Indemnified Parties, or breach of this Agreement by the Company, or the failure of the Company or any of the Company Indemnified Parties, as applicable, to take reasonable steps in mitigation of the foregoing.

23.3 Liability

No Party shall be liable to the other in contract, tort, warranty, strict liability, or any other legal theory for any indirect, consequential, incidental, punitive, or exemplary damages, except as expressly provided herein.

23.4 Mitigation

The Parties shall make all reasonable endeavours to mitigate any loss, cost or expense they may suffer as a result of any breach of the other Party's material obligations under this Agreement.

23.5 Joint Negligence

In the event any injury or damage results from the joint or concurrent negligent or intentional acts or omissions of the Parties (as determined by the Independent Appointees), each Party shall be liable under this indemnification in proportion to its relative degree of fault, as determined by the Independent Appointees.

24. ASSIGNMENT

24.1 Assignment with Consent

Save as expressly provided otherwise in this Agreement, no Party shall be entitled to assign or transfer its rights or obligations under this Agreement without the prior written consent of the other Parties.

24.2 Assignment to Financing Parties

23.2.1 The Company shall have the right, in accordance with the Legal Requirements and the Concession and License Direct Agreement, to assign its rights under this Agreement to any Financing Parties or to any third-party security agent or trustee nominated by the Financing Parties. Upon the Company's request, the GoS Parties shall provide such co-operation to the Financing Parties as may be requested by the Financing Parties, including providing acknowledgements and notices to the Financing Parties dealing with matters such as the respective rights and obligations of the Financing Parties and the Company under the Financing Documents, provided that:

23.2.1.1 such co-operation and the terms of such acknowledgements and notices shall not (except as expressly provided in this Agreement) be interpreted as diminishing the GoS Parties' rights and entitlements under this Agreement; and

23.2.1.2 by providing such co-operation, the GoS Parties shall not assume (and shall not be deemed to be assuming) any obligations under the Financing Documents (other than under any Concession and License Direct Agreement).

23.2.2 The GoS Parties agree to enter into the Concession and License Direct Agreement with the Financing Parties in respect of this Agreement as the Company, or the Financing Parties, may reasonably request in connection with the financing of the Project, provided that, in so doing, the GoS Parties shall not assume (and shall not be deemed

to be assuming) any obligations under the Financing Documents (other than as expressly set out in the Concession and License Direct Agreement).

25. REPRESENTATIONS AND WARRANTIES

25.1 Company Representations and Warranties

The Company represents and warrants to each of the GoS Parties as follows:

25.1.1 it is duly incorporated and is validly existing and in good standing under the Legal Requirements;

25.1.2 it has the power and authority to enter into and perform its obligations under this Agreement;

25.1.3 it has the financial standing and capability to undertake and implement the Project in accordance with the terms of this Agreement;

25.1.4 the Sponsors have the financial standing and resources to comply with their obligations under the EFU Agreement;

25.1.5 neither the Company nor the Sponsors have committed a breach in respect of their payment obligations in relation to a financial indebtedness;

25.1.6 this Agreement has been duly authorised, executed and delivered by it and constitutes the legal, valid and binding obligation of it;

25.1.7 there is no pending or threatened litigation or claim which would materially impair its ability to perform its obligations under this Agreement;

25.1.8 the performance of its obligations under this Agreement will not result in the breach of any term or provision of, or constitute a default under, any judgment, decree, indenture, mortgage or other agreement or instrument to which it is a party or by which it is bound, nor will such performance conflict with any charter, by-law or similar provision applicable to it. There are no conflicts or violations of Legal Requirements which would materially affect its right or ability to comply with the terms of this Agreement;

25.1.9 it has no knowledge of any violation or default with respect to any order, writ, injunction or decree of any court or any legally binding order of any Competent Authority which may result in any material impairment of its ability to perform its obligations under this Agreement and no fact or circumstance exists which may give rise to such proceedings that would result in material impairment of its ability to perform its obligations under this Agreement;

25.1.10 it has not been subject to any fines, penalties, injunctive relief or any other civil or criminal liabilities which in the aggregate have or may materially impair its ability to perform its obligations under this Agreement;

25.1.11 no representation or warranty made by the Company and contained herein or in any other document furnished by it to the GoS or to any Competent Authority in relation to the Approvals contains any untrue or misleading statement of material fact or omits or will omit to state a material fact rendering such representation or warranty misleading;

25.1.12 it has not engaged in any fraudulent, collusive, coercive, or obstructive practices or other integrity violations (and is in full compliance with Asian Development Bank's Anticorruption Policy, 1998, as amended from time to time) and no sums, in cash or kind, have been paid or will be paid, by it or on its behalf, to any Person by way of fees, commission or otherwise, in each case for securing the Concession or entering into this Agreement or any other Project Agreement, or for influencing or attempting to influence any officer or employee of the GoS, KW&SB or any other Competent Authority in connection therewith; and

25.1.13 the Company has undertaken all acts and deeds necessary and complied with all Legal Requirements and the RFP for the award of the Concession to the Company and the performance of its obligations under this Agreement.

25.2 Breach of Representations and Warranties

25.2.1 In the event that any occurrence or circumstance renders any of its representations or warranties incorrect, the Company shall immediately notify the GoS Parties and the Independent Appointees of the same and take reasonable steps to ensure compliance with its representations or warranties. Such notification shall not have the effect of remedying any incorrect representation or warranty made by the Company nor shall it adversely affect or waive any right, remedy or obligation of the Parties under this Agreement.

25.2.2 In the event any statement, representation or warranty made by the Company in this Agreement is rendered incorrect, in any material respect, due to any occurrence or circumstance, when made or reaffirmed, and such incorrect statement, representation or warranty has materially impaired the Company's ability to perform its obligations under this Agreement, then such incorrect statement, representation or warranty shall give rise to a Company Event of Default pursuant to clause 21.5.

25.2.3 The representations and warranties under clause 25.1 shall be deemed repeated on the Mobilisation Date, the Commencement Date and each Payment Date.

25.3 GoS Parties' Representations and Warranties

Each GoS Party, severally, represents and warrants to the Company as follows:

25.3.1 it has the power and authority to enter into and perform its obligations under this Agreement;

25.3.2 this Agreement has been duly authorised, executed and delivered by it and constitutes its legal, valid and binding obligation;

25.3.3 there is no pending or threatened litigation or claim which would materially impair its ability to perform its obligations under this Agreement; and

25.3.4 the performance of its obligations under this Agreement will not result in the breach of any term or provision of, or constitute a default under, any judgment, decree, indenture, mortgage or other agreement or instrument to which it is a party or by which it is bound, nor will such performance conflict with any decree, charter, by-law or similar provision applicable to the GoS Party. There are no conflicts or violations of Legal Requirements

that would materially affect its right or ability to comply with the terms of this Agreement.

25.4 Immunity

25.4.1 Each GoS Party unconditionally and irrevocably:

25.4.1.1 agrees that the execution, delivery and performance by it of this Agreement constitutes private and commercial acts and not public or governmental acts;

25.4.1.2 agrees that should any proceedings be brought against it or its assets (other than any of its assets which are significant in respect of national security of Pakistan (the **"GoS Protected Assets"**)) in any jurisdiction in relation to this Agreement or any transaction contemplated by this Agreement, no immunity, sovereign or otherwise, from such proceedings, execution, attachment or other legal process shall be claimed by or on behalf of itself or with respect to any of its assets (other than the GoS Protected Assets); and

25.4.1.3 waives any such right of immunity, sovereign or otherwise, which the GoS or its assets (other than the GoS Protected Assets) now has or may acquire in the future, in respect of proceedings under this Agreement.

25.4.2 The Company expressly and irrevocably waives any immunity in any jurisdiction in respect of this Agreement and/or any matters arising hereunder including any obligation, liability, or responsibility hereunder.

25.5 Project Implementation Unit

25.5.1 The Project Implementation Unit shall:

25.5.1.1 oversee day to day implementation of the Project on behalf of the GoS Parties in accordance with the Legal Requirements;

25.5.1.2 together with KW&SB and the Company, develop and establish a grievance redress mechanism in accordance with the Legal Requirements and the E&S Standards (and accounting for all consultations and engagements conducted pursuant to clauses 4.10.1 and 4.10.2) to record, address, and manage grievances related to the Project Activities, including a focus on:

(a) the Settlements;

(b) KW&SB employees; and

(c) other Stakeholders (the **"Grievance Redress Mechanism"**); and

25.5.1.3 forward any matter, which cannot be resolved in accordance with the Grievance Redress Mechanism, to the Public Private Partnership Policy Board for resolution.

25.5.2 The Company shall provide all necessary cooperation and coordination:

25.5.1.4 to the Project Implementation Unit to allow it to carry out its functions; and

25.5.1.5 to KW&SB and the Project Implementation Unit to ensure Stakeholder grievances (whether addressed to the Company or otherwise) are adequately and timely resolved.

26. GOVERNING LAW

This Agreement and any non-contractual obligations arising out of or in connection with it shall be governed by and construed in accordance with the Laws.

27. DISPUTE RESOLUTION

27.1 Negotiation

The Parties agree to attempt to resolve any Dispute promptly, amicably, and in good faith. Each Party shall designate a representative who shall be entitled to enter into discussions to resolve by amicable agreement any Dispute in connection with this Agreement.

27.2 Public Private Partnership Policy Board

If any Dispute is not finally resolved between the Parties pursuant to the clause 27.1 within thirty (30) Days from the date on which a Party receives notice from any of the other Parties that a Dispute exists, then the Parties shall endeavour to settle the Dispute in an amicable manner by mediation administered by an independent and impartial person appointed by the Public Private Partnership Policy Board. If any Dispute is not resolved between the Parties pursuant to this clause 27.2 within sixty (60) Days from the date on which the matter has been referred by the Public Private Partnership Policy Board to an independent and impartial person so appointed, then such Dispute shall be settled exclusively and finally in accordance with clause 27.3.

27.3 Arbitration

27.3.1 Each of the Parties unconditionally and irrevocably agrees in respect of a Dispute, which cannot be resolved by the Parties pursuant to clause 27.2:

27.3.1.1 to the submission of such Dispute to binding arbitration governed by the Arbitration Act 1940, by appointment of three (3) arbitrators, of which, one (1) shall be appointed jointly by the GoS Parties, one (1) shall be appointed by the Company, and one shall be appointed jointly by the two (2) arbitrators appointed by the GoS Parties and the Company (the **"Arbitrators"**). Any arbitration proceedings commenced pursuant to this clause 27.3.1 shall be referred to as Arbitration (**"Arbitration"**);

27.3.1.2 not to claim any right it may have under the Laws to hinder, obstruct, or nullify the submission of the Dispute to Arbitration; and

27.3.1.3 to accept the Award rendered by the Arbitrators and any judgment entered thereon by a court of competent jurisdiction as final and binding and not to hinder, obstruct or nullify the enforcement or execution of any decision rendered by the Arbitrators or court of competent jurisdiction.

27.3.2 The place of Arbitration shall be Karachi, Pakistan.

27.3.3 The language of Arbitration shall be English.

27.3.4 Any decision or award resulting from the Arbitration (**"Award"**) shall be final and binding upon the Parties.

27.3.5 The Parties hereby waive, to the extent permitted under the Laws, any rights to appeal or to review of such Award by any Competent Authority.

27.3.6 The fees and expenses of the Arbitrators and all other expenses relating to Arbitration shall be borne and paid by the respective Parties, unless the Award states otherwise. The Arbitrators may provide in the Award, for reimbursement to a Party, of its costs and expenses in bringing or defending the Arbitration claim, including legal fees and expenses incurred by such Party.

27.3.7 This Agreement and the rights and obligations of the Parties shall remain in full force and effect pending the Award for any Arbitration, which Award, if appropriate, shall determine whether and when any termination shall become effective.

27.4 Exclusive Jurisdiction

No Party shall have the right to, nor shall they, commence or maintain any legal proceedings in or outside of Pakistan, concerning a Dispute, until the Dispute has been resolved in accordance with clauses 27.2 or 27.3 and then only to enforce or execute an Award.

27.5 Obligations Continuing

Unless otherwise agreed in writing, the existence of a Dispute shall not relieve any Party from the performance of its obligations under this Agreement not the subject of the Dispute.

28. INTELLECTUAL PROPERTY RIGHTS

28.1 Company IPR

28.1.1 The Company (or its relevant licensor) shall retain exclusive ownership of the Company IPR and nothing in this Agreement (other than the licence granted under clause 28.1.2) shall operate to transfer to KW&SB or vest in KW&SB any licence to use or rights in the Company IPR.

28.1.2 The Company hereby grants to KW&SB a perpetual, irrevocable, royalty-free, and non-exclusive licence (with the free right to sub-licence and/or assign to any third party) to use, reproduce and maintain the Company IPR to the extent and for the duration necessary to enable KW&SB to exercise its rights and perform its obligations under this Agreement.

28.1.3 The Company shall ensure that KW&SB is provided with copies of such items of Company IPR as KW&SB may from time-to-time reasonably request.

28.2 Project IPR

28.2.1 The Company shall use its best endeavours to procure that any licence or other arrangement with a third party or a Contractor relating to the Project IPR permits the Company to:

28.2.1.1 grant the licence set out in clause 28.2.2; and

28.2.1.2 make the transfer required by clause 28.2.3.3.

If the Company, despite the use of its best endeavours, is unable to secure the rights described above, the Company shall notify KW&SB and shall (at its cost) take such other measures as are required to put KW&SB in the position it would have been in if such rights had been procured or as close thereto as is reasonably possible in the circumstances. The Company shall pay any costs resulting from the performance of this clause 28.2.1, save for any on-going fees payable for the maintenance in force of the Project IPR following the Final Expiry Date to the extent such fees are unaffected, directly or indirectly, by its transfer to KW&SB or its nominee, which fees shall, to that extent, be paid by KW&SB.

28.2.2 The Company hereby grants to KW&SB a royalty-free and non-exclusive licence (with the free right to sub-licence and/or assign to any third party) to use, reproduce and maintain the Project IPR to the extent and for the duration necessary to enable KW&SB to exercise its rights and perform its obligations under this Agreement.

28.2.3 On:

28.2.3.1 the Final Expiry Date where KW&SB has elected under the Handover Conditions that the Company should not fully reinstate in terms thereof; or

28.2.3.2 early termination of this Agreement for any reason where the GoS is obliged or has elected to purchase the Company's right, title and interest in the Project in accordance with clause 21.8 and has paid the purchase price in accordance with clause 21.9.2,

the Company shall deliver to KW&SB or its nominee copies of all Project IPR, in each case in the form utilised by the Company in the operation of the Project and either:

28.2.3.3 transfer by way of future assignment to KW&SB all Project IPR and execute a transfer or any other documents necessary to transfer absolutely such Intellectual Property Rights to KW&SB and otherwise to perfect KW'SB's title thereto; or

28.2.3.4 to the extent that Project IPR is capable of use by the Company in any project other than in respect of the Project, grant KW&SB a royalty free, non-exclusive, sub-licensable, irrevocable, perpetual and freely assignable licence to use the Project IPR for any purpose in connection with the Project or the KWC, any such licence to be effective from the Final Expiry Date.

28.3 Breaches of Intellectual Property Rights

28.3.1 The Company shall defend, indemnify and hold the GoS Indemnified Parties harmless against all Claims, costs, charges and expenses arising from or incurred by reason of any actual infringement or alleged infringement of Project IPR licenced to KW&SB under clause 28.2 because of the use by or on behalf of KW&SB of the rights granted under clause 28.2 provided that such infringement has arisen out of the use of the Project IPR in accordance with the terms of this Agreement.

28.3.2 Without in any way limiting the foregoing provisions of this clause 28.3, in circumstances where the Company is liable to indemnify the GoS Indemnified Parties in accordance with clause 28.3.3, the Company shall at KW&SB's request but at the Company's own expense, complete one or more of the following without delay:

28.3.2.1 procure for KW&SB the right to continue to use the Intellectual Property Rights in question; or

28.3.2.2 modify or replace the subject-matter of the activities permitted by this Agreement (at no cost to KW&SB) so that it becomes non-infringing without loss of functionality or compatibility or affecting its use.

29. CONFIDENTIALITY

29.1 Confidentiality Obligation

During the term of this Agreement and after termination or expiry of this Agreement for any reason whatsoever, a Party shall:

29.1.1 keep the Confidential Information confidential;

29.1.2 not disclose the Confidential Information to any other person who is not a Party other than:

29.1.2.1 with the prior written consent of the other Parties; or

29.1.2.2 in accordance with clause 29.2; and

29.1.3 not use the Confidential Information for any purpose other than the performance of its obligations under this Agreement.

29.2 Disclosure

During the term of this Agreement and after termination or expiry of this Agreement for any reason, a Party may disclose the Confidential Information:

29.2.1 in the case of GoS Parties, to any of its ministers, civil servants, directors, officers and employees, and in the case of the Company, to its direct shareholders, directors, officers or employees (each a **"Recipient"**) to the extent necessary to achieve the purposes of this Agreement, provided that:

29.2.1.1 the disclosing Party shall procure that each Recipient is made aware of and complies with the disclosing Party's obligations of confidentiality under this Agreement as if the Recipient was a party to this Agreement; and

29.2.1.2 in no circumstances shall disclosure to the public be permitted pursuant to this clause 29.2.1;

29.2.2 if, and only to the extent, required to disclose such information by judicial, regulatory or administrative process or otherwise in accordance with any law or the rules of any recognised stock exchange applicable to the disclosing Party;

29.2.3 with the consent of the other Parties (not to be unreasonably withheld), in the interests of attracting debt or equity financing for the Project, provided that prior to making such disclosure, the disclosing Party obtains an appropriate confidentiality undertaking from the person to whom the Confidential Information is to be disclosed;

29.2.4 to its Contractors, provided that prior to making such disclosure, the disclosing Party obtains an appropriate confidentiality undertaking from the person to whom the Confidential Information is to be disclosed;

29.2.5 to its legal, financial and/or technical advisors or pursuant to the Financing Documents, provided that prior to making such disclosure, the disclosing Party obtains an appropriate confidentiality undertaking from the person to whom the Confidential Information is to be disclosed; or

29.2.6 in a legal action or proceeding brought by the disclosing Party in pursuit of its rights or in exercise of its remedies; or

29.2.7 to its insurers, provided that prior to making such disclosure, the disclosing Party obtains an appropriate confidentiality undertaking from the person to whom the Confidential Information is to be disclosed.

29.3 Exceptions

The obligations contained in clauses 29.1 and 29.2 shall not apply to any Confidential Information which:

29.3.1 is at the Effective Date in, or at any time after the Effective Date comes into, the public domain other than through breach of this Agreement by the disclosing Party or any Recipient;

29.3.2 can be shown by the disclosing Party to the reasonable satisfaction of the other Parties to have been known to the disclosing Party independently; or

29.3.3 on, before or after the Effective Date, has come lawfully into the possession of the disclosing Party from a third party.

29.4 Press Releases

This prohibition shall not forbid a Party, with the prior written consent of the other Parties, from issuing press releases containing Confidential Information in relation to the progress of the Project.

29.5 Definition

For the purposes of this clause 29, **"Confidential Information"** means this Agreement and all information concerning the Project and the other Parties (or their Affiliates), whether:

29.5.1 in writing, verbally or by any other means; or

29.5.2 acquired directly or indirectly before or after the Effective Date.

30. NOTICES

30.1 Addresses for Service

A notice and all other forms of written communication shall be personally delivered, sent by registered post, sent by facsimile transfer or sent by email to the relevant address below. Notice or communication by email shall only be valid if receipt is confirmed by the recipient acknowledging receipt of the email.

30.1.1 **GoS**

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

30.1.2 KW&SB

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

30.1.3 Company

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

30.2 Deemed Service

A notice or communication shall be deemed to have been made or delivered:

30.2.1 in the case of any communication made by letter, when delivered by hand, by recognised courier or by mail (registered return receipt requested) at the address set out in clause 30.1.1, clause 30.1.2 or clause 30.1.3 (as applicable);

30.2.2 in the case of any communication made by facsimile, when transmitted properly addressed to the facsimile number set out in clause 30.1.1, clause 30.1.2 or clause 30.1.3 (as applicable) and the sender has received a sent receipt; and

30.2.3 in the case of any communication made by email, when transmitted properly addressed to the email address set out in clause 30.1.1, clause 30.1.2 or clause 30.1.3 (as applicable), and the sender has received a sent receipt.

30.3 Changes to Addresses for Service

If a Party changes its notice details set out in clause 30.1, it shall provide the other Parties with prompt notice of any such changes prior to effecting the same.

31. MISCELLANEOUS

31.1 Amendments

This Agreement may be amended only with the prior written consent of all the Parties.

31.2 No Implied Waiver

The failure of any Party to insist upon strict performance of any provisions of this Agreement shall not be construed as a waiver of any such provisions or the relinquishment of any such right for the future.

31.3 Invalidity

The invalidity or unenforceability of any provisions of this Agreement shall be determined in accordance with clause 27.3. The Parties hereby agree to use good faith efforts to negotiate an equitable adjustment to any provisions of this Agreement determined to be invalid or unenforceable with a view towards effecting the purposes of this Agreement, and the validity or enforceability of the remaining provisions of this Agreement shall not be affected by such determination.

31.4 Binding Effect

This Agreement shall be binding upon and inure to the benefit of the Parties and their respective successors, legal representatives and permitted assigns.

31.5 Relationship of the Parties

31.5.1 Nothing contained in this Agreement shall be construed to create an association, trust, partnership or joint venture between the Parties. Each Party shall be liable individually and severally for its own obligations under this Agreement.

31.5.2 Unless stated otherwise herein, the obligations of the GoS in this Agreement are limited to payments due to the Company. The GoS' obligations in this Agreement shall, in no event, extend to the performance obligations of KW&SB.

31.5.3 KW&SB shall not be responsible for any payments due to the Company pursuant to this Agreement by the GoS.

31.5.4 Obligations of the GoS and KW&SB under this Agreement and the Project Agreements are several and not joint.

31.6 Expenses

Without prejudice to the terms of this Agreement, each Party shall pay its own costs and expenses (including the fees and expenses of its agents, representatives, advisors, counsel and

accountants) necessary for the negotiation, execution, delivery, performance of, and compliance with this Agreement.

31.7 Language

This Agreement is being executed in the English language.

31.8 Entire Agreement

This Agreement and its appendices constitute the entire agreement and understanding between the Parties with respect to the subject matter hereof and supersedes all previous understandings, representations, or agreements between the Parties, whether written or oral.

31.9 No Waiver

The granting of any consent, approval or review by the Independent Appointees or a GoS Party to any of the designs, works, plans or time programmes or the manner of implementation of the Project shall not relieve or reduce the Company's responsibility in performing its obligations as stipulated in the Agreement, or its responsibility to achieve the level of performance provided for in the Agreement.

31.10 Counterparts

The Parties may execute this Agreement in counterparts, which shall, in the aggregate, when signed by all the Parties constitute one and the same instrument; and thereafter, each counterpart shall be deemed to be an original instrument as against any Party who has signed it.

APPENDIX 1: TECHNICAL SPECIFICATIONS

[The appendix 1 to the Concession Agreement will comprise Volume II of the RFP and will be inserted at signing with any necessary changes for references to the Proposal.]

APPENDIX 2: IMPLEMENTATION SCHEDULE

1. MOBILISATION AND COMMENCEMENT

Milestones	Date
Effective Date (date of signing of Concession Agreement)	**T**
Scheduled Mobilisation Date	**T + 2 months**
Finalization of ESIA, including all required studies	**T + 3 months**
Installation of Metering Systems and Monitoring Systems	**T + 3 months**
Mobilisation Testing	**T + 4 months**
Project handover to the Company	**T + 4 months**
Start of Site preparation	**T + 2 months**
Proposed Construction Documents submission by the Company	**T + 5 months**
Proposed Construction Documents approval by the Independent Engineer	**T + 6 months**
Scheduled Commencement Date	**T + 6 months**

2. PROJECT COMPLETION

Milestones	Date
Project completion of:	
– KWC rehabilitation;	**T + 12 months**
– new pipeline and associated works;	**T + 16 months**
– pump stations;	**T + 18 months**
– rising mains;	**T + 20 months**
– Treatment Plant and Reservoir rehabilitation;	**T + 19 months**
– Solar Plant; and	**T + 20 months**
– SCADA, metering, and communications.	**T + 21 months**

3. COMMISSIONING

Milestones	Date
Commissioning of canal rehabilitation and connecting pipelines	
– Start of Performance Tests	**T + 22 months**
– Start of Reliability Test Runs	**T + 23 months**

Pumping station 1	
– Start of Start-up Tests	**T + 18 months**
– Start of Performance Tests	**T + 22 months**
– Start of Reliability Test Runs	**T + 23 months**
Pumping station 2 (if any)	
– Start of Start-up Tests	**T + 18 months**
– Start of Performance Tests	**T + 22 months**
– Start of Reliability Test Runs	**T + 23 months**
Commissioning of the Solar Plant	
– Scheduled PV Provisional Acceptance Date	**T + 22 months**
Commissioning of the water treatment plant including Reservoir	
– Start of Start-up Test	**T + 19 months**
– Start of Performance Test	**T + 22 months**
– Start of Reliability Run	**T + 23 months**
Scheduled Project Commercial Operations Date	**T + 24 months**

APPENDIX 3: MINIMUM INSURANCE REQUIREMENTS

INSURANCE FOR CONSTRUCTION ACTIVITIES

1. **Marine Cargo**

Cover	:	Physical loss or damage to all materials, equipment, machinery, spares and other items for incorporation in the C&O Activities on an "all risks" basis whilst in transit by sea, air, or land from the country of origin anywhere in the world to the Site; Cover is to be on the basis of Institute Cargo Clauses (A) plus war, strike, riot and civil commotion and should include a minimum of sixty (60) Days of storage on the Site.
Sum Insured	:	The value of largest shipment or the highest value in temporary storage (as part of the journey to the Site) plus insurance and freight (CIF) whichever is greater. At any time, the shipment value shall not exceed United States Dollars ten million only (USD 10,000,000/-).
Deductibles	:	Not to exceed United States Dollars fifteen thousand only (USD 15,000/-) for each loss.
Period of Insurance	:	From commencement of first shipment to the unloading of final shipment at the Site.
Insured Parties	:	KW&SB, EPC Contractor and all other contractors and sub-contractors of any tier involved in the supply of goods, materials or equipment for incorporation into the Project Activities.
Extensions and Conditions	:	Cover to include: (i) Institute Cargo Clauses "A"; (ii) Institute Cargo Clauses (Air Cargo); (iii) Institute Strikes & War clauses (Cargo); (iv) Institute Strikes & War clauses (Air Cargo); (v) Institute Replacement clause; (vi) Institute Classification clause; (vii) 50/50 clause; and (viii) 200% accumulation clause.

2. **Construction "All Risks"**

Cover	:	Physical loss or damage to the assets installed or rehabilitated as part of the Mobilisation Activities or the C&O Activities, including all equipment, materials, plant, machinery, spares, temporary structures and all other property of whatsoever nature or description (but excluding the construction plant and equipment belonging to or the responsibility of the contractors) to be incorporated in, used or rehabilitated in connection with

the Project, including testing and commissioning.

Sum Insured : The full reinstatement or replacement value of the assets installed or rehabilitated as part of the Mobilisation Activities or C&O Activities, including any "free issue" items.

Deductibles : Not to exceed for each and every occurrence:

(i) United States Dollars twenty thousand only (USD 20,000/-) in respect of testing and commissioning, extended maintenance and defects coverage;

(ii) United States Dollars thirty thousand only (USD 30,000/-) in respect of storm, tempest, flood, tsunami; and

(iii) United States Dollars fifteen thousand only (USD 15,000/-) in respect of all other losses.

Period of Insurance : From the earlier of the notice to proceed as defined in the EPC Contract, the Commencement Date or from the commencement of the construction activity at Site, until the Project Commercial Operations Date, plus cover for minimum twelve (12) Months extended maintenance.

Insured Parties : The GoS Parties, the Company, the EPC Contractor and all other contractors and sub-contractors of any tier, including consultants for their activities on or about the Site only.

Extensions and Conditions : To include:

(i) Offsite storage;

(ii) Inland transit of locally procured materials wholly within Pakistan;

(iii) Strike, riot and civil commotion (unless covered under the Terrorism and Sabotage insurance);

(iv) Insurers to waive all rights of subrogation against the Karachi Water and Sewerage Board (KW&SB) and against all other Insured Parties as provided above;

(v) LEG 2/96 faulty design / defects coverage;

(vi) Escalation provision;

(vii) Inadvertent errors and omissions;

(viii) Claims will be paid in the currency in which the cost is incurred;

(ix) 50/50 clause;

(x) Removal of debris;

(xi) Expediting expenses;

(xii) Public authority requirements; and

(xiii) Professional fees,

and subject to sub-limits based on prevailing insurance market norms.

3. **Third Party Liability**

Cover	:	Legal liability of the Insured Parties as provided below for death or bodily injury to third parties or loss or damage to third party property arising out of or in connection with the Mobilisation Activities and C&O Activities.
Limit of Indemnity	:	No less than United States Dollars ten million only (USD 10,000,000/-) for each occurrence but in the aggregate in respect of sudden and accidental pollution risks.
Deductibles	:	Not to exceed United States Dollars ten thousand only (USD 10,000/-) for each and every occurrence.
Period of Insurance	:	As per the Construction All Risks insurance.
Insured Parties	:	The GoS Parties, the EPC Contractor and all other contractors and sub-contractors of any tier and their respective directors, officers and employees, and including consultants for their activities on or about the Site only.
Geographical Limits	:	Pakistan and including business trips worldwide in connection with the Project.
Extensions and Conditions	:	To include: (i) Cross liability; (ii) Worldwide jurisdiction subject to North American conditions; and (iii) Sudden, unintended and unexpected seepage, pollution and contamination.

4. **Terrorism and Sabotage**

Cover	:	Physical loss or damage and consequent loss of gross profit following delay to the anticipated Project Commercial Operations Date caused by an act of terrorism and/or sabotage to the Project.
Sum Insured	:	A sum which is sufficient to cover the largest foreseeable loss scenario for full reinstatement value of such lost or damaged property.
Indemnity Period	:	Twelve (12) Months from the anticipated Project Commercial Operations Date or as otherwise approved by the Independent Engineer.
Deductibles	:	Not to exceed United States Dollars twenty-five thousand only (USD 25,000/-) in respect of physical loss or damage for each and every occurrence.
Period of Insurance	:	As per the Construction All Risks insurance.
Insured Parties	:	KW&SB, the EPC Contractor and all other contractors and sub-

contractors of any tier.

Geographical Limits : Pakistan.

5. **Marine Delay in Start-Up ("MDSU") Insurance**

Cover : Loss of revenue following delay in start of commercial operations of the Project, as a direct result of physical loss or damage covered under the Marine Cargo Insurance above.

Sum Insured : Estimated gross revenue or an amount at least equal to the estimated amount due to Financing Parties under the Financing Documents and fixed expenses incurred during the Indemnity Period.

Indemnity Period : Not less than twelve (12) Months from the anticipated Project Commercial Operations Date.

Period of Cover : As per Marine Cargo insurance above.

Insured : The borrower and the lenders each for their respective rights and interests.

Deductibles : No more than forty-five (45) Days.

General : To include delay due to damage to the carrying vessel or conveyance.

6. **Delay in Start Up ("DSU") Insurance**

Cover : Loss of revenue following delay in start of commercial operations of the Project as a direct result of physical loss or damage covered under Construction All Risk Insurance above.

Sum Insured : Estimated gross revenue or an amount at least equal to the estimated amount due to Financing Parties under the Financing Documents and fixed expenses during the Indemnity Period.

Indemnity Period : Not less than twelve (12) Months from the anticipated Project Commercial Operations Date.

Period of Cover : As per the Construction All Risks insurance.

Insured : The borrower and the lenders each for their respective rights and interests.

Deductible : No more than sixty (60) Days.

General : To include:

(a) Denial of access; and

(b) Customers' and suppliers' extensions (in respect of FLEXA perils.

7. **Miscellaneous**

Other insurance as is customary, desirable or necessary to comply with the Legal Requirements, such as workers' compensation and employers' liability insurance in relation to all workmen employed in the construction of the Project, and motor vehicle liability insurance for all vehicles owned, hired, leased, used or borrowed for use in Pakistan in connection with the Project.

INSURANCE FOR OPERATIONS AND MAINTENANCE ACTIVITIES (*during the Concession Period*)

From the Commencement Date, as applicable, and renewable annually unless otherwise agreed by KW&SB:

1. **Property Damage "All Risks"**

Cover	:	To cover physical loss or damage to all assets comprising the Project, including but not limited to, buildings and their contents, machinery, spares, fixtures, fittings and all other personal property, against "all risks" of physical loss or damage and machinery breakdown.
Sum Insured	:	An amount sufficient to reinstate the KWC.
Deductibles	:	Not to exceed for each and every occurrence: • United States Dollars twenty-five thousand only (USD 25,000/-) in respect of storm, tempest, flood, tsunami; and • United States Dollars fifteen thousand only (USD 15,000/-) for all other losses.
Period of Insurance	:	From the Project Commercial Operations Date and renewable annually till the Term Expiry Date.
Insured Parties	:	The GoS Parties, the O&M Contractor and all other contractors and sub-contractors of any tier and including consultants for their activities on or about the Site only.
Extensions and Conditions	:	To include: (i) Offsite storage; (ii) Inland transit of locally procured materials wholly within Pakistan; (iii) Strike, riot and civil commotion (unless covered under the Terrorism and Sabotage insurance); (iv) Insurers to waive all rights of subrogation against KW&SB and, in respect of their Site activities only, against all other Insured Parties as provided above; (v) Escalation provision; (vi) Inadvertent errors and omissions; (vii) Claims will be paid in the currency in which the cost is incurred; (viii) Removal of debris; (ix) Expediting expenses; (x) Public authority requirements; and

(xi) Professional fees,

and subject to sub-limits based on prevailing insurance market norms.

2. **Third Party Liability**

Cover	:	Legal liability of the Insured Parties, as provided below, for death or bodily injury to third parties or loss or damage to third party property arising out of or in connection with the ownership, operation, use or maintenance of the Project, including supply of products.
Limit of Indemnity	:	No less than United States Dollars ten million only (USD 10,000,000/-) for each occurrence but in the aggregate in respect of sudden and accidental pollution risks.
Deductibles	:	Not to exceed United States Dollars ten thousand only (USD 10,000/-) for each and every occurrence.
Period of Insurance	:	As per the Property Damage All Risks insurance.
Insured Parties	:	The GoS Parties, the O&M Contractor and all other contractors and sub-contractors of any tier and their respective directors, officers and employees, and including consultants for their activities on or about the Site only.
Geographical Limits	:	Pakistan and including business trips worldwide in connection with the Project.
Extensions and Conditions	:	To include: (i) Cross liability; (ii) Worldwide jurisdiction subject to North American conditions; and (iii) Sudden, unintended and unexpected seepage, pollution and contamination.

3. **Terrorism and Sabotage**

Cover	:	Physical loss following interruption in the O&M Activities by an act of terrorism and/or sabotage to the Project.
Sum Insured	:	A sum which is sufficient to cover the largest foreseeable loss scenario for full reinstatement value of such lost or damaged property.
Indemnity Period	:	Twelve (12) Months from the anticipated Project Commercial Operations Date.
Deductibles	:	Not to exceed United States Dollars twenty-five thousand only (USD 25,000/-) in respect of physical loss or damage for each and every occurrence.
Period of Insurance	:	As per the Property Damage All Risks insurance.

Insured Parties : The GoS Parties, the O&M Contractor and all other contractors and sub-contractors of any tier.

Geographical Limits : Pakistan.

4. **Business Interruption Insurance**

Cover : Loss of revenue as a direct consequence of loss of or damage to the Project insured under Property All Risks Insurance.

Sum Insured : Gross revenue or an amount equal to the estimated amount due to Financing Parties under the Financing Documents due and fixed expenses incurred during the Indemnity Period.

Indemnity Period : Not less than twelve (12) Months.

Period of Cover : As per Property All Risks Insurance above.

Insured : The GoS Parties, the O&M Contractor and all other contractors and sub-contractors of any tier and including consultants for their activities on or about the Site only.

Deductibles : No more than thirty (30) Days for each and every loss.

General : To include denial of access.

5. **Miscellaneous**

Other insurances which are:

(i) customary or necessary to comply with the Legal Requirements, such as contractual insuring responsibility, workers' compensation and employers' liability insurances in relation to all workmen employed in the Project or in connection with its operation; and motor vehicle liability insurance for all vehicles owned, hired, leased, used or borrowed for use in Pakistan in connection with the Project; and

(ii) required by applicable Laws in Pakistan.

APPENDIX 4: CONDITIONS

Part 1: Mobilisation Conditions Precedent

1. Company's Responsibility

It shall be a condition precedent to the Mobilisation Date that each of the following conditions are satisfied and supplied to the Independent Appointees by the Company, unless any such condition precedent is waived or deferred in writing by the GoS:

1.1 copies of the corporate documents (*i.e.*, memorandum and articles of association, certificate of incorporation and certificate of commencement of business (if applicable)) of the Company, duly certified as true copies by the company secretary or director of the Company;

1.2 copies of the corporate documents (*i.e.*, memorandum and / or articles of association, certificate of incorporation, certificate of commencement of business, business license, charter and / or partnership deed (as the case may be) of the Sponsor(s), duly certified as true copies by the company secretary or director or other authorized person of the Sponsor(s);

1.3 copies of the Board Resolutions (or authority letters, in case the Sponsor(s) is a partnership) that duly authorize:

(a) the Company and the Sponsor(s) (as the case may be) to enter into the relevant Project Agreements (to which they are a party) and to undertake the obligations, liabilities, as set out in the applicable Project Agreements, and the transactions as contemplated by the Project Agreements (to which they are a party); and / or

(b) a specified person or persons to:

(i) execute the relevant Project Agreements, on behalf of the Company and the Sponsor(s), to which they are a party; and

(ii) undertake all other acts and to issue and / or execute any document / instrument, specifically relating to and / or under the Project Agreements (to which they are a party), as contemplated therein;

1.4 the Financial Model;

1.5 certified true copies of the signed Financing Documents;

1.6 within thirty (30) Days of the Effective Date, the Company has signed and entered into a valid and effective:

(a) Independent Engineer Contract for the appointment of the Independent Engineer; and

(b) Independent Auditor Contract for the appointment of the Independent Auditor;

1.7 two (2) certified copies of the signed Concession and License Direct Agreement;

1.8 two (2) certified copies of the signed License Agreement;

1.9 evidence of establishment of the:

(a) Independent Engineer Payment Account and issuance of the Independent Engineer Payment Account Standing Instructions; and

(b) Independent Auditor Payment Account and issuance of the Independent Auditor Payment Account Standing Instructions;

1.10 two (2) certified copies of signed EPC Contract(s) and the O&M Contract(s);

1.11 two (2) certified copies of the licenses issued by the Pakistan Engineering Council to the EPC Contractor and the O&M Contractor, for construction and operation works (respectively) in respect of the Project;

1.12 copies of a full or limited notice to proceed (as applicable), in the event the Company has issued a full or limited notice to proceed to the EPC Contractor;

1.13 copies of the Approvals procured by the Company and the same are effective and valid and have not been cancelled and / or rescinded;

1.14 a copy of the Environmental and Social Impact Assessment (ESIA) report, duly approved by the Sindh Environmental Protection Agency, Government of Sindh;

1.15 two (2) certified copies of the evidence of establishment of the Company Payment Account, certified by the bank in which Company Payment Account has been opened by the Company;

1.16 a legal opinion from the legal counsel of the Company confirming that (a) the Company has been duly organized and is validly existing under the laws of Pakistan and has the requisite power and authority to enter into this Agreement and the EFU Agreement and to undertake the transactions as contemplated by this Agreement and the EFU Agreement and to assume the obligations as contained herein and the EFU Agreement and the enforceability of the same against the Company, (b) this Agreement and the EFU Agreement have been duly executed and are legally valid, binding and enforceable against the Company in accordance with the terms herein and the EFU Agreement, and (c) all consents and approvals or actions required to be undertaken, fulfilled and obtained (including the obtaining of any necessary Approvals on behalf of or in the name of the Company) in order for the Company to enter into and comply with its obligations under this Agreement and the EFU Agreement (as the case may be), have been undertaken, fulfilled or obtained;

1.17 a legal opinion from the legal counsel(s) of the Sponsor(s) confirming that (a) the Sponsor(s) has / have been duly organized and is / are validly existing under the laws of the jurisdiction where it / they are incorporated and has / have the requisite power and authority to enter into the EFU Agreement and to undertake the transactions as contemplated by the EFU Agreement and to assume the obligations as contained in the EFU Agreement and the enforceability of the same against the Sponsor(s), (b) the EFU Agreement has been duly executed and is legally valid, binding and enforceable against the Sponsor(s) in accordance with the terms of the EFU Agreement, and (c) all consents and approvals or actions required to be undertaken, fulfilled and obtained (including the obtaining of any necessary Approvals on behalf of or in the name

of the Sponsor(s)) in order for the Sponsor(s) to enter into and comply with its / their obligations under the EFU Agreement, have been undertaken, fulfilled or obtained; and

1.18 such other documents which the GoS may require in connection with the above.

2. KW&SB's Responsibility

It shall be a condition precedent to the Mobilisation Date that each of the following conditions is satisfied and supplied to the Independent Appointees by KW&SB, unless any such condition precedent is waived or deferred in writing by the Company:

2.1 within thirty (30) Days of the Effective Date, KW&SB has signed and entered into a valid and effective:

(a) Independent Engineer Contract for the appointment of the Independent Engineer; and

(b) Independent Auditor Contract for the appointment of the Independent Auditor;

2.2 two (2) certified copies of the signed Concession and License Direct Agreement; and

2.3 two (2) certified copies of the signed License Agreement.

3. GoS' Responsibility

It shall be a condition precedent to the Mobilisation Date that each of the following conditions is satisfied and supplied to the Independent Appointees by the GoS, unless any such condition precedent is waived or deferred in writing by the Company:

3.1 within thirty (30) Days of the Effective Date, GoS has signed and entered into a valid and effective:

(a) Independent Engineer Contract for the appointment of the Independent Engineer; and

(b) Independent Auditor Contract for the appointment of the Independent Auditor;

3.2 two (2) certified copies of the signed Concession and License Direct Agreement; and

3.3 two (2) certified copies of the signed License Agreement.

4. General Conditions Precedent

It shall be a condition precedent to the Mobilisation Date that by the Scheduled Mobilisation Date, as such date may be extended pursuant to the terms of this Agreement, or such later date as the Parties hereto may agree in writing, a closing certificate dated the date of the Mobilisation Date, from:

(i) each Party hereto in favour of the other Parties to the effect that the representations and warranties of each of the GoS Parties and the Company, as the case may be, contained or incorporated by reference herein are true and correct in all material respects on and as of the Mobilisation Date with the same force as though made on and as of the Mobilisation Date; and

(ii) each party to the EFU Agreement in favour of the other parties to the EFU Agreement, to the effect that the representations and warranties of each of the parties to the EFU Agreement, contained or incorporated by reference in the EFU Agreement are true and correct in all material respects on and as of the Mobilisation Date with the same force as though made on and as of the Mobilisation Date.

Part 2: Commencement Conditions Precedent

5. Company's Responsibility

It shall be a condition precedent to the Commencement Date that each of the following conditions are satisfied and supplied to the Independent Appointees by the Company, unless any such condition precedent is waived or deferred in writing by the GoS:

5.1 a letter from the Financing Parties (or an agent of the same) confirming that all conditions precedents to Financial Closing have been satisfied, deferred or waived except:

5.1.1 the issuance of the SBP Debit Authority or GoS Termination SBLC (as applicable); and

5.1.2 the funding of the GoS Payment Account with the GoS Payment Account Required Balance (the **"Partial FC Letter"**);

5.2 not later than thirty (30) Days from the Mobilisation Date, submit the Operating and Maintenance Procedures in accordance with clause 10.3;

5.3 not later than thirty (30) Days prior to the Scheduled Commencement Date, submit the construction manual and the operations and maintenance manuals;

5.4 not later than thirty (30) Days prior to the Scheduled Commencement Date, submit evidence of establishment of the Environmental and Social Management System;

5.5 submit evidence of procurement of all insurances in terms of clause 18;

5.6 submit the Mobilisation Testing Acceptance Certificate in accordance with appendix 5;

5.7 evidence of incorporation of share transfer restrictions for Sponsors, as specified in clause 8 of the EFU Agreement, in the corporate documents of the Company;

5.8 certified copy of the Operations Handover Certificate; and

5.9 such other documents which the GoS may reasonably require in connection with the above;

6. GoS' Responsibility

It shall be a condition precedent to the Commencement Date that each of the following conditions are satisfied and supplied to the Independent Appointees by the GoS, unless any such condition precedent is waived or deferred in writing by the Company:

6.1 following confirmation by the Independent Appointees to the GoS that the Commencement Conditions Precedent set out in paragraph 5.1 of this appendix 4 have been satisfied, deferred or waived and the Partial FC Letter has been issued, evidence of:

(a) establishment of the GoS Payment Account and issuance of the GoS Payment Account Standing Instructions;

(b) the funding of the GoS Payment Account with the GoS Payment Account Required Balance;

(c) establishment of the GoS Equity Account and issuance of the GoS Equity Account Standing Instructions; and

(d) issuance of the SBP Debit Authority or the GoS Termination SBLC (as applicable).

7. General Conditions Precedent

It shall be a condition precedent to the Commencement Date that by the Scheduled Commencement Date, as such date may be extended pursuant to the terms of this Agreement, or such later date as the Parties hereto may agree in writing, that a closing certificate dated the date of the Commencement Date from each Party hereto in favour of the other Parties to the effect that the representations and warranties of the GoS Parties and the Company, as the case may be, contained or incorporated by reference herein are true and correct in all material respects on and as of the Commencement Date with the same force as though made on and as of the Commencement Date.

APPENDIX 5: TESTING

CONTENTS

1. INTRODUCTION 141
2. DEFINITIONS 141
3. GENERAL CONSIDERATIONS 144
4. REPORTING 146
5. INTERNAL AND EXTERNAL AUDITS 146
6. MOBILISATION TESTING 147
7. KWC START-UP TESTS DURING C&O PERIOD 148
8. KWC TRIAL RUN 150
9. KWC PERFORMANCE TEST AND RELIABILITY TEST RUNS 150
10. HANDOVER PERFORMANCE TESTING 154

ATTACHMENT 1: GUARANTEED PERFORMANCE 155

ATTACHMENT 2: GUARANTEED MAXIMUM NOISE LEVELS 156

ATTACHMENT 3: POTABLE WATER QUALITY SPECIFICATIONS 156

1. INTRODUCTION

The Company shall establish the Metering and Monitoring System (including any additional systems) to address all metering and monitoring of inputs to and outputs from the KWC.

The Company shall also develop and implement a proper Metering and Testing Plan to address all metering and monitoring requirements to:

- demonstrate compliance with Legal Requirements;
- demonstrate compliance with its obligations as set out in the Concession Agreement;
- ensure that process monitoring is adequately implemented throughout the KWC including the canal, new pipeline and offtakes, K-III Conduit, pumping stations, rising mains, power supply facilities such as the Solar Plant, and the Treatment Plant, including sludge handling and treated effluent discharge infrastructure.

During the C&O Period, the water quality parameters shall be determined through Mobilisation Testing. During the Operating Period, the main compliance monitoring of the KWC shall focus on the metering, monitoring and analysis of the received and the delivered water, as well as the by-pass discharges. These main compliance criteria shall be measured against the prescribed range of influent volumes and quality and set limits. The combined compliance and impact of events will be applied to the Service Payments and deduction formulae to calculate the Service Payments due to the Company for each Billing Period, in accordance with appendix 8.

The Performance Guarantees included in this appendix 5 constitutes the minimum parameters that are explicitly stated herein, as key performance indicators (KPIs) for the KWC. However, the Company can and should consider more variables in the Metering and Testing Plan that shall be approved by the Independent Engineer. In general, where the method or frequency for any activities is prescribed under Law, the Metering and Testing Plan shall adopt those frequencies and methods.

This appendix 5 is neither addressing nor referring to the quality control and quality assurance testing for construction materials, such as concrete and earthworks, where, for instance, compressive strength or compaction tests are carried out. The Detailed Engineering Design that must be developed by the Company and approved by the Independent Engineer, shall address the necessary materials quality control according to current regulations and engineering standards. This shall be explicitly included in all Construction Drawings and the quality control and assurance plan to be developed by the Company and approved by the Independent Engineer.

2. DEFINITIONS

2.1 General Definitions

"Performance Guarantees" means the performance guarantees of the KWC as provided in attachment 1, attachment 2 and attachment 3 to this appendix 5, including key parameters associated with water quality, water volumes, power consumption, and health and safety.

"Technical Limits" means the water quality design limits of the Treatment Plant, as set out in table 1.1 of attachment 1 of this appendix 5.

Different types of testing are considered in this appendix 5, though the Company can propose a different approach within the Metering and Testing Plan and, eventually, implement it if the Independent Engineer approves of the same.

2.2 Testing during the Mobilisation Period

"Mobilisation Testing" means all the tests to be carried out to assess the condition of the existing KWC prior to the handover of KWC to the Company on the Commencement Date, in accordance with paragraph 6 of this appendix 5.

The Mobilization Period is assumed to last for six (6) Months from the Effective Date, though the testing should be carried out during two (2) weeks, after the implementation of the minimum metering systems in accordance with appendix 1. This Mobilization Testing will set the performance parameters of KWC to be respected by the Company during the C&O Period.

2.3 Testing during the C&O Period

The Metering and Testing Plan shall consider Start-up Tests and Trial Runs according to the following:

"Start-up Tests" means the tests to be performed in respect of the KWC in accordance with paragraph 7 of this appendix 5. This testing shall be performed for the purpose of proving the operational performance of elements, equipment, and ancillary systems of KWC identified in the Metering and Testing Plan. During the Start-up Tests, the Company shall demonstrate that each applicable element of equipment and related system achieves the applicable technical specifications provided by the equipment manufactures as incorporated in the Construction Documents.

- The Start-up Tests can imply testing at the factory of each such item of equipment to ascertain the mechanical, electrical, electronic and structural suitability and reliability, as appropriate. For instance, the tests shall include hydraulic leakage testing of the equipment prior to installation.

- Upon arrival of equipment at the Site, all equipment shall be made available for inspection in order to determine whether any part of the equipment may have been damaged during transit. The equipment shall be installed without delay whenever possible. If the equipment cannot be installed immediately, it must be stored under the manufacturers' recommended and appropriate conditions.

- Upon installation, the Start-up Tests shall confirm the operational reliability of the different elements and equipment.

"Trial Run" means the tests to be performed in respect of the KWC in accordance with paragraph 8 of this appendix 5. This testing shall encompass the entire KWC once all components have been rehabilitated, and construction is finished. A trial run may last for twenty-four (24) hours at least, and it will help the Company to assess the proper performance of the KWC as a prior step before commissioning.

2.4 Testing during the commissioning phase

The commissioning phase of the KWC (which will occur during the C&O Period) once the

construction is finished shall last for three (3) months, and during the commissioning, inflows from Hub Dam shall be introduced into the system in a stable state. During commissioning:

- the inlet works (Head Regulator) and all elements of the KWC will be operational,
- the Company shall monitor and check all equipment at regular intervals in accordance with the checklists established in the Metering and Testing Plan; and
- equipment may be stopped to make adjustments, but the KWC should not stop operations. The control systems shall be tested thoroughly under normal operating conditions with adjustments made to simulate process faults and equipment failures.

Commissioning is deemed completed once the KWC has been fully stabilized and achieves the performance requirements under a full range of anticipated flow conditions.

The following types of testing shall be considered in the Metering and Testing Plan during commissioning, in accordance with paragraph 9 of this appendix 5:

"Performance Tests" means the tests to assess the performance of the entire KWC for at least twenty-four (24) continuous hours, in terms of water losses, water quality, power consumption, and noise levels as set out in attachments 1,2, and 3 of this appendix 5. Acceptance details are given in paragraph 9.3.8 of this appendix 5.

"Reliability Test Runs" means the tests to be carried out in order to assess the reliability of the entire KWC for a period of thirty (30) consecutive Days. Acceptance details are given in paragraph 9.4.4 of this appendix 5.

Once the Performance Tests, the Reliability Test Runs and such other tests agreed and set out in the Metering and Testing Plan are successfully completed, the Independent Engineer shall issue the Project Commercial Operations Certificate.

2.5 Testing during the Operating Period

Testing during the Operating Period shall be defined in the Metering and Testing Plan submitted to the Independent Engineer ninety (90) Days prior to the Schedule Project Commercial Operations Date and may consist of:

"Regular monitoring, metering and testing" during the Operating Period, which include the minimum flow and water quality monitoring requirements for the KWC, taking into consideration the Performance Guarantees. Flow and quality monitoring devices shall be installed, based on Good International Industry Practices, at the locations, and with reference to the metering and monitoring system schedule described in paragraphs 2.6.1 and 2.6.2 of appendix 1. Those are the minimum requirements that shall be defined and implemented according to the Metering and Testing Plan;

"Performance Tests" that are carried out for twenty-four (24) hours at least and **"Reliability Test Runs"** that are performed during thirty (30) consecutive Days, shall also be considered during the Operating Period as a complement to the regular monitoring, metering and testing. The Metering and Testing Plan shall define the frequency and details associated with these types of testing, and they shall be implemented after approval by the Independent Engineer.

"Handover Performance Testing" means all the tests to be carried out to assess the condition of the KWC during the handover from the Company to KW&SB at the end of the Concession Period. This testing shall be like the one carried out during the commissioning stage and will be further defined in the Metering and Testing Plan.

3. GENERAL CONSIDERATIONS

3.1 Metering and Testing Plan

3.1.1 The Company shall be responsible for providing all inputs, materials and other supplies required to carry out all tests under this appendix 5, except the quantity of water required to be provided by KW&SB under clauses 8.2.2 and 8.3.2 of the Concession Agreement.

3.1.2 The overall Metering and Testing Plan for the Project shall be carried out over the following periods:

3.1.2.1 Mobilisation Period, during which, the Mobilisation Testing shall be carried out to set the parameters that should be respected during the C&O Period;

3.1.2.2 C&O Period, during which,

(a) Start-up Tests of the KWC and related equipment and systems;

(b) Performance Test;

(c) Reliability Test Run; and

(d) such other tests as agreed and approved in the Metering and Testing Plan,

shall be carried out; and

3.1.2.3 Operating Period, as per paragraph 2.5 of this appendix 5 including the Handover Performance Tests before handover of the Project in terms of clause 21.10 of the Concession Agreement.

3.1.3 At least thirty (30) Days prior to the start of Mobilisation Testing, the Company shall submit to the Independent Engineer, in writing, all relevant procedures in the Metering and Testing Plan relating to the Mobilisation Testing. At least ninety (90) Days prior to the proposed commencement of any subsequent phases of testing described in paragraphs 2.3, 2.4 and 2.5 of this appendix 5, the Company shall submit to the Independent Engineer, in writing, all relevant procedures in the Metering and Testing Plan, which shall include:

3.1.3.1 the test program and frequencies;

3.1.3.2 the test standards;

3.1.3.3 the type of inspection and tests;

3.1.3.4 the methodology of tests of the KWC;

3.1.3.5 the checklists, including process data to be recorded;

3.1.3.6 the description of instrumentation to be used during testing and calibration of test results;

3.1.3.7 a list of the tests which are to be witnessed by third parties;

3.1.3.8 the quality control procedures;

3.1.3.9 the Company / Contractor manpower allocation and deployment schedule for performing the tests; and

3.1.3.10 the forms of test records and reports.

3.1.4 The Independent Engineer shall have the right, within forty-five (45) Days after receipt of the Metering and Testing Plan, to request the Company to amend the Metering and Testing Plan to include additional tests, which in the opinion of the Independent Engineer should be carried out to establish that the KWC is:

3.1.4.1 installed and capable of being operated according to the design, performance and operation requirements specified in appendix 1; and

3.1.4.2 capable of attaining the requirements of this appendix 5,

and the Company shall incorporate any such reasonable requests in the Metering and Testing Plan.

3.1.5 If the Company and the Independent Engineer are unable to agree upon any additional tests as required under paragraph 3.1.4 of this appendix 5, the Dispute shall be referred for resolution pursuant to clause 27 of the Concession Agreement, provided that the Company shall be entitled to proceed with the testing under its proposed Metering and Testing Plan pending resolution of such matter.

3.2 Right to Witness Inspections and Tests

3.2.1 The Company shall carry out all necessary off-site tests (including factory acceptance tests) on items relating to the KWC at the manufacturers' works before delivery of such items to the Site. The items shall include as a minimum, the major pumps, major flow meters, motors, pressure vessels, and major electrical and instrumentation and control equipment. The off-site tests shall comply with the appropriate standards for the equipment, and/or the manufacturer's requirements.

3.2.2 Test certificates shall be submitted as part of the quality assurance / quality control plan, and shall include all test results, calculations, performance graphs and curves, and other requisite information. The test certificates shall be endorsed by representatives of the manufacturer and the Company and submitted to the Independent Engineer for approval.

3.2.3 KW&SB shall have the right to have one or more representatives present during any inspections or tests of major equipment and systems of the KWC in the workshops. Unless otherwise specified in this appendix 5, or in the Metering and Testing Plan to be developed in accordance with this appendix 5, the Company shall submit to the

Independent Engineer a testing schedule at least ten (10) Business Days prior to the commencement of such testing. The Company shall provide regular updates of such testing schedule to the Independent Engineer.

3.2.4 The presence of the Independent Engineer or KW&SB's representatives during any inspection or test shall in no way relieve the Company of its responsibility for supplying the equipment or systems in accordance with the milestone dates as set out in appendix 2 of the Concession Agreement.

3.3 Taking of Samples and Laboratory Tests

Unless otherwise specified in the Metering and Testing Plan, taking of samples required for the purposes of these tests shall be undertaken in accordance with national and international standards. Laboratory testing shall be performed by institutions which are licensed and accredited to perform the specific tests.

4. REPORTING

4.1 In addition to, or in combination with any other reporting that is required under the Concession Agreement, the Company shall submit monthly, quarterly, and annual reports for the Metering and Monitoring Systems.

4.2 The Company shall report only on those components of the infrastructure that were being operated by the Company in the corresponding reporting period.

4.3 The reports shall clearly address compliance with the applicable requirements of both the existing regulations and the Concession Agreement and shall include the relevant information, including at least, compliance with Performance Guarantees and other matters such as energy consumption and production data, analyses and trending of operational process monitoring and control data, etc.

4.4 Any incident that has or is likely to have a detrimental impact on the surrounding environment, and adjoining water resource quality or the quality of treated water to be supplied to an end-user must be reported to the Independent Engineer within twenty-four (24) hours of such incident.

5. INTERNAL AND EXTERNAL AUDITS

5.1 Internal Audits

5.1.1 The Company must conduct internal audits on a quarterly basis of its Metering Systems and Monitoring Systems. Audits shall be scheduled in advance for each year.

5.1.2 Each audit must assess / address any previous audit findings which remain unresolved. The internal audit process shall also provide for periodic inter-laboratory checking of laboratory analysis results.

5.1.3 The internal audit report shall be submitted to the Independent Engineer within no more than fourteen (14) Days of the completion of the audit.

5.2 External Audits

5.2.1 Independent external audits on the Metering Systems and Monitoring Systems must be conducted on an annual basis. This may be undertaken in conjunction with other audits, e.g., audits of the management and quality systems.

5.2.2 The external auditors shall be appointed by the Company and the scope of the external audit must include:

- assessing the effectiveness of the internal audits conducted;
- making recommendations, if enhancements are required in terms of, but not limited to, the audit scope, audit participants or team, audit findings, corrective actions, and management approval criteria;
- assessing, making findings and recommending corrective actions on the level of compliance with the Company's Metering and Testing Plan;
- making recommendations for any enhancements to the Metering and Testing Plan.

5.2.3 All external audit reports must be submitted to the Independent Engineer within no more than fourteen (14) Days of the completion of the audit, serving as fulfilment of the auditing criteria.

6. MOBILISATION TESTING

6.1 The Mobilisation Testing shall be carried out for twenty-four (24) continuous hours for the existing KWC prior to the handover of KWC to the Company. Exact details of the performance test standards and procedures shall be mutually agreed upon by the Company and the Independent Engineer but proposed and defined by the Company in the Metering and Testing Plan.

6.2 The total electrical power consumption of the KWC shall be measured during the twenty-four (24) hour Mobilisation Testing. The average power consumption shall be used to determine the reference value for the C&O Period.

6.3 The Company shall notify the Independent Engineer of readiness of the KWC for Mobilisation Testing, and the installation and verification of the instrumentation required therefor. Within five (5) Days of such notification, the Mobilisation Testing shall commence.

6.4 The Mobilisation Testing is scheduled to take place when 100 MGD are being received by the KWC. If that situation does not take place during the Mobilisation Testing, the obtained values can be adjusted during the C&O Period after measuring the real values when 100 MGD are received by the KWC.

6.5 During the Mobilisation Testing, the Company and the Independent Engineer shall accept such tests that will define the technical parameters for the KWC during the C&O Period.

6.6 Certification of Mobilisation Testing

6.6.1 Within five (5) Business Days of receipt of a test report from the Company on the

Mobilisation Testing, including all information reasonably necessary to evaluate the results, the Independent Engineer shall indicate in writing whether it accepts or disputes the accuracy of the test results, and the successful completion of the Mobilisation Testing.

6.6.2 If the Independent Engineer disputes the results submitted by the Company, and the Company is unable to agree with the determination of the Independent Engineer, such Dispute shall be referred for resolution pursuant to clause 27 of the Concession Agreement. If it is agreed or determined that retesting is required, the Company shall perform such retesting as promptly as possible after the date of such agreement, or determination thereof under clause 27 of the Concession Agreement.

6.7 Issuance of Mobilisation Testing Acceptance Certificate

Within three (3) Days of the acceptance of the Mobilisation Testing results, the Independent Engineer shall issue the Mobilisation Testing Acceptance Certificate, setting out the:

6.7.1 Allowable NRW;

6.7.2 Output Water Quality Specifications; and

6.7.3 Contracted Specific Net Electricity Consumption.

7. KWC START-UP TESTS DURING C&O PERIOD

7.1 The Independent Engineer shall have the right to witness the start-up and operational tests of the KWC, including all related equipment and systems. The Company shall submit to the Independent Engineer a test schedule for all Start-up Tests at least twenty (20) Business Days prior to the proposed commencement date of such tests and provide regular updates of such testing schedule to the Independent Engineer. The tests shall include, but not be limited to items such as:

7.1.1 start-up and operational tests of the firefighting system;

7.1.2 start-up tests of the fire protection system;

7.1.3 the pre-energisation tests;

7.1.4 the protection and trip setting of the pumping stations and the water treatment plant equipment, including related auxiliaries;

7.1.5 demonstration of the functioning of various trip and bypass protections under operating conditions by initiating malfunctioning of any system or by genuine mistake in operation;

7.1.6 start-up and operational tests of common systems such as, but not limited to:

7.1.6.1 electricity supply system;

7.1.6.2 compressed air system;

7.1.6.3 raw water supply system from the pumping station;

7.1.6.4 dosing system

7.1.6.5 chlorination system;

7.1.6.6 filtration systems; and

7.1.6.7 sand filters cleaning system;

7.1.7 protection systems/settings, in accordance with the agreed design and the requirements of the water and power connection systems;

7.1.8 protection and trip setting of main pumps installed in the KWC;

7.1.9 outage of one of the filters to simulate proper operation of the remaining filters in the Treatment Plant;

7.1.10 start-up tests of the relevant part of the Treatment Plant equipment and related facilities and systems, including checking of automatic change-over of standby facilities, interlocks, protections, and alarms;

7.1.11 verification of start-up times and loading rates of the pumping stations and the Treatment Plant at various downtime conditions;

7.1.12 hydrostatic testing using potable water, including the following as a minimum:

7.1.12.1 hydrostatic testing of the potable water storage facilities, which shall include a twenty-four (24) hour leakage test for each product water storage facility; and

7.1.12.2 pressure tests for all pressure pipes and elements of pressure systems including the potable water storage facilities interconnecting pipes and pumping station, as well as the delivery pipe work up to the Output Water Connection Point or the KWC offtakes;

7.1.13 environmental monitoring equipment, water quality monitoring equipment, functioning tests, and verification of guarantees;

7.1.14 demonstration of the dispatch and metering data acquisition systems, including the SCADA;

7.1.15 verification of mechanical completeness of the pumping stations and the Treatment Plant;

7.1.16 functional test of all electromechanical and safety equipment (e.g., pumps, blowers, backwash systems, wastewater treatment, filters, safety equipment, etc.); and

7.1.17 all other tests required to demonstrate the safety and security of the KWC and trip systems and to demonstrate compliance with requirements set out in the Concession Agreement.

7.2 Certification of Start-Up Tests

7.2.1 The Independent Engineer shall indicate in writing within five (5) Business Days after receiving from the Company a test report on the start-up tests, including all information reasonably necessary to evaluate the results, whether it accepts or disputes that such test results are accurate and the Start-up Tests have been successfully completed.

7.2.2 If the Independent Engineer disputes the results submitted by the Company, and the Company is unable to agree with the determination of the Independent Engineer, such Dispute shall be referred for resolution pursuant to clause 27 of the Concession Agreement. If it is agreed or determined that re-testing is required, the Company shall perform such re-testing as promptly as possible after the date of such agreement, or determination thereof under clause 27 of the Concession Agreement.

8. KWC TRIAL RUN

8.1 After the Start-up Tests have been completed, the KWC, including its corresponding integrated equipment and facilities, shall be operated for a minimum twenty-four (24) hour trial run at the load settings and operating conditions agreed by the Company and the Independent Engineer. The start, stop and switch-over (to standby equipment) procedures shall be included in the Trial Run. The Company shall be permitted to undertake such work during the Trial Run as is necessary to optimise the running of the KWC. The Company may extend (without adjustment to the Scheduled Project Commercial Operations Date) the duration of the Trial Run to evaluate whether the KWC shall be able to achieve the quality and stability of operations which would be required for the Reliability Test Run and the Performance Tests.

8.2 After the Trial Run has been duly completed, the Company shall, prior to undertaking the Performance Test and the Reliability Test Run, demonstrate that:

8.2.1 the KWC is providing the received volumes;

8.2.2 the Reservoir is fully capable of maintaining the capacity storage as specified in appendix 1 of the Concession Agreement;

8.2.3 the Treatment Plant is capable of delivering water in accordance with the Output Water Quality Specifications, and complying with the minimum Performance Guarantees; and

8.2.4 the pumping stations and the Treatment Plant are stable, and the treated water matches with the water quality values provided by the equipment suppliers as set out in the relevant attachments to this appendix 5.

9. KWC PERFORMANCE TEST AND RELIABILITY TEST RUNS

9.1 General considerations

The performance and reliability testing of the KWC shall be for the purpose of demonstrating the respective Performance Guarantees and the reliability of the KWC during commissioning.

9.2 Test Procedures and Reporting

9.2.1 The testing of the KWC items shall be conducted in accordance with the Metering and

Testing Plan, and pursuant to the Operating and Maintenance Procedures.

9.2.2 A test report shall be prepared by the Company promptly after completion of each test of the KWC items. The report shall include data as recorded, including valid calibration certificates (not older than six (6) Months).

9.3 Performance Test

9.3.1 After successful completion of the Start-up Tests and the Trial Run, and after relevant test protocols have been submitted by the Company and accepted by the Independent Engineer, the Company shall be allowed to prepare the KWC for the Performance Tests.

9.3.2 The Company shall adjust the test results for capacity and power consumption in case the applicable conditions during the test are between the relevant Technical Limits for the:

9.3.2.1 pH;

9.3.2.2 Turbidity;

9.3.2.3 Aluminium;

9.3.2.4 Chlorine residual;

9.3.2.5 Faecal Coliform; and

9.3.2.6 Total Coliforms.

9.3.3 The Performance Test shall be carried out for twenty-four (24) continuous hours for the entire KWC. The exact details of the Performance Test standards and procedure shall be mutually agreed to by the Company and the Independent Engineer, in accordance with the requirements of the Operating and Maintenance Procedures and coherent with the Metering and Testing Plan.

9.3.4 The Company shall be permitted to annul a Performance Test upon demonstrating to the satisfaction of the Independent Engineer that any parameter of the Technical Limits was exceeded during the initial Performance Test and such exceedance was for a period of time and to a degree which was material to the results of the Performance Test. If a Performance Test is annulled, the Company shall at its own cost carry out a further Performance Test for a second continuous twenty-four (24) hours period as soon as the relevant parameter is within the Technical Limits.

9.3.5 The total electrical power consumption of the KWC will be measured during the twenty-four (24) hours Performance Test. The average power consumption shall be used to determine compliance.

9.3.6 The Company shall notify the Independent Engineer of readiness of the KWC for the Performance Tests and that the instrumentation for the Performance Tests is installed and checked. Within five (5) Days of such notification, the Performance Test shall commence.

9.3.7 During the Performance Test, the Company shall demonstrate by means of performance and acceptance tests that the KWC, including related equipment and systems, achieves the Performance Guarantees, such as:

9.3.7.1 percentage of losses as set out in attachment 1;

9.3.7.2 guaranteed water quality specification as set out in attachment 3 based on water quality technical limits as set out in attachment 1;

9.3.7.3 guaranteed specific power demand as set out in attachment 1; and

9.3.7.4 the guaranteed noise levels as set out in attachment 2;

9.3.8 The Performance Tests shall be deemed to be satisfactorily completed only if the following conditions are met for the entire KWC:

9.3.8.1 the percentage of losses is not more than the value set out in attachment 1 of the transferred volume;

9.3.8.2 the water quality specification achieves the guaranteed water quality specifications as set out in the attachments to this appendix 5;

9.3.8.3 the specific power demand is less than the maximum specific power demand as set out in attachment 1; and

9.3.8.4 the guaranteed noise levels as set out in attachment 2 are met.

9.3.9 The Independent Engineer shall indicate in writing within seven (7) Business Days after receiving from the Company a test report on the Performance Tests, including all information reasonably necessary to evaluate the results, whether it accepts or disputes that such test results are accurate.

9.3.10 If the following circumstances arise:

9.3.10.1 KW&SB or the Independent Engineer dispute the results submitted by the Company and the Company is unable to agree with such determination; or

9.3.10.2 the Company disputes an Independent Engineer decision pursuant to paragraph 9.3.4 of this appendix 5 as to whether any Performance Test should be annulled,

such Dispute shall be referred for resolution pursuant to clause 27 of the Concession Agreement. If it is agreed or determined that re-testing is required, the Company shall perform such re-testing as promptly as possible after the date of such agreement, or determination thereof under clause 27 of the Concession Agreement. The Company shall bear all reasonable costs of KW&SB's advisors in attending any repeated testing procedures. For the sake of clarity, KW&SB shall bear the cost of attending the first testing procedure.

9.4 Reliability Test Run

9.4.1 After completion of the Performance Test for the KWC, and compilation of relevant

test protocols by the Company, the Company shall be entitled to prepare the KWC for its Reliability Test Run. The Company shall notify the Independent Engineer that the KWC is ready to commence the Reliability Test Run. Within five (5) Days of such notification, the Reliability Test Run shall commence.

9.4.2 The Reliability Test Run for the KWC shall last for a period of thirty (30) consecutive Days.

9.4.3 During the Reliability Test Run, the KWC shall be operated normally and complying with the Performance Guarantees.

9.4.4 The Reliability Test Run for the KWC shall be deemed to be satisfactorily completed only if the following conditions are met:

9.4.4.1 save as provided below in paragraph (a) to (d), no shutdowns shall be permitted during the Reliability Test Run, except if owing to causes beyond the Company's responsibility or control, which must be proven by the Company:

(a) between Day 1 up to Day 10 (both Days inclusive), an aggregate of four (4) interruptions in the operations shall be allowed. If these interruptions exceed four (4) in number or twenty-four (24) hours in aggregate, then the Reliability Test Run of the whole KWC must be restarted from Day 1;

(b) between Day 11 up to Day 20 (both Days inclusive), an aggregate of two (2) interruptions in the operations shall be allowed. If these interruptions exceed two (2) in number or twenty-four (24) hours in aggregate, then the Reliability Test Run of the whole KWC must be restarted from Day 11;

(c) between Day 21 up to Day 30 (both Days inclusive), one (1) interruption in the operations shall be allowed. If such interruption exceeds twelve (12) hours or if there is more than one (1) interruption, then the Reliability Test Run of the whole KWC must be restarted from Day 21; and

(d) if any interruption in the operations, occurs at any time which exceeds twenty-four (24) hours, then the Reliability Test Run of the whole KWC shall be restarted from Day 1;

9.4.4.2 cleaning of filter elements and other actions normally required during operation of the Treatment Plant shall be allowed, provided that the Company informs the Independent Engineer of such actions in advance and the target output is not affected.

9.4.5 An “interruption in operations” in this paragraph 9.4 of this appendix 5 shall be interpreted as any of the following:

9.4.5.1 a shutdown of a component of the KWC which causes a reduction in the target water output;

9.4.5.2 failure to comply with Output Water Quality Specifications at the Output Water Connection Point as set out in appendix 1; or

9.4.5.3 the occurrence of a Defective Metering Event.

9.4.6 A test report shall be prepared by the Company promptly after completion of each Reliability Test Run. The report shall include data as recorded, including valid calibration certificates (not older than six (6) Months).

9.5 Project Commercial Operations Certificate

9.5.1 Within three (3) Days of the acceptance or deemed acceptance (as the case may be) of the Performance Test, Reliability Test Runs and such other test agreed and approved under the Metering and Testing Plan, the Independent Engineer shall issue the Project Commercial Operations Certificate to the Parties.

9.5.2 The Independent Engineer shall indicate in writing within five (5) Business Days after receiving from the Company a test report on the Performance Tests or Reliability Test Runs, including all information reasonably necessary to evaluate the results, whether it accepts or disputes that such test results are accurate and that the KWC has been successfully completed.

9.5.3 If the Independent Engineer disputes the results submitted by the Company, and the Company is unable to agree with the determination of the Independent Engineer, such Dispute shall be referred for resolution pursuant to clause 27 of the Concession Agreement. If it is agreed or determined that re-testing is required, the Company shall perform such re-testing as promptly as possible after the date of such agreement, or determination thereof under clause 27 of the Concession Agreement.

10. HANDOVER PERFORMANCE TESTING

10.1 The Handover Performance Testing shall be carried out before the KWC is handed back to KW&SB at the end of the Concession period. The principles for performing the Handover Performance Testing shall be the same as the one described in paragraph 2.4 of this appendix 5 for the commissioning phase. That means that the Handover Performance Testing period shall include both Performance Tests and Reliability Test Runs as defined in paragraph 9 of this appendix 5.

10.2 The handover phase shall take place at the end of the Concession Period, and in any case, the Company shall prepare a detailed proposal in the Metering and Testing Plan for such testing, to be approved by the Independent Engineer, and in compliance with the Concession Agreement.

ATTACHMENTS: PERFORMANCE GUARANTEE DATA FOR THE PROJECT

Attachment 1: Guaranteed Performance

DESCRIPTION	UNIT	DATA	
1.1: Guaranteed Water Quality Technical Limits (The required Treatment Plant to be implemented by the Company should be able to provide the adequate water quality when receiving influent quality parameters within the range shown below)			
		Design Technical Lower Limit	**Design Technical Upper Limit**
pH value	Hydrogen ion	6.5	8.5
Turbidity	NTU	0	50
Aluminium	mg/l	0	1.0
Residual Chlorine	mg/l	0	0.02
Faecal Coliform (E. Coli)	cfu/100ml	0	100
Total Coliforms	cfu/100ml	0	100
1.2: Performance of the Entire KWC			
		C&O Period	**Operating Period**
Percentage of losses from the volume provided / NRW	%	Allowable NRW (as per Mobilisation Testing Acceptance Certificate)	Allowable NRW (as bid by the Company)
Guaranteed total specific power consumption (total for the KWC). Total per m^3 electricity consumption (net gross per m^3 consumption including alternative energy per m^3 sources on Site and energy recovery measures).	kWh/m^3	Contracted Specific Net Electricity Consumption (as per Mobilisation Testing Acceptance Certificate)	Contracted Specific Net Electricity Consumption (as bid by the Company)
Capacity of KWC	m^3/day	454,609 (Contracted Availability)	454,609 (Contracted Availability)

Attachment 2: Guaranteed Maximum Noise Levels

DESCRIPTION	UNIT	DATA
Noise levels at a distance of one (1) meter from the noise source and within the pumping station or water treatment plant and major buildings	dB(A)	max. eighty-five (85)
Noise levels at the Site boundary	dB(A)	max. sixty (60)
Noise levels within all offices and the laboratory	dB(A)	max. fifty (50)

Note: Guaranteed maximum noise levels and subsequent requirements may be adjusted depending on the ambient noise baseline which shall be confirmed as part of the ESIA.

Attachment 3: Potable Water Quality Specifications

The table below shows the contractual limits for water quality to be provided at the Output Water Connection Point by the Company.

During C&O Period: Output Water Quality Specifications as per the Mobilisation Testing Acceptance Certificate.

During Operating Period: Output Water Quality Specifications summarized below:

PARAMETERS	UNIT	ALLOWED RANGE
pH value	Hydrogen ion	6.5 - 8.5
Turbidity	NTU	Max. 5
Aluminium	mg/l	Max. 0.20
Residual Chlorine	mg/l	0.2 - 0.5
Faecal Coliform (E. Coli)	cfu/100ml	Absent
Total Coliforms	cfu/100ml	Absent

Note: All the other potable water parameters not mentioned in the table above shall be in compliance with the most stringent of the latest applicable Pakistan standards or the WHO drinking water guidelines (latest revision).

APPENDIX 6: PERFORMANCE SECURITIES

Part 1 – C&O Performance Security

TO
GOVERNMENT OF SINDH
[INSERT DETAILS]
GUARANTEE NO. [●] (hereinafter referred to as the **"Bank Guarantee"**)

Dated: [●]

[INSERT NAME OF BANK], being the Bank Guarantee issuing bank (hereinafter referred to as the **"Guarantor Bank"**) understands that the following parties shall enter into an agreement titled the "CONCESSION AGREEMENT" (hereinafter referred to as the **"Agreement"**) for the design, construction, rehabilitation, operation, maintenance, commissioning, financing and transfer of the Karachi Water Canal under the public-private partnership mode (the **"Project"**):

(a) **THE GOVERNOR OF SINDH** (through Secretary, Local Government & Housing Town Planning Department, Government of Sindh) having its office located at Local Government & Housing Town Planning Department, Ground Floor, Tughlaq House, Sindh Secretariat, Karachi, Pakistan, for and on behalf of the Government of Sindh (the **"GoS"**, which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors and assigns);

(b) **KARACHI WATER AND SEWERAGE BOARD,** a statutory body constituted pursuant to section 3 of the Karachi Water and Sewerage Board Act, 1996, with its office located at 9th Mile, Karsaz, Karachi, Pakistan (**"KW&SB"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns); and

(c) **[*COMPANY*],** a company incorporated under the Laws of Pakistan whose registered office is located at [●] (the **"Company"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns).

Further, the Guarantor Bank understands that pursuant to the terms of the request for proposals issued in respect of the Project by KW&SB (the **"RFP"**) read with the Agreement, the Company is required to provide the GoS with a Bank Guarantee (referred to in the RFP and the Agreement as the C&O Performance Security) in an amount equal to Pakistani Rupees one billion only (PKR 1,000,000,000/).

The above premised, the Guarantor Bank hereby undertakes irrevocably, unconditionally and on-demand to pay to the GoS (without any notice, reference or recourse to the Company or to any other entity or without any recourse or reference to any contract, agreement, document or other instruments (including the RFP and the Agreement) whether executed or not), any sum or sums (or any part thereof) equivalent in aggregate up to but not exceeding a maximum amount of:

Pakistani Rupees one billion only (PKR 1,000,000,000/-)
(hereinafter referred to as the **"Guaranteed Amount"**)

immediately, however not later than within five (5) business days from the date of the Guarantor Bank's receipt of the GoS' first written demand (hereinafter referred to as the **"Demand"**) at the Guarantor Bank's office located at [INSERT ADDRESS OF THE GUARANTOR BANK AT WHICH DEMAND SHALL BE MADE], or through SWIFT instructions transmitted by the GoS' bank, on behalf of the GoS, to the

Guarantor Bank, or through fax sent by the GoS at the Guarantor Bank's fax number i.e., [●], such Demand stating:

(a) the Bank Guarantee number;

(b) the total amount demanded; and

(c) the bank account to which the amounts demanded pursuant to the demand are to be credited / transferred (hereinafter referred to as the **"Beneficiary Account"**).

A Demand shall only be honoured by us: (i) in the case of a written Demand, if it is made by and bears the signature of an authorised officer or other representative of the GoS; or (ii) in the case of a Demand transmitted through SWIFT, if it is transmitted through authenticated SWIFT instructions by the GoS' bank, on behalf of the GoS; or (iii) in the case of a Demand made through fax, it is made by and bears the signature of an authorised officer or other representative of the GoS.

The Guarantor Bank shall unconditionally honour a Demand hereunder made in compliance with this Bank Guarantee at sight and immediately on the date of receipt of your Demand, as stated earlier, and shall transfer the amount specified in the Demand to the Beneficiary Account, in immediately available and freely transferable funds in the currency of this Bank Guarantee, free and clear of and without any set-off or deduction for or on account of any present or future taxes, levies, imposts, duties, charges, fees, deductions or withholdings of any nature whatsoever and by whomsoever imposed.

This Bank Guarantee shall come into force and shall become automatically effective upon its issuance.

After having come into force, this Bank Guarantee and the Guarantor Bank's obligations hereunder shall expire on [INSERT DATE AND TIME] (the **"Expiry Date"**) irrespective of whether this Bank Guarantee has been returned to the Guarantor Bank provided that, in the event that the GoS issues a Demand to the Guarantor Bank on or immediately prior to the Expiry Date and the same is received by the Guarantor Bank on or prior to the Expiry Date, the Guarantor Bank shall honour such Demand.

Upon expiry, this Bank Guarantee shall be returned to the Company without undue delay. multiple Demands may be made by the GoS under this Bank Guarantee, but the Guarantor Bank's aggregate liability shall be restricted up to the Guaranteed Amount.

The Guaranteed Amount shall be revised upon receipt by the Guarantor Bank of a notice duly signed by the GoS and the Company of the revised Guaranteed Amount. The Expiry Date shall be revised upon receipt by the Guarantor Bank of a notice duly signed by the GoS and the Company of the revised date.

The Guarantor Bank hereby agrees that any part of the Agreement or the RFP may be amended, renewed, extended, modified, compromised, released or discharged without:

(a) in any way impairing or affecting the Guarantor Bank's liabilities hereunder;

(b) notice to the Guarantor Bank; and

(c) the necessity for any additional endorsement, consent or guarantee by the Guarantor Bank.

This Bank Guarantee, for its validity period, shall not be affected in any manner by any change in the Guarantor Bank's constitution or of the Company's constitution or of their successors and assignees and this Bank Guarantee shall be legally valid, enforceable and binding on each of their successors and permitted assignees.

All references to any contract, agreement, document or other instruments (including the Agreement and the RFP), whether executed or not, are by way of reference only and shall not affect the Guarantor Bank's obligations to make payment under the terms of this Bank Guarantee.

If one or more of the provisions of this Bank Guarantee are held or found to be invalid, illegal, or unenforceable for any reason whatsoever, in any respect, any such invalidity, illegality, or unenforceability of any provision shall not affect the validity of the remaining provisions of this Bank Guarantee.

The Guarantor Bank hereby declares and confirms that under its constitution and applicable laws, it has the necessary power and authority and all necessary authorizations, approvals and consents thereunder, to:

(a) enter into, execute and deliver this Bank Guarantee; and

(b) perform the obligations it has undertaken under this Bank Guarantee, which obligations are valid and legally binding on and enforceable against the Guarantor Bank under the laws of Pakistan.

Further, the Guarantor Bank hereby declares and confirms that the signatory(ies) to this Bank Guarantee is/are its duly authorized officer(s) to execute this Bank Guarantee.

This Bank Guarantee and all rights and obligations arising from this Bank Guarantee shall be governed and construed in all respects in accordance with the laws of Pakistan. The courts in Karachi, Pakistan shall have exclusive jurisdiction in respect of any dispute relating to any matter contained herein.

The issuance of this Bank Guarantee is permitted according to the laws of Pakistan and the laws of the jurisdiction where this Bank Guarantee is issued.

This Bank Guarantee is subject to the Uniform Rules for Demand Guarantee, ICC Publication No.758. To the extent that there is any inconsistency between the terms of this Bank Guarantee and the Uniform Rules for Demand Guarantees, ICC Publication No. 758, the terms of this Bank Guarantee shall prevail.

EXECUTED & ISSUED
FOR & ON BEHALF OF THE GUARANTOR BANK

.....
NAME:
DESIGNATION:
DATED:

Part 2 – O&M Performance Security

TO
[●],
[●],
GOVERNMENT OF SINDH

GUARANTEE NO. [●] (hereinafter referred to as the **"Bank Guarantee"**)

Dated: [●]

[INSERT NAME OF BANK], being the Bank Guarantee issuing bank (hereinafter referred to as the **"Guarantor Bank"**) understands that the following parties have entered into an agreement titled the "CONCESSION AGREEMENT" dated [●] (hereinafter referred to as the **"Agreement"**) for the design, construction, rehabilitation, operation, maintenance, commissioning, financing and transfer of the Karachi Water Canal under the public-private partnership mode:

(a) **THE GOVERNOR OF SINDH** (through Secretary, Local Government & Housing Town Planning Department, Government of Sindh) having its office located at Local Government & Housing Town Planning Department, Ground Floor, Tughlaq House, Sindh Secretariat, Karachi, Pakistan, for and on behalf of the Government of Sindh (the **"GoS"**, which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors and assigns);

(b) **KARACHI WATER AND SEWERAGE BOARD,** a statutory body constituted pursuant to section 3 of the Karachi Water and Sewerage Board Act, 1996, with its office located at 9th Mile, Karsaz, Karachi, Pakistan (**"KW&SB"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns); and

(c) **[*COMPANY*],** a company incorporated under the Laws of Pakistan whose registered office is located at [●] (the **"Company"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns).

Further, the Guarantor Bank understands that pursuant to the terms of the Agreement, the Company is required to provide the GoS with a Bank Guarantee (referred to in the Agreement as the O&M Performance Security) in an amount equal to Pakistani Rupees five hundred million only (PKR 500,000,000/-).

The above premised, the Guarantor Bank hereby undertakes irrevocably, unconditionally and on demand to pay to the GoS (without any notice, reference or recourse to the Company or to any other entity or without any recourse or reference to any contract, agreement, document or other instruments (including the Agreement) whether executed or not), any sum or sums (or any part thereof) equivalent in aggregate up to but not exceeding a maximum amount of:

Pakistani Rupees five hundred million only (PKR 500,000,000/-)
(hereinafter referred to as the **"Guaranteed Amount"**)

immediately, however not later than within five (5) business days from the date of the Guarantor Bank's receipt of the GoS' first written demand (hereinafter referred to as the **"Demand"**) at the Guarantor Bank's office located at [INSERT ADDRESS OF THE GUARANTOR BANK AT WHICH DEMAND SHALL BE MADE], or through SWIFT instructions transmitted by the GoS' bank, on behalf of the GoS, to the

Guarantor Bank, or through fax sent by the GoS at the Guarantor Bank's fax number i.e., [●], such Demand stating:

(a) the Bank Guarantee number;

(b) the total amount demanded; and

(c) the bank account to which the amounts demanded pursuant to the demand are to be credited/transferred (hereinafter referred to as the **"Beneficiary Account"**).

A Demand shall only be honoured by us: (i) in the case of a written Demand, if it is made by and bears the signature of an authorised officer or other representative of GoS; or (ii) in the case of a Demand transmitted through SWIFT, if it is transmitted through authenticated SWIFT instructions by GoS's bank, on behalf of GoS; or (iii) in the case of a Demand made through fax, it is made by and bears the signature of an authorised officer or other representative of GoS.

The Guarantor Bank shall unconditionally honour a Demand hereunder made in compliance with this Bank Guarantee at sight and immediately on the date of receipt of your Demand, as stated earlier, and shall transfer the amount specified in the Demand to the Beneficiary Account, in immediately available and freely transferable funds in the currency of this Bank Guarantee, free and clear of and without any set-off or deduction for or on account of any present or future taxes, levies, imposts, duties, charges, fees, deductions or withholdings of any nature whatsoever and by whomsoever imposed.

This Bank Guarantee shall come into force and shall become automatically effective upon its issuance.

After having come into force, this Bank Guarantee and the Guarantor Bank's obligations hereunder shall expire on [INSERT DATE AND TIME] (the **"Expiry Date"**) irrespective of whether this Bank Guarantee has been returned to the Guarantor Bank provided that, in the event that the GoS issues a Demand to the Guarantor Bank on or immediately prior to the Expiry Date and the same is received by the Guarantor Bank on or prior to the Expiry Date, the Guarantor Bank shall honour such Demand.

Upon expiry, this Bank Guarantee shall be returned to the Company without undue delay. multiple Demands may be made by the GoS under this Bank Guarantee, but the Guarantor Bank's aggregate liability shall be restricted up to the Guaranteed Amount.

The Guaranteed Amount shall be revised upon receipt by the Guarantor Bank of a notice duly signed by the GoS and the Company of the revised Guaranteed Amount. The Expiry Date shall be revised upon receipt by the Guarantor Bank of a notice duly signed by the GoS and the Company of the revised date.

The Guarantor Bank hereby agrees that any part of the Agreement may be amended, renewed, extended, modified, compromised, released or discharged without:

(a) in any way impairing or affecting the Guarantor Bank's liabilities hereunder;

(b) notice to the Guarantor Bank; and

(c) the necessity for any additional endorsement, consent or guarantee by the Guarantor Bank.

This Bank Guarantee, for its validity period, shall not be affected in any manner by any change in the Guarantor Bank's constitution or of the Company's constitution or of their successors and assignees and this Bank Guarantee shall be legally valid, enforceable and binding on each of their successors and permitted assignees.

All references to any contract, agreement, document or other instruments (including the Agreement), whether executed or not, are by way of reference only and shall not affect the Guarantor Bank's obligations to make payment under the terms of this Bank Guarantee.

If one or more of the provisions of this Bank Guarantee are held or found to be invalid, illegal, or unenforceable for any reason whatsoever, in any respect, any such invalidity, illegality, or unenforceability of any provision shall not affect the validity of the remaining provisions of this Bank Guarantee.

The Guarantor Bank hereby declares and confirms that under its constitution and applicable laws, it has the necessary power and authority and all necessary authorizations, approvals and consents thereunder, to:

(a) enter into, execute and deliver this Bank Guarantee; and

(b) perform the obligations it has undertaken under this Bank Guarantee, which obligations are valid and legally binding on and enforceable against the Guarantor Bank under the laws of Pakistan.

Further, the Guarantor Bank hereby declares and confirms that the signatory(ies) to this Bank Guarantee is/are its duly authorized officer(s) to execute this Bank Guarantee.

This Bank Guarantee and all rights and obligations arising from this Bank Guarantee shall be governed and construed in all respects in accordance with the laws of Pakistan. The courts in Karachi, Pakistan shall have exclusive jurisdiction in respect of any dispute relating to any matter contained herein.

The issuance of this Bank Guarantee is permitted according to the laws of Pakistan and the laws of the jurisdiction where this Bank Guarantee is issued.

This Bank Guarantee is subject to the Uniform Rules for Demand Guarantee, ICC Publication No.758. To the extent that there is any inconsistency between the terms of this Bank Guarantee and the Uniform Rules for Demand Guarantees, ICC Publication No. 758, the terms of this Bank Guarantee shall prevail.

EXECUTED & ISSUED
FOR & ON BEHALF OF THE GUARANTOR BANK

.....
NAME:
DESIGNATION:
DATED:

APPENDIX 7: FORM OF CONCESSION & LICENSE DIRECT AGREEMENT

CONCESSION & LICENSE DIRECT AGREEMENT

between

(1) THE GOVERNOR OF SINDH
(THROUGH THE LOCAL GOVERNMENT & HOUSING TOWN PLANNING DEPARTMENT, GOVERNMENT OF SINDH)

(2) THE KARACHI WATER AND SEWERAGE BOARD

(3) [THE COMPANY]

- and -

(4) [BANK]

AS AGENT

relating to

KARACHI HUB WATER CANAL PROJECT

Dated [●]

CONTENTS

1. DEFINITIONS AND INTERPRETATION 165
2. ASSIGNMENT 168
3. SUSPENSION 170
4. OUTSTANDING OBLIGATIONS 170
5. STEP-IN AND STEP-OUT 171
6. NOVATION 173
7. REVIVAL OF REMEDIES 174
8. NOTICES 175
9. CONFIDENTIALITY 176
10. MISCELLANEOUS 177
11. GOVERNING LAW 179
12. DISPUTE RESOLUTION 179

THIS CONCESSION & LICENSE DIRECT AGREEMENT is made on [●], 2022, at [●].

BETWEEN

(1) **GOVERNOR OF SINDH** (through Secretary, Local Government & Housing Town Planning Department, Government of Sindh) having its office located at Local Government & Housing Town Planning Department, Ground Floor, Tughlaq House, Sindh Secretariat, Karachi, Pakistan, for and on behalf of the Government of Sindh (the **"GoS"**, which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors and assigns);

(2) **KARACHI WATER AND SEWERAGE BOARD**, a statutory body constituted pursuant to section 3 of the Karachi Water and Sewerage Board Act, 1996, with its office located at 9th Mile, Karsaz, Karachi, Pakistan (**"KW&SB"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns);

(3) **[*INSERT COMPANY DETAILS*]**, a company incorporated under the Laws of Pakistan whose registered office is located at [*INSERT ADDRESS*] (the **"Company"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns); and

(4) [*INSERT NAME OF BANK*], a [bank] organized and existing under the Laws of Pakistan, whose registered address is at [*INSERT ADDRESS*], as agent for and on behalf of the Financing Parties (the **"Agent"**),]

(each a **"Party"** and together the **"Parties"**).

WHEREAS

A. The GoS, KW&SB and the Company have entered into the Concession Agreement in relation to the Project.

B. KW&SB and the Company have entered into the License Agreement in relation to the Project.

C. In order to facilitate the Company raising finance from the Financing Parties in connection with the Project, the GoS Parties have consented to enter into this Agreement with the Company and the Agent (acting on behalf of the Financing Parties), which sets out certain rights and obligations of the GoS Parties, the Company and the Financing Parties.

NOW THEREFORE, in consideration of the mutual covenants contained herein, the Parties agree as follows:

1. DEFINITIONS AND INTERPRETATION

1.1 Definitions

Unless otherwise stated, words and expressions defined in the Concession Agreement and the License Agreement (including by reference to any other agreement or document) shall have the same meaning and expression in this Agreement. In addition, the following terms shall have the following meanings, unless the context otherwise requires:

"Additional Obligor" means any of (a) the Agent; or (b) a company which (i) is controlled or appointed by any of the Financing Parties, (ii) is not an Adverse Person, (iii) is authorized to

carry on business in Pakistan, (iv) has been approved by the GoS Parties in writing (such approval not to be unreasonably withheld where the relevant third party is able to demonstrate to the satisfaction of the GoS Parties (acting in consultation with the Independent Appointees) that it has the legal capacity and authority, and the technical and financial resources available to enter into, assume and perform the obligations of the Company under the Applicable Agreements) and, (v) has executed the undertaking contemplated in the definition of Step-In Notice and an original of the same has been submitted to the GoS Parties by the Agent;

"Agreement" means this Concession and License Direct Agreement (including the recitals and appendices hereto), as amended and supplemented from time to time;

"Applicable Agreements" means the Concession Agreement and the License Agreement, and **"Applicable Agreement"** means either of them;

"Arbitration" has the meaning given to it in clause 12.2.1.1;

"Arbitrators" has the meaning given to it in clause 12.2.1.1;

"Assigned Rights" has the meaning given to it in clause 2.1.1;

"Award" has the meaning given to it in clause 12.2.4;

"CA Novation Agreement" has the meaning given to it in clause 6.2.1 (a);

["Common Terms Agreement" means the agreement so entitled, entered into, on or around the date hereof between, amongst others, the Company, the Financing Parties and the Agent;][11]

"Concession Agreement" means the concession agreement dated [*INSERT DATE*] between the GoS, KW&SB and the Company (as may from time to time be amended, novated, supplemented or varied);

"Confidential Information" has the meaning given to it in clause 9.1;

"Default Notice" has the meaning given to it in clause 2.1.2;

"Discharged Rights and Obligations" has the meaning given to it in clause 6.2.2(a);

"Dispute" has the meaning given to it in clause 12.1;

"Effective Date" has the meaning given to it in clause 6.2.2;

"Enforcement Action" means:

(a) the taking of any steps to wind up the Company; or

(b) the taking of any steps to appoint a liquidator, receiver, administrator, custodian or other similar person in respect of the Company or any material part of its undertakings or assets; or

[11] To be updated based on Financing Documents.

(c) the taking of any steps to terminate the Applicable Agreements;

"Enforcement Action Notice" has the meaning given to it in clause 2.2.5.1;

"Event of Default" has the meaning given to it in the Common Terms Agreement;

"GoS Additional Notification" has the meaning given to it in clause 4.2;

"LA Novation Agreement" has the meaning given to it in clause 6.2.1(b);

"Novation Notice" has the meaning given to it in clause 6.1;

"Revival Date" has the meaning given to it in clause 7.1;

"Step-In Date" means, subject to clause 5.4, the date on which the Agent gives the relevant Step-In Notice;

"Step-In Notice" means a notice from the Agent to the GoS Parties, stating that an Additional Obligor is to become a party to the Applicable Agreements on and from the Step-In Date, which notice includes a legally binding and enforceable undertaking (governed by the Laws of Pakistan) in favour of the GoS Parties from the Additional Obligor in terms of which it has agreed:

(a) to become a party to the Applicable Agreements in the capacity of the Company;

(b) to comply with any Legal Requirements;

(c) to be bound by the terms of this Agreement as applicable to the Additional Obligor; and

(d) to exercise its rights and perform its obligations, in accordance with this Agreement and the Applicable Agreements;

"Step-In Period" means the period from and including the Step-In Date to and including the earlier of the:

(a) Effective Date;

(b) Step-Out Date; and

(c) the date falling twelve (12) Months from the Step-In Date;

"Step-Out Date" has the meaning given to it in clause 5.6;

"Step-Out Notice" has the meaning given to it in clause 5.6;

"Substitute" means any third party which is (a) authorized to carry on business in Pakistan, (b) is not an Adverse Person, and (c) has been previously approved by the GoS Parties in writing (such approval not to be unreasonably withheld where the relevant third party is able to demonstrate to the satisfaction of the GoS Parties (acting in consultation with the Independent Appointees that it has the legal capacity and authority, and the technical and financial resources available to enter into, assume and perform the obligations of the Company under the Applicable Agreements); and

"Suspension Period" has the meaning given to it in clause 3.1.

1.2 Interpretation

The rules of construction and interpretation set forth in clause 1.2 of the Concession Agreement shall apply, *mutatis mutandis*, to this Agreement.

1.3 Conflict

In the event of any conflict between any provision of this Agreement and any provision of the Applicable Agreements, the provisions of this Agreement shall prevail.

2. ASSIGNMENT

2.1 Notice of Assignment

The Company hereby gives notice to each GoS Party that:

2.1.1 the Company has assigned by way of security all of its rights and interests in, and benefit of, the Applicable Agreements, to the Agent (the **"Assigned Rights"**);

2.1.2 until such time as it or the Agent notifies the GoS Parties in writing that an Event of Default has occurred and is continuing unremedied (a **"Default Notice"**), the Company may exercise all of its rights and powers under the Applicable Agreements;

2.1.3 the GoS is hereby authorized and instructed to make all payments due, or which may become due from the GoS to the Company under or arising from the Concession Agreement, to the Company Payment Account (account number [*INSERT ACCOUNT NUMBER*]) at [*INSERT DETAILS*] or to such other account in Pakistan as the Agent may from time to time direct by notice to the GoS), and the Company irrevocably agrees that, where the Agent so specifies payment to a different account, the account so specified shall be accepted by the Company as the appropriate account for payment, and any sums paid to such account shall be treated as sums paid in accordance with the Concession Agreement, and such account shall be construed as the Company Payment Account (ten (10) Business Days after the GoS has received notice thereof by the Agent) for the purposes of this Agreement and the Concession Agreement; and

2.1.4 the authority and instructions contained in clause 2.1.3 cannot be revoked or varied without the prior written consent of the Agent, and the GoS shall make all payments due or which may become due from it to the Company under or arising from the Concession Agreement in accordance with such authority and instruction, and payments so made shall *pro tanto* satisfy any and all obligations of the GoS under the Concession Agreement in respect of such payments.

2.2 Acknowledgement of Assignment

By execution of this Agreement:

2.2.1 each GoS Party acknowledges receipt of the notice of the assignment of the Assigned Rights provided by the Company pursuant to clause 2.1 and confirms that:

(a) it has not received any other notice relating to assignment of the Assigned Rights; and

(b) it has not received any notice of, nor has it consented to, any previous assignment of the Assigned Rights;

2.2.2 each GoS Party agrees that it will not consent to any further assignment, transfer or lien by the Company under the Concession Agreement;

2.2.3 KW&SB agrees that it will not consent to any further assignment, transfer, or lien by the Company under the License Agreement;

2.2.4 each GoS Party consents to the creation of the assignment by way of security of the Assigned Rights, provided that such consent shall not extend to the creation of any Encumbrance of any nature on the Site;

2.2.5 each GoS Party undertakes:

2.2.5.1 to notify the Agent of its intention to take any Enforcement Action (to the extent it is permitted to take such action under the Applicable Agreements) including, without limitation, its intention to terminate any of the Applicable Agreements pursuant to clauses 21.2, 21.3, 21.4, , 21.7 and 21.8 of the Concession Agreement or pursuant to the License Agreement (the **"Enforcement Action Notice"**);

2.2.5.2 following receipt of a Default Notice pursuant to clause 2.1.2 or the issuance of an Enforcement Action Notice pursuant to clause 2.2.5.1, to accept as valid, any notices or demands given or made by the Agent under, and in accordance with the terms of, the Applicable Agreements in place of the Company;

2.2.5.3 following receipt of a Default Notice pursuant to clause 2.1.2 or the issuance of an Enforcement Action Notice pursuant to clause 2.2.5.1, to accept performance of any of the obligations of the Company under, and in accordance with the terms of, the Applicable Agreements by the Additional Obligor as performance by the Company; and

2.2.5.4 to pay any amount due from the GoS to the Company under the Concession Agreement in accordance with the provisions of clause 2.1.3, provided that this clause 2.2.5.4 shall only apply to the GoS, and not KW&SB.

2.3 Obligation to release security

Notwithstanding anything to the contrary, the Company and the Agent (for and on behalf of the Financing Parties) acknowledge, agree and undertake that once GoS has paid the Termination Payment under and in accordance with the Concession Agreement, the Agent and the Company shall forthwith release all Encumbrances held on the KWC and promptly execute any and all documents in relation thereto regardless of any payment due under any working capital facility or any other financing arrangement obtained by the Company from any other financial institution to which the Agent is also acting as an agent or a security trustee.

3. SUSPENSION

3.1 Suspension Period

Following:

3.1.1 the service by the GoS or KW&SB (as applicable) on the Agent of an Enforcement Action Notice pursuant to clause 2.2.5.1; or

3.1.2 the service by the Agent on the GoS Parties of a Default Notice pursuant to clause 2.1.2,

each GoS Party undertakes that, subject to clause 7, it shall not take any Enforcement Action until the expiry of a period of sixty (60) Days after the date on which the relevant Enforcement Action Notice or Default Notice as the case may be, was served (the **"Suspension Period"**).

3.2 Enforcement Action

Each GoS Party undertakes:

3.2.1 that it shall not take any Enforcement Action in relation to any relevant event or circumstance or breach or default at the end of the Suspension Period relating thereto:

(a) if such event or circumstance no longer subsists; or

(b) if in respect of any breach or default under the Applicable Agreements, such breach or default has been remedied; or

(c) subject as provided in clause 5.3 and clause 6.2, if there has been a Step-In Notice and no Step-Out Notice, or there has been a Novation Notice;

provided that in each such case, any damages due and payable to GoS resulting from such event or circumstance or breach or default, as the case may be, and notified in accordance with clause 4.1 and clause 4.2, have been paid in respect of any damages which may become due and payable in respect of such breach or default; and

3.2.2 each GoS Party shall continue to comply with all its obligations under the Applicable Agreement to which it is a party during such Suspension Period.

4. OUTSTANDING OBLIGATIONS

4.1 Statement of Outstanding Obligations

4.1.1 Within thirty (30) Days after the date of receipt by the Agent of an Enforcement Action Notice or the service by the Agent of a Default Notice or a Novation Notice, GoS shall deliver to the Agent, details of:

(a) all amounts that, so far as GoS is aware, are due and payable by the Company or the Sponsors under or pursuant to the Relevant Agreements as at the date of the Enforcement Action Notice, Default Notice or the Novation Notice (as applicable) but remain unpaid on the relevant date;

(b) all amounts that, so far as GoS is aware, are to become due and payable by the Company or the Sponsors under or pursuant to the Relevant Agreements during the remainder of the Suspension Period or from the date of the Novation Notice until the relevant Effective Date (as applicable); and

(c) all outstanding claims by GoS of which it is aware, under or pursuant to the Relevant Agreements against the Company or the Sponsors, whether arising out of or in connection with any breach or default or otherwise specifying:

(i) the provisions of the Relevant Agreement under or pursuant to which such claim arises; and

(ii) the amount of any monetary claim.

4.2 Adjustment

If, following the end of any thirty (30) Day period referred to in clause 4.1 but before the relevant Step-In Date or Effective Date, as the case may be, GoS becomes aware of (and notifies the Agent accordingly of) any outstanding amounts and claims which would have been notified by GoS to the Agent pursuant to clause 4.1 had GoS been aware of the same at the relevant time (a **"GoS Additional Notification"**), such outstanding amounts and claims shall be treated as having been notified by GoS to the Agent during such thirty (30) Day period pursuant to clause 4.1 for the purposes of this Agreement. If such GoS Additional Notification is issued in less than seven (7) Days prior to the expiry of the thirty (30) Day period referred to in clause 4.1, the Step-In Date or Effective Date shall be postponed until the date that is seven (7) Days after the date of the GoS Additional Notification.

4.3 Conclusive Evidence

Without prejudice to the rights of GoS to pursue any claims against the Company or the Sponsors following the Revival Date (if any), any Additional Obligor and any Substitute shall not be liable to GoS in respect of any claims by GoS arising before the Step-In Date or the Effective Date, as the case may be, which were not disclosed by GoS pursuant to clause 4.1 or clause 4.2.

4.4 Overpayment

If the Agent or any Additional Obligor pays to GoS an amount which GoS is not entitled to receive under the Concession Agreement as determined by the Independent Auditor, the GoS undertakes to repay such excess amount to the Agent within thirty (30) Days of receiving a written demand therefor.

5. STEP-IN AND STEP-OUT

5.1 Step-In Notice

At any time during any Suspension Period, the Agent may deliver a Step-In Notice to the GoS Parties.

5.2 Rights and Obligations of Additional Obligor

On and from the Step-In Date:

5.2.1 subject to clause 4.3 and provided that any Legal Requirements have been complied with, the Additional Obligor shall become a party to the Applicable Agreements with all of the rights of the Company thereunder and, save as provided in clause 4.3, the Additional Obligor shall be jointly and severally be liable with the Company for all of its obligations thereunder whether arising before, on or after the Step-In Date;

5.2.2 as between the Company, the GoS Parties and the Additional Obligor, only the Additional Obligor shall be authorized to deal with GoS Parties and to exercise the rights of the Company under the Applicable Agreements, and each GoS Party shall be discharged of its obligations under the Applicable Agreement (to which it is a party) only to the extent that such obligations are performed in favour of the Additional Obligor.

5.3 Enforcement Action during Step-In Period

Without prejudice to clause 3.1, during the Step-In Period, the GoS Parties shall not take any Enforcement Action in respect of events or circumstances arising:

5.3.1 before the Step-In Date; or

5.3.2 to the extent the events or circumstances are the same or substantially the same as the events or circumstances contemplated by the Event of Default giving rise to a Default Notice, after the Step-In Date,

unless:

(a) where such breach or default is capable of remedy or cure, it is not remedied or cured by a date reasonably determined by the GoS after the Step-In Date; or

(b) where such breach or default is not capable of remedy or cure, and without prejudice to the terms of clause 5.2, the effect of such breach or default has not been mitigated to the reasonable satisfaction of GoS by a date reasonably determined by the GoS after the Step-In Date.

5.4 No Effect

On or before any Step-In Date, the Additional Obligor shall pay to GoS all amounts and outstanding claims which have been notified by GoS pursuant to clause 4.1 and clause 4.2. If no such payment is made on or before the relevant Step-In Date, then subject to clause 7, such Step-In Date shall be postponed until, and shall be deemed to occur on, the date on which the Additional Obligor makes such payment.

5.5 No Termination Event

The appointment of an Additional Obligor in accordance with the terms and conditions of this clause 5, subject to the terms of clause 7, shall not constitute a termination event in accordance with clause 21 of the Concession Agreement.

5.6 Step-Out Date

The Additional Obligor may, at any time during the Step-In Period, give the GoS Parties, a notice terminating the Additional Obligor's obligations and rights under the Applicable

Agreements (the **"Step-Out Notice"**) as and from a date falling not earlier than thirty (30) Days after the date of the Step-Out Notice (the **"Step-Out Date"**), provided that, other than where such obligations have been assumed by a Substitute, the Additional Obligor may not so terminate its obligations under the Applicable Agreements and the Step-Out Date shall not occur, until and unless the Additional Obligor has discharged all of its obligations under the Applicable Agreements that are existing or outstanding as at the Step-Out Date which have arisen due to the actions or inactions of the Additional Obligor occurring on or after the Step-In Date.

5.7 Release

On and from the earlier of the Step-Out Date and the Effective Date, the Additional Obligor shall:

5.7.1 be released from all obligations to the GoS Parties under the Applicable Agreements; and

5.7.2 not be entitled to exercise any rights under the Applicable Agreements.

6. NOVATION

6.1 Proposal for Novation

At any time:

(a) during any Suspension Period; or

(b) during a Step-In Period,

the Agent may give notice (a **"Novation Notice"**) to the GoS Parties that the Substitute shall assume the obligations of the Company under the Applicable Agreements and specifying the date on which such assumption is to be affected, provided always, that all Legal Requirements are complied with by such specified date.

6.2 Novation

6.2.1 The novation contemplated in the Novation Notice shall, subject to compliance of any Legal Requirements, be affected by:

(a) in respect of the Concession Agreement, execution by the Parties and the Substitute of the novation agreement substantially in the form appended hereto as attachment A (the **"CA Novation Agreement"**);

(b) in respect of the License Agreement, execution by KW&SB, the Company, the Agent and the Substitute of a novation agreement substantially in the form appended hereto as attachment B (the **"LA Novation Agreement"**);

6.2.2 In which event, subject to clause 6.3, on the first Business Day (as defined in the Concession Agreement) after the date of execution of both the CA Novation Agreement and the LA Novation Agreement (the **"Effective Date"**):

(a) the Company and the GoS Parties shall each be released from further obligations to the other, under the Applicable Agreements to which they are a party and their respective rights against each other shall be cancelled (such rights and obligations being referred to in this clause 6.2.2 as **"Discharged Rights and Obligations"**);

(b) the GoS Parties and the Substitute shall each assume obligations towards each other and/or acquire rights (which shall include the rights and obligations of the Company which arose prior to the Effective Date) against each other which differ from such Discharged Rights and Obligations only insofar as the GoS Parties and the Substitute have assumed and/or acquired the same in place of the GoS Parties and the Company; and

(c) the GoS shall not take any Enforcement Action in respect of events or circumstances arising:

(A) before the Effective Date; or

(B) to the extent the events or circumstances are the same or substantially the same as the events or circumstances contemplated by the Event of Default giving rise to a Default Notice, after the Effective Date,

unless:

(I) where such breach or default is capable of remedy or cure, it is not remedied or cured by a date reasonably determined by the GoS after the Effective Date; and

(II) where such breach or default is not capable of remedy or cure, and without prejudice to the terms of clause 6.2.2, the effect of such breach or default has not been mitigated to the reasonable satisfaction of the GoS by a date reasonably determined by the GoS after the Effective Date.

6.3 No Effect

On or before any Effective Date, the Substitute shall pay to the GoS all outstanding amounts and outstanding claims notified by GoS pursuant to clause 4. If no such payment is made on or before the relevant Effective Date, then subject to clause 7 and without prejudice to any other rights or remedies available to the GoS, such Effective Date shall be postponed until, and shall be deemed to occur on, the date on which the Substitute makes such payment.

7. REVIVAL OF REMEDIES

7.1 If an Enforcement Action Notice or a Default Notice has been given and:

7.1.1 neither a Step-In Notice nor a Novation Notice has been given prior to the expiry of the Suspension Period relating to that Enforcement Action Notice or Default Notice, as the case may be;

7.1.2 the Step-In Date has occurred, and a Step-Out Date occurs prior to or upon the expiry of the Suspension Period relating to that Enforcement Action Notice or Default Notice, as the case may be; or

7.1.3 the Step-In Date has occurred, but no Novation Notice has been given prior to the date falling twelve (12) Months from the Step-In Date relating to that Enforcement Action Notice or Default Notice, as the case may be,

then either the GoS Party, in the case of clause 7.1.1, on and after the expiry of the Suspension Period, in the case of clause 7.1.2, on and after the Step-Out Date, and in the case of clause 7.1.3, upon the expiry of the referenced twelve (12) Months period, (each of the foregoing, the **"Revival Date"**) shall be entitled to:

(a) act upon any and all grounds for termination, in respect of breaches or defaults not remedied or waived, available to it, under or pursuant to the Applicable Agreements;

(b) pursue any and all claims and exercise any and all remedies against the Company; and

(c) take any Enforcement Action.

8. NOTICES

8.1 In Writing

Any notice to be served pursuant to the provisions of this Agreement shall be (a) made in the English language, (b) made in writing, (c) delivered personally (by hand delivery or courier) to the address of another Party as provided in clause 8.2 or to such other address as another Party shall by notice require, or sent by facsimile transmission (with receipt of transmission confirmation) to the facsimile number of another Party provided in clause 8.2, or to such other facsimile number as a Party shall by notice require. Any notice or other communication made by one Party to the other Party in accordance with the foregoing provisions of this clause 8.1 shall be deemed received by the other Party, if delivered by hand or by courier, on the day on which it is left at that Party's address, or, if sent by facsimile transmission, on the next Business Day following the day on which it is sent to that Party's address.

8.2 Address for Service

The address for service of notices shall be as set out below or such other address as the Party on whom the notice is to be served has notified in writing to the Party serving the notice.

8.2.1 **GoS**

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

8.2.2 **KW&SB**

Address:	[●]
Attention:	[●]

Fax:	[●]
Email	[●]

8.2.3 **Company**

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

8.2.4 **Agent**

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

9. CONFIDENTIALITY

9.1 Confidential Information

Subject to clause 9.2, each Party shall, at all times during and after the continuance of this Agreement, hold confidential and not disclose to any third party and use only for the purposes of the Project and this Agreement all confidential information, reports or documents relating to the Project received by it pursuant to, or in the course of the negotiations leading to, this Agreement (the **"Confidential Information"**).

9.2 Permitted Disclosure

A Party shall be permitted to disclose Confidential Information:

9.2.1 to its insurers, auditors, or other professional advisers;

9.2.2 if required to do so by law or if required in connection with any legal proceedings; and

9.2.3 to each of the Financing Parties (or any prospective lenders) and their respective professional advisers subject to the relevant Party obtaining from the recipient of such Confidential Information an undertaking substantially in the terms of clause 9.1.

9.3 Exceptions

Nothing in this clause 9 shall apply to any information, reports or documents which shall have come into the public domain (otherwise than in consequence of a breach of clause 9.1). Nor shall clause 9.1 apply to any information, report or document received in good faith by a Party otherwise than from any of the Parties or a person acting on a Party's behalf.

10. MISCELLANEOUS

10.1 GoS Parties' liabilities

Except as expressly provided in this Agreement, nothing:

10.1.1 in this Agreement or in the arrangements contemplated thereby; or

10.1.2 arising as a result of the exercise by the Agent, the Financing Parties, any Additional Obligor and/or any Substitute of any rights given to any such party under or pursuant to this Agreement, shall in any way:

(a) affect any limitation or exclusion of the GoS Parties' liability to the Company under the Applicable Agreements, which exclusions and limitations of liability are hereby incorporated into this Agreement (*mutatis mutandis*);

(b) increase the total amount of any liability any GoS Party may have (whether to the Company, the Agent (for itself, or as agent for and on behalf of the Financing Parties), any Additional Obligor and/or any Substitute) under the Applicable Agreements; or

(c) make the GoS Parties liable to the Company, the Agent, the Financing Parties, any Additional Obligor and/or any Substitute to any greater extent or for any longer duration, than the GoS Parties would have been liable to the Company under the Applicable Agreements.

10.1.3 In no event, shall any payment obligations (actual or contingent) of the GoS Parties under the Relevant Agreements increase as a result of the GoS Parties entering into this Agreement.

10.1.4 The GoS Parties shall have no obligation or liability under the Financing Documents due to any reference to any Financing Document being made in this Agreement or otherwise.

10.1.5 The Agent on behalf of itself and as agent of the Financing Parties, acknowledges and agrees that notwithstanding anything to the contrary expressed or implied in this Agreement, nothing contained in the Financing Documents and no amendment, supplement or other modification to the Financing Documents or any sell-down or other form of transfer of rights and obligations thereunder shall affect the obligations or liabilities of the GoS Parties under any Relevant Agreement. Furthermore, each of the Company and the Agent (acting for itself and on behalf of Financing Parties) hereby confirms and agrees that the Financing Parties as of the date of this Agreement have not transferred their rights and obligations under the Financing Documents or otherwise to any other bank or financial institution or to any third-party.

10.2 No Assignment

10.2.1 No Party shall assign or transfer any part of its respective rights or obligations under this Agreement without the written consent of the other Parties, provided that the Agent may assign or transfer its rights and obligations to a successor Agent under this Agreement in accordance with the Common Terms Agreement without the consent of (but prior notice to) the GoS Parties and the Company.

10.2.2 The GoS Parties acknowledge and agree that the Financing Parties or any of them, may sell down or otherwise transfer the rights and obligations under the Finance Documents, to any other bank or a financial institution, with written notice to GoS Parties, provided that:

(a) if the bank is a scheduled bank, as defined in the Banking Companies Ordinance, 1962, or a financial institution, that in each case has been awarded a minimum long-term credit rating of "A" by a credit rating agency registered with the Securities and Exchange Commission of Pakistan, and meets the rules and regulations of the State Bank of Pakistan; or

(b) if the bank or a financial institution has been awarded a minimum long term credit rating of "A" by Moody's Investors Services Limited or equivalent rating by Fitch Rating Limited or Standard and Poor Rating Services provided that, in such case prior to any sell down or transfer, the Financing Party proposing to sell down or transfer its share shall give written notice to the GoS Parties of the jurisdiction of incorporation of the proposed bank or financial institution and the jurisdiction of incorporation of its ultimate beneficial holding company, if any. If the GoS Parties do not object to the proposed bank or financial institution within thirty (30) Business Days of the Financing Party notifying the GoS Parties of the same, the GoS Parties shall be deemed to have approved of the bank or financial institution for the purposes of sell down or transfer. The Financing Parties shall not sell down or transfer to any bank or financial institution to which the GoS Parties object in pursuance of this clause 10.2.2, provided that the GoS Parties shall ensure that such objection by GoS Parties is not unreasonable.

10.3 No Waiver

The failure of a Party to enforce an obligation or to exercise any right under this Agreement shall not be considered to be a waiver save when the same has been expressly waived in writing. Any written waiver at any time by a Party of its rights with respect to the non-compliance of the other Party with its obligations under this Agreement or with respect to any other matter arising in connection with this Agreement shall not be deemed a waiver with respect to any subsequent non-compliance or any other matter. Except as expressly provided in this Agreement, any delay in asserting or enforcing any right hereunder shall not be deemed a waiver of such right. The rights and remedies under this Agreement, may be exercised as often as necessary, are cumulative, and not exclusive of any rights or remedies provided by law.

10.4 Continuing Nature of Obligations

This Agreement shall remain in full force and effect until the Financing Termination Date.

10.5 Benefit

The benefit of this Agreement (including the warranties and undertakings and any sum received by the Agent pursuant to this Agreement) shall be held by the Agent upon and subject to the terms of the Common Terms Agreement for the benefit of the Financing Parties.

10.6 Entire Agreement

The terms and provisions contained in this Agreement constitute the entire agreement between the GoS Parties, the Agent and the Financing Parties on the matters addressed herein, and supersede all previous communications, representations, or agreements, either verbal or written, between the Parties with respect to the subject matter hereof.

10.7 Amendments

No modification of this Agreement shall be valid unless it is in writing and signed by the Parties.

10.8 Counterparts

This Agreement may be executed in any number of counterparts, all of which, when taken together, shall constitute one and the same instrument.

10.9 Termination of No Effect

The Parties agree that any purported termination of the Applicable Agreements by the GoS Parties in breach of the provisions of this Agreement shall be void and of no effect.

11. GOVERNING LAW

This Agreement and any non-contractual obligation arising out of or in connection with it shall be governed by and construed in accordance with the Laws of Pakistan.

12. DISPUTE RESOLUTION

12.1 Negotiation

The GoS Parties and the Agent agree to attempt to resolve any dispute, controversy, difference, or claim (**"Dispute"**) between them in connection with this Agreement promptly, amicably, and in good faith. If any Dispute is not resolved between the GoS Parties and the Agent within thirty (30) Days from the date on which it arises, then such Dispute shall be settled exclusively and finally by arbitration in accordance with this clause 12.

12.2 Arbitration

12.2.1 Each of the Parties unconditionally and irrevocably agrees in respect of a Dispute, which cannot be resolved by the Parties pursuant to clause 12.1:

(a) to the submission of such Dispute to binding arbitration governed by the Arbitration Act, 1940, by appointment of a board of arbitrators, consisting of one (1) arbitrator appointed jointly by the Company and the Agent (acting for itself and each of the Financing Parties), and one (1) arbitrator appointed jointly by the GoS Parties and one (1) arbitrator appointed by the arbitrators so selected by the disputing Parties (the **"Arbitrators"**). Any arbitration proceedings commenced pursuant to this clause 12.2.1 shall be referred to as Arbitration (**"Arbitration"**);

(b) not to claim any right it may have under the Laws to hinder, obstruct, or nullify the submission of the Dispute to Arbitration; and

(c) to accept the Award rendered by the Arbitrators and any judgment entered thereon by a court of competent jurisdiction as final and binding and not to hinder, obstruct or nullify the enforcement or execution of any decision rendered by the Arbitrators or a court of competent jurisdiction.

12.2.2 The place of arbitration shall be Karachi, Pakistan.

12.2.3 The language of Arbitration shall be English.

12.2.4 Any decision or award resulting from the Arbitration (**"Award"**) shall be final and binding upon the Parties.

12.2.5 The Parties hereby waive, to the extent permitted under the Laws, any rights to appeal or to review of such Award by any Competent Authority.

12.2.6 The fees and expenses of the Arbitrators and all other expenses relating to Arbitration shall be borne and paid by the respective disputing Parties unless the Award states otherwise. The Arbitrators may provide in the Award, for reimbursement to a Party, of its costs and expenses in bringing or defending the Arbitration claim, including legal fees and expenses incurred by such Party.

12.2.7 This Agreement and the rights and obligations of the Parties shall remain in full force and effect pending the Award for any Arbitration, which Award, if appropriate, shall determine whether and when any termination shall become effective.

12.3 Obligations Continuing

This Agreement and the rights and obligations of the Parties hereunder shall remain in full force and effect pending the award of such arbitration proceeding. Unless otherwise agreed in writing, the Parties shall continue to perform their respective obligations under this Agreement which are not the subject of the Dispute during the period of any proceedings in accordance with this clause 12.

ATTACHMENT A

FORM OF CA NOVATION AGREEMENT

[*TO BE EXECUTED ON STAMP PAPER*]

Relating to the Concession Agreement between [*INSERT DETAILS*] (the **"GoS Parties"**) and [*Company*] (the **"Company"**) dated [*INSERT DATE*] (as may from time to time be amended, supplemented, or varied, the **"Concession Agreement"**).

Terms defined in the Concession and License Direct Agreement dated [*INSERT DATE*], between the GoS Parties, the Company and [Bank] (as agent for and on behalf of the Financing Parties, the **"Agent"**) (the **"Direct Agreement**") shall, subject to any contrary indication, have the same meaning herein.

1. The Agent requests that the Substitute (specified below) accept and procure the transfer to the Substitute of all of the rights, title, and interest of any and all of the obligations of the Company under the Concession Agreement and the Direct Agreement by executing this CA Novation Agreement.

2. The Substitute hereby requests the GoS Parties to accept this CA Novation Agreement pursuant to and for the purposes of clause 6.2 of the Direct Agreement so as to take effect in accordance with the terms thereof on the Effective Date or on such later date as may be determined in accordance with the terms thereof.

3. The Substitute warrants that it is has received a copy of the Concession Agreement together with such other information as it has required in connection with this transaction and that it has not relied and will not hereafter rely on the Agent to check or enquire on its behalf into the legality, validity, effectiveness, adequacy, accuracy or completeness of any such information, and further agrees that it has not relied and will not rely on the Agent in relation to its entering into this CA Novation Agreement and the Concession Agreement.

4. The Substitute hereby undertakes to each GoS Party that it will perform, in accordance with the terms thereof, all obligations of the Company which by the terms of the Concession Agreement and the Direct Agreement will be assumed by it on execution of this CA Novation Agreement.

5. The Agent makes no representation or warranty and assumes no responsibility with respect to the legality, validity, effectiveness, adequacy or enforceability of the Concession Agreement or any document relating thereto and assumes no responsibility for the performance and observance by any party of any of its obligations under the Concession Agreement or any document relating thereto and any and all such conditions and warranties whether expressed or implied by law or otherwise are hereby excluded.

6. This CA Novation Agreement and the rights and obligations of the parties hereunder shall be governed by and construed in accordance with the laws of Pakistan.

SIGNED by [ ] and the Substitute:

ATTACHMENT B

FORM OF LA NOVATION AGREEMENT

[*TO BE EXECUTED ON STAMP PAPER*]

Relating to the License Agreement between [*INSERT DETAILS*] (the **"KWS&B"**) and [Company] (the **"Company"**) dated [*INSERT DATE*] (as may from time to time be amended, supplemented, or varied, the **"License Agreement"**).

Terms defined in the Concession and License Direct Agreement dated [*INSERT DATE*], between the GoS Parties (as specified therein), the Company and [Bank] (as agent for and on behalf of the Financing Parties, the **"Agent"**) (the **"Direct Agreement"**) shall, subject to any contrary indication, have the same meaning herein.

1. The Agent requests that the Substitute (specified below) accept and procure the transfer to the Substitute of all of the rights, title, and interest of any and all of the obligations of the Company under the License Agreement and the Direct Agreement by executing this LA Novation Agreement.

2. The Substitute hereby requests the GoS Parties to accept this LA Novation Agreement pursuant to and for the purposes of clause 6.2 of the Direct Agreement so as to take effect in accordance with the terms thereof on the Effective Date or on such later date as may be determined in accordance with the terms thereof.

3. The Substitute warrants that it is has received a copy of the Concession Agreement and the License Agreement together with such other information as it has required in connection with this transaction and that it has not relied and will not hereafter rely on the Agent to check or enquire on its behalf into the legality, validity, effectiveness, adequacy, accuracy or completeness of any such information, and further agrees that it has not relied and will not rely on the Agent in relation to its entering into this LA Novation Agreement and the License Agreement.

4. The Substitute hereby undertakes to each GoS Party that it will perform, in accordance with the terms thereof, all obligations of the Company which by the terms of the Concession Agreement, the License Agreement and the Direct Agreement will be assumed by it on execution of this LA Novation Agreement.

5. The Agent makes no representation or warranty and assumes no responsibility with respect to the legality, validity, effectiveness, adequacy or enforceability of the License Agreement or any document relating thereto and assumes no responsibility for the performance and observance by any party of any of its obligations under the License Agreement or any document relating thereto and any and all such conditions and warranties whether expressed or implied by law or otherwise are hereby excluded.

6. This LA Novation Agreement and the rights and obligations of the parties hereunder shall be governed by and construed in accordance with the laws of Pakistan.

SIGNED by [ ] and the Substitute:

IN WITNESS WHEREOF, the Parties, intending to be legally bound, have caused this Agreement to be executed by their duly authorized representatives as of the date first written above.

GOVERNOR OF SINDH, THROUGH THE SECRETARY, LOCAL GOVERNMENT & HOUSING TOWN PLANNING DEPARTMENT, GOVERNMENT OF SINDH

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

.....

Witness signature .....

Witness name (block capitals) .....

KARACHI WATER AND SEWERAGE BOARD

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name
(block capitals) .....

Witness signature .....

Witness name
(block capitals) .....

THE COMPANY

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

Witness signature .....

Witness name (block capitals) .....

THE AGENT

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

Witness signature .....

Witness name (block capitals) .....

APPENDIX 8: SERVICE PAYMENT CALCULATIONS

1.1 Definitions

"Actual Electricity Consumption" or **"AEC"** means the electricity delivered by the Electricity Supplier (in kWh) at the Electricity Connection Point, as set out in the relevant electricity bill issued by the Electricity Supplier to KW&SB;

"Actual Loss of Water Output" or **"LCWa"** means the actual loss of water output (in m^3) determined in accordance with paragraph A.4 of Attachment A (Agreed Values for Payment Calculation) to this appendix 8;

"Allowable NRW" means:

(a) for the C&O Period, the figure stated in the Mobilisation Testing Acceptance Certificate; and

(b) for the Operating Period, [●%][12]

"Available" or **"Availability"** means the Contracted Availability or the Reduced Contracted Availability, as the case maybe;

"Availability Payment" or **"APW"** means the water payment (in PKR) payable for a Billing Period falling after the Project Commercial Operations Date, that covers capital cost recovery payment and the fixed operating and maintenance payment, paid by GoS for the Contracted Availability *less* any Deductions;

"Billing Period" means: (a) from the Commencement Date, each Quarter falling within the C&O Period, with the first Quarter starting at 00:00 hours on the Commencement Date and ending at 23.59 on the Day immediately preceding the start of the next Quarter, with the last Quarter ending at 23.59 on the Day immediately preceding the Project Commercial Operations Date; (b) from the Project Commercial Operations Date, each Quarter falling within the Operating Period, with the first Quarter starting at 00:00 hours on the Project Commercial Operations Date and ending at 23:59 on the Day immediately preceding the start of the next Quarter and the last Quarter ending at 23:59 on the Term Expiry Date;

"Bypass HD Water" means the water, monitored and sampled at Input HD Water Connection Point reasonably expected to damage the Treatment Plant or impact health of people in the opinion of the Independent Engineer as a direct consequence of the presence of toxic or inhibiting substances;

"Bypass Input Water" means Bypass HD Water and / or Bypassed KIII Water;

"Bypass KIII Water" means the water, monitored and sampled at Input KIII Water Connection Point reasonably expected to damage the Treatment Plant or impact health of people in the opinion of the Independent Engineer as a direct consequence of the presence of toxic or inhibiting substances;

[12] Insert percentage stated in Bidding Form F-3 E (*Output Payment*) of Proposal.

"Bypass Off-Spec Mixed Water" means the monitored and sampled Off-Spec Mixed Water, reasonably expected to damage the Treatment Plant or impact health of people in the opinion of the Independent Engineer as a direct consequence of the presence of toxic or inhibiting substances;

"Bypass Water Connection Point" means the physical connection point at which the KWC and drainage are connected, specified as M7 in attachment D of appendix 8;

"Bypass Water Output" or **"BPWa"** means the water (in m^3 per specified period) metered at the Bypass Water Connection Point;

"Capital Cost Recovery Charge" or **"CCRW"** means the aggregate amount (in PKR/m^3) of:

(a) Foreign Debt Principal Recovery Charge,

(b) Foreign Debt Interest Recovery Charge,

(c) Local Debt Principal Recovery Charge,

(d) Local Debt Interest Recovery Charge,

(e) Foreign Equity Recovery Charge, and

(f) Local Equity Recovery Charge;

"Contract Year" means a Construction Contract Year or an Operating Contract Year, as applicable;

"Contracted Availability" or **"CAW"** means (in m^3/Day):

(a) for the C&O Period, four hundred fifty-four thousand six hundred nine (454,609); and

(b) for the Operating Period, four hundred fifty-four thousand six hundred nine (454,609);

"Contracted Specific Net Electricity Consumption" or **"ECR_{CC}"** means the efficiency (in kWh/m^3):

(a) for the C&O Period, the figure stated in the Mobilisation Testing Acceptance Certificate; and

(b) for the Operating Period, as defined in paragraph 1.5 of this appendix 8 and specified in Table 2A of paragraph A.1 in Attachment A (Agreed Values for Payment Calculation) to this appendix 8;

"Contracted Specific Net Solar Generation" or **"ESG"** means the captive solar generation (in kWh) defined in paragraph 1.5 of this appendix 8 and specified in Table 2B of paragraph A.1 in Attachment A (Agreed Values for Payment Calculation) to this appendix 8;

"Deductions" means the deductions to the Availability Payments on account of Deductions for Reduced Water Availability, Deductions for NRW and Deductions for Off-Spec Output Water;

"Deduction for NRW" or **"DNRW"** means the deductions (in PKR) described in paragraph 1.5 of this appendix 8;

"Deduction for Off-Spec Output Water" or **"DRQW"** means the deductions (in PKR) described in paragraph 1.5 of this appendix 8;

"Deduction for Reduced Water Availability" or **"DRAW"** means the deductions (in PKR) described in paragraph 1.5 of this appendix 8;

"Electricity Connection Point" means the physical connection at which KWC and the electricity transmission and distribution facilities of the Electricity Supplier are connected;

"Electricity Reimbursement Payment" has the meaning given in paragraph 2.2.1.1 of this appendix 8;

"Electricity Price" or **"EP"** means, in any given period, A divided by B (in PKR/Kwh), where:

A = total amount (in PKR) set out in the electricity bill issued from time to time by the Electricity Supplier to KW&SB for electricity supplied to the KWC at the Electricity Connection Point in such Billing Period including taxes and charges, but excluding any late payment charges and any arrears prior to the Commencement Date,

B = total number of electricity units (in kWh) in such Billing Period as set out in the electricity bill issued from time to time by the Electricity Supplier to KW&SB for electricity supplied to the KWC at the Electricity Connection Point;

"Fixed O&M Cost Recovery Charge for Water" or **"FOMRW"** means the amount (in PKR/ m^3) as stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Availability Payment calculation for a Billing Period after being adjusted in accordance with paragraph B.3 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8;

"Foreign Debt Interest Recovery Charge" or **"FD_I_RC"** means the amount (in PKR/m^3) stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Availability Payment calculation for a Billing Period after being adjusted in accordance with paragraph B.2 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8;

"Foreign Debt Principal Recovery Charge" or **"FD_P_RC"** means the amount (in PKR/m^3) stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Availability Payment calculation for a Billing Period;

"Foreign Equity Recovery Charge" or **"FE_RC"** means the amount (in PKR/m^3) stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Availability Payment calculation for a Billing Period after being adjusted in accordance with paragraph B.2 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8;

"Input HD Water Connection Point" means the physical connection point where water from Hub Dam will enter KWC, specified as M1 in attachment D of appendix 8;

"Input HD Water Quality Specifications" means: the inlet water quality parameters / specifications for the Net HD Water Input set out in appendix 1;

"Input KIII Water Quality Specifications" means the inlet water quality parameters / specifications for the Net KIII Water Input set out in appendix 1;

"Input KIII Water Connection Point" means the physical connection point where water from KIII Conduit will enter the KWC, specified as M3 in attachment D of appendix 8;

"Input Water Connection Point" means Input HD Water Connection Point and/ or Input KIII Water Connection Point, as applicable;

"KIBOR" means the three (3) month Karachi Inter-Bank Offer Rate, being the average rate, Offer, for the three (3) months tenor, as published on State Bank of Pakistan page on that date or as published by the Financial Markets Association of Pakistan in case the State Bank of Pakistan page is unavailable;

"LIBOR" means the interbank offered rate administered by ICE Benchmark Administration Limited for three (3) month deposits in USD which appears on the relevant page of the Reuters Service (currently page LIBOR01) or, if not available, on the relevant pages of any other service (such as Bloomberg Financial Markets Service) that displays such ICE Benchmark Administration Limited rates. In the event that the Reuters service, or any successor thereto, no longer provides such information, such other service as agreed by the Commercial Parties (in consultation with the Independent Auditor);

"Local Debt Interest Recovery Charge" or **"LD_I_RC"** means the amount (in PKR/m^3) as stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Availability Payment calculation for a Billing Period after being adjusted in accordance with paragraph B.2 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8;

"Local Debt Principal Recovery Charge" or **"LD_P_RC"** means the amount (in PKR/m^3) as stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Availability Payment calculation for a Billing Period;

"Local Equity Recovery Charge" or **"LE_RC"** means the amount (in PKR/m^3) stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Availability Payment calculation for a Billing Period;

"$LCWp_{ns}$" means the projected Unplanned Outages (in m3) during Summer Period as per Table 3 in paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8;

"$LCWp_{nw}^{P}$" means the projected Planned Outages (in m^3) during Winter Period as per Table 3 in paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8;

"$LCWp_{nw}^{U}$" means the projected Unplanned Outages (in m^3) during Winter Period as per Table 3 in paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8;

"Mixed Water Monitoring Point" means the physical point between the pumping station and the Treatment Plant, specified as M5 in attachment D of appendix 8;

"N-CPI" means the National Consumer Price Index as notified from time to time by the Pakistan Bureau of Statistics;

"Net HD Water Input" or **"HDWi"** means the water (in m^3 in any given period) metered at the Input HD Water Connection Point;

"Net KIII Water Input" or **"KIIIWi"** means the water (in m^3 in any given period) metered at the Input KIII Water Connection Point;

"Net Water Input" means the sum of the Net HD Water Input and the Net KIII Water Input;

"Net Water Output" or **"Wa"** means the water (in m^3 for any given period) metered at the Output Water Connection Point;

"Non-Revenue Water" or **"NRW"** means (in m^3) the amount calculated in m^3 in accordance with paragraph 2.1.4 of this appendix 8;

"Off-Spec Mixed Water" means water that: (a) met the Input Water Quality Specifications at the Input Water Connection Point, but did not meet the Input Water Quality Specification when tested at Mixed Water Monitoring Point; or (b) did not meet the Input Water Quality Specifications at the Input Water Connection Point, and fell further outside those specifications when tested at the Mixed Water Monitoring Point;

"Off-Spec Output Water based on Within Spec Input Water" means, water that does not meet the Output Water Quality Specifications at the Output Water Connection Point, where water inflow is Within Spec Input Water;

"Off-Spec Output Water due to Off-Spec Input Water and Off-Spec Mixed Water" means water that does not meet the Output Water Quality Specifications, at the Output Water Connection Point, due to Off-Spec Input Water and Off-Spec Mixed Water;

"Off-Spec Output Water" means Off-Spec Output Water based on Within Spec Input Water or Off-Spec Output Water due to Off-Spec Input Water and Off-Spec Mixed Water, as applicable;

"Off-Spec Input Water" or **"OSIW"** means Off-Spec HD Water or Off-Spec KIII Water, as applicable;

"Off-Spec HD Water" means the water entering the KWC from the Input HD Water Connection Point that does not meet the Input HD Water Quality Specifications;

"Off-Spec KIII Water" means the water entering the KWC from the Input KIII Water Connection Point that does not meet the Input KIII Water Quality Specifications;

"Outages" means Planned Outages or Unplanned Outages, as applicable;

"Output Payment" or **"OPW"** means the water payment (in PKR) payable for a Billing Period, that covers electricity reimbursement payment and the variable operating and maintenance payment, paid by GoS for the Net Water Output delivered to KWSB as defined in paragraph 1.2.2 of this appendix 8;

"Output Water Connection Point" means the physical connection point after the Reservoir at which the KWC and the water transmission facilities, operated by KWSB for downstream water distribution, are connected, specified as M8 in attachment D of appendix 8;

"Output Water Quality Specifications" means the quality parameters / specifications for the Net Water Output:

(a) for the C&O Period, as set out in the Mobilisation Testing Acceptance Certificate; and

(b) for the Operating Period, as set out in appendix 1;

"Projected Electricity Consumption" or **"PEC"** means the electricity consumption for producing Net Water Output, calculated in accordance with paragraph 2.2.1.2 of this appendix 8;

"Planned Outage" means the removal of the KWC (or any part thereof) from service to perform work on specific components that is co-ordinated with KWSB and scheduled not less than ninety (90) days prior to the Contract Year in which it is to be undertaken and has a predetermined start date and duration, expressed in m^3/day;

"Projected Available Net Water Output" or **"ANWOp"** means the net potential water production (in m^3) defined in paragraph 1.5 of this appendix 8 and calculated according to the provisions of paragraph A.3 of Attachment A (Agreed Values for Payment Calculation) of this appendix 8;

"Projected Loss of Net Water Output" or **"LCWp"** means the projected loss of net water output (in m^3) as per paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8;

"Quarter" means each three (3) Month period commencing at 00:00 on 1 January, 1 April, 1 July and 1 October in each calendar year;

"Reduced Contracted Availability" means (in m^3/day) the reduction in the Contracted Availability due to Outages;

"Reference Exchange Rate" [●][13];

"Reference LIBOR" means, [●][14];

"Reference Inflation Rate" means [●][15];

"Reference KIBOR" means [●][16]

"Summer Period" or "Summer" means the period between 1 April and 30 September;

[13] Insert figure stated in clause 1.2.3(c) of clause 1.2 (*Assumptions for Calculation of Required Values*) of Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP.

[14] Insert figure stated in clause 1.2.3(e) of clause 1.2 (*Assumptions for Calculation of Required Values*) of Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP.

[15] Insert figure stated in clause 1.2.3(a) of clause 1.2 (*Assumptions for Calculation of Required Values*) of Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP.

[16] Insert figure stated in Insert figure stated in clause 1.2.3(d) of clause 1.2 (*Assumptions for Calculation of Required Values*) of Section II (*Financial Evaluation Criteria*) of Annexure B (*Evaluation Criteria*) of Part 4 (*Annexures*) of Volume I (*Bidding Procedure*) of the RFP

"Treatment Plant" means the water treatment facility to be upgraded by the Company to treat up to four hundred fifty-four thousand six hundred nine (454,609) m^3/Day and achieve the water quality parameters set out in appendix 1;

"Unavailable" or **"Unavailability"** means any period during which the KWC (or any part thereof) is undergoing an Outage;

"Unavailability Notice" means the notice to be delivered by the Company to KWSB in terms of clause of 10.1.9 of this Agreement, setting out the Outages as well as the extension of such Outages and declaring the Reduced Contracted Availability (in m^3/day) on hourly basis during such Outages. Each notice shall supersede all previous notices, notwithstanding that an Unavailability Notice has to specify a duration, finish time or the Reduced Contracted Availability. Each Unavailability Notice shall specify the reason for the Outage and each component of the KWC that is affected;

"Unplanned Outages" means all outages which are not Planned Outages expressed in m^3/day;

"Variable O&M Cost Recovery Charge" or **"VOMRW"** means the amount (in PKR/m^3) stated by the Company in Attachment C (Cost Recovery Charges) to this appendix 8 and applied for Output Payment calculation for a Billing Period after being adjusted in accordance with paragraph B.4 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8;

"Within Spec Input Water" or **"WSIW"** means Within Spec HD Water and Within Spec KIII Water;

"Within Spec HD Water" means water entering the KWC from the Input HD Water Connection Point that meets the Input HD Water Quality Specifications;

"Within Spec KIII Water" means the water entering the KWC from the Input KIII Water Connection Point that meets the Input KIII Water Quality Specifications; and

"Winter Period" or **"Winter"** means the period between 1 October and 31 March.

1.2 Payment Structure

The Service Payments to be paid for Contracted Availability and Net Water Output shall consist of two components, as follows:

1.2.1 The Availability Payment:

This part of the Service Payments shall constitute payment for Contracted Availability and shall consist of Component AW (as set out in paragraph 2.1.1 of this appendix 8) and Component BW (as set out in paragraph 2.1.1 of this appendix 8), each such component to be calculated as provided in paragraph 2.1 of this appendix 8. Availability Payments will be subject to the Deductions.

Availability Payments will only be applicable after the Project Commercial Operations Date.

1.2.2 The Output Payment:

This part of the Service Payments shall constitute payment for Net Water Output and shall consist of Component CW (as set out in paragraph 2.1.1 of this appendix 8) and Component

DW (as set out in paragraph 2.1.12 of this appendix 8), each such component to be calculated as provided in paragraph 2.2 of this appendix 8. Output Payments will be subject to Deductions in the C&O Period.

Output Payments will be applicable from the Commencement Date.

1.3 Term and Structure of Availability Payments

Availability Payments will be payable in accordance with clauses 11, 12 and 13 of this Agreement and this appendix 8.

1.4 Electricity Reimbursement Payment

Electricity Reimbursement Payments will be billed by the Company in respect of Net Water Output and will be determined in accordance with the procedures set out in paragraph 2.2.1 of this appendix 8. Electricity consumption will be adjusted for the generation through the Solar Plant in accordance with this appendix 8.

1.5 Performance Criteria

The formulas for payment set out in paragraph 2 of this appendix 8 include factors related to the performance of the KWC. The derivations of these performance factors are as follows:

ECR_{CC}: The Contracted Specific Net Electricity Consumption is the efficiency (in kWh/m^3) of the KWC, as agreed in Table 2A of paragraph A.1 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8, for each Operating Contract Year. For each Construction Contract Year, ECR_{CC} will be as stated in the Mobilisation Testing Certificate.

ESG: The Contracted Specific Net Solar Generation is the captive solar generation (in kWh) for the KWC, as agreed in Table 2B of paragraph A.1 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8, for each Operating Contract Year. The ESG for the Billing Period will be deducted from overall electricity requirement of the KWC for the Billing Period. For each Construction Contract Year, ESG will be zero (0).

DRAW: Deduction for Reduced Water Availability will be calculated based on the Actual Loss of Water Output (in m^3) due to Unavailability being greater than the Projected Loss of Net Water Output (in m^3) due to Unavailability. In case of actual loss of water is higher than the projected loss of water, then deduction is made for actual losses or losses over and above the projected losses. However, in case the actual loss of water is less than the projected, then benefit of lower loss shall be shared between the Commercial Parties (as set out in paragraphs 2.1.3 of this appendix 8).

DNRW: Deduction for NRW will be calculated based on the NRW as a percentage of Net Water Input, being greater than the Allowable NRW limit (as calculated in paragraphs 2.1.4 of this appendix 8).

DRQW: Deduction for Off-Spec Output Water (as set out in paragraphs 2.1.5 of this appendix 8) will be calculated based on the deviation between the required and actual output water parameters. (Note: Attachment D To Appendix 8 has the general scheme for monitoring and metering)

For any Billing Period, DRQW will not apply where:

(a) Net Water Output is within Output Water Quality Specifications;

(b) Net Water Output that does not meet the Output Water Quality Specifications due to Off-Spec Input Water, provided there is no Off-Spec Mixed Water;

(c) in case of Bypass Water Output due to Bypass Input Water and there is no Bypass Off-Spec Mixed Water;

For any Billing Period, DRQW will apply:

(a) to Off-Spec Output Water based on Within Spec Input Water;

(b) to Bypass Water Output based on Within Spec Input Water;

(c) to Off-Spec Output Water due to Off-Spec Input Water and Off-Spec Mixed Water;

(d) in case of Bypass Water Output due to Bypass Input Water and Bypass Off-Spec Mixed Water.

Moreover, the water quality output requirements will be different during the C&O Period and the Operating Period.

ANWOp: The Projected Available Net Water Output (in m^3), as values in Table 3 of paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8, for each Contract Year. ANWOp means the net potential water production at the Output Water Connection Point and Water Access Points specified as M2 in attachment D of appendix 8, which shall be derived from (a) the maximum potential net output that could have been produced at the Output Water Connection Point and Water Access Points if the KWC had been operated at the Contracted Availability (in m^3/d) of the KWC during the Contract Year, (b) minus the total number of anticipated Outages in such Contract Year (in m^3).

1.6 Payment Formulas

The formulas for calculation of the payment components are defined in paragraph 2 (Payment Calculation) of this appendix 8.

In applying the payment formulas for each Billing Period, the factors to be used shall be, where applicable, those to be in effect for such Billing Period as specified in or derived from Attachment A (Agreed Values for Payment Calculation) and shall, where applicable, be adjusted in Attachment B (Indexation / Adjustment to Cost Recovery Charges).

1.7 Rounding of Calculations

In making the calculations required in this appendix 8, values shall be calculated to five (5) decimal places of accuracy.

2. Payment Calculation

2.1 Availability Payments

The Availability Payment shall be computed as the sum of Component AW and Component BW and it will be subject to Deduction for Reduced Water Availability (DRAW), NRW (DNRW) and Off-Spec Output Water (DRQW). For each Billing Period m:

$$\mathbf{APW_m = AW_m + BW_m - DRAW_m - DNRW_m - DRQW_m}$$

APW_m = Availability Payment (in PKR) for the Billing Period m

AW_m = Capital Cost Recovery Payment (in PKR) for the Billing Period m

BW_m = Fixed O&M Cost Recovery Payment (in PKR) for the Billing Period m

$DRAW_m$ = Deduction for Reduced Water Availability (in PKR) for the Billing Period m

$DNRW_m$ = Deduction for NRW (in PKR) for the Billing Period m

$DRQW_m$ = Deduction for Off-Spec Output Water (in PKR) for the Billing Period m

m = Billing Period

2.1.1 Availability Payment Equation for Component AW

Component AW (the **"Capital Cost Recovery Payment"**) of the Availability Payment for a Billing Period m in an Operating Contract Year n shall be calculated as follows:

$$\mathbf{AW_m = CCRW_m * DCW_m /24 * PH_m}$$

$$\mathbf{CCRW_m = FD\_P\_RC_m + FD\_I\_RC_m + LD\_P\_RC_m + LD\_I\_RC_m + FE\_RC_m + LE\_RC_m}$$

where:

AW_m = Capital Cost Recovery Payment (in PKR) for the Billing Period m

$CCRW_m$ = Capital Cost Recovery Charge for the Billing Period m

$FD\_P\_RC_m$ = Foreign Debt Principal Recovery Charge (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8

$FD\_I\_RC_m$ = Foreign Debt Interest Recovery Charge (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8 and subject to indexation as per paragraph B.2 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8

$LD\_P\_RC_m$ = Local Debt Principal Recovery Charge (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8

$LD\_I\_RC_m$ = Local Debt Interest Recovery Charge (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8 and subject to indexation as per paragraph B.2 of

Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8

FE_RC_{m} = Foreign Equity Recovery Charge (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8 and subject to indexation as per paragraph B.2 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8

LE_RC_{m} = Local Equity Recovery Charge (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8

DCW_{m} = Contracted Availability (m^3/day) for Billing Period m

PH_m = Total hours in the Billing Period m

m = as previously defined

2.1.2 **Availability Payment Equation for Component BW**

Component BW (the **"Fixed O&M Cost Recovery Payment"**) of the Availability Payment for a Billing Period m in an Operating Contract Year n shall be calculated as follows:

$$\mathbf{BW_m = FOMRW_m * DCW_m / 24 * PH_m}$$

where:

BW_m = Fixed O&M Cost Recovery Payment (in PKR) for the Billing Period m.

$FOMRW_m$ = Fixed O&M Cost Recovery Charge for Water (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8 and subject to indexation as per paragraph B.3 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8

DCW_{m} = As defined previously

PH_m = As defined previously

m = As defined previously

2.1.3 **Deduction for Reduced Water Availability**

The Deduction for Reduced Water Availability (DRAW) shall be calculated as follows:

(i) For Billing Periods during a Summer Period:

Case One:

$LCWa_m$ for the Billing Period m exceeds $LCWp_m$ i.e.

$$\mathbf{LCWa_m > LCWp_m}$$

In this case:

$$\mathbf{DRAW_m = (CCRW_m + FOMRW_m) * LCWa_m}$$

Case Two:

$LCWa_m$ for the Billing Period m is equal or less than $LCWp_m$ i.e.

$$\mathbf{LCWa_m <= LCWp_m}$$

In this case:

$$\mathbf{DRAW_m = (CCRW_m + FOMRW_m) * (LCWp_m - b * (LCWp_m - LCWa_m))}$$

Where in both cases:

$DRAW_m$ = as previously defined

$CCRW_m$ = as previously defined

$FOMRW_m$ = as previously defined

$LCWp_m$ = Projected Loss of Net Water Output due to Unavailability during a Summer Period according to paragraph A.3 of this Attachment A (Agreed Values for Payment Calculation)

$LCWa_m$ = Actual Loss of Water Output due to Unavailability during a Summer Period, calculated according to paragraph A.4 of this Attachment A (Agreed Values for Payment Calculation)

m = as previously defined

b = 0.5

(ii) For the Billing Periods during Winter Period:

- for the first Billing Period during Winter Period of an Operating Contract Year n:

$$\mathbf{DRAW_m = (CCRW_m + FOMRW_m) * LCWp_m}$$

- for the last Billing Period during Winter Period of an Operating Contract Year n:

Case One:

- $LCWa_{nW}$ for the Winter Period exceeds $LCWp_{nW}$ i.e.

$$\mathbf{LCWa_{nW} > LCWp_{nW}}$$

$$\mathbf{DRAW_m = (CCRW_m + FOMRW_m) * (LCWp_m + (LCWa_{nW} - LCWp_{nW}))}$$

where:

$DRAW_m$ = as defined previously

DFA_m = as defined previously

$CCRW_m$ = as defined previously

$FOMRW_m$ = as previously defined

$LCWp_m$ = Projected Loss of Net Water Output due to Unavailability during the Billing Period m in Winter Period according to paragraph A.3 of this Attachment A (Agreed Values for Payment Calculation)

$LCWp_{nW}$ = Projected Loss of Net Water Output (in m^3) due to Unavailability in the two Billing Periods in Winter Period in the Operating Contract Year n, calculated as aggregate value of i) $LCWp_{nW}^U$ and ii) $LCWp_{nW}^P$. $LCWp_{nW}^U$ and $LCWp_{nW}^P$ are tabulated in Table 3 in paragraph A.3 (Agreed Values for Payment Calculation)

$$\mathbf{LCWp_{nW} = LCWp_{nW}^U + LCWp_{nW}^P}$$

$LCWa_{nW}$ = Sum of all Actual Losses of Net Water Production (in m^3) $LCWa_m$ due to Unavailability in the two Billing Periods in Winter Period in the Operating Contract Year n, calculated according to paragraph A.4 of this Attachment A (Agreed Values for Payment Calculation)

n = Operating Contract Year

m = as defined previously

Case Two:

- $LCWa_{nW}$ for the Billing Period m is equal or less than $LCWp_{nW}$ i.e.

$$\mathbf{LCWa_{nW} <= LCWp_{nW}}$$

In this case:

$$\mathbf{DRAW_m = (CCRW_m + FOMRW_m) * (LCWp_m – b * (LCWp_{nW} - LCWa_{nW}))}$$

Where in both cases:

$DRAW_m$ = as previously defined

$CCRW_m$ = as previously defined

$FOMRW_m$ = as previously defined

$LCWp_m$ = as previously defined

$LCWp_{nW}$ = as previously defined

$LCWa_{nW}$ = as previously defined

m = as previously defined

b = as previously defined

2.1.4 **Deduction for NRW**

The Deduction for NRW (DNRW) shall be calculated as follows:

$$\mathbf{NRW_m = (HDWi_m + KIIIWi_m) - (OW_m + APOW_m + BPW_m)}$$

where:

NRW_m = NRW (in m^3) for the Billing Period m

$HDWi_m$ = Aggregate of daily Net HD Water Input (in m^3) in Billing Period m

$KIIIWi_m$ = Aggregate of daily Net KIII Water Input (in m^3) in Billing Period m

OW_m = Aggregate of daily water metered at Output Water Connection Point (in m^3) in Billing Period m

$APOW_m$ = Aggregate of daily water metered at Water Access Points (in m^3) in Billing Period m

BPW_m = Aggregate of daily water metered at Bypass Water Connection Point (in m^3) in Billing Period m (Note: not applicable prior to the Project Commercial Operations Date)

m = as previously defined

$$\mathbf{DNRW_m = ((NRW_m / (HDWi_m + KIIIWi_m)) - ANRW_m) * (CCRW_m + FOMRW_m) * V * NRW\_DCW_m}$$

$$\mathbf{NRW\_DCW_m = \sum_{d=1}^{D} (DCW_d)}$$

where:

$DNRW_m$ = as previously defined

NRW_m = as previously defined

$HDWi_m$ = as previously defined

$KIIIWi_m$ = as previously defined

$ANRW_m$ = Allowable NRW (in %) for the Billing Period m

$CCRW_m$ = as defined previously

$FOMRW_m$ = as defined previously

DCW_d = Contracted Availability (m^3/day) for Day d during Billing Period m

D = Number of Days in Billing Period m

m = as previously defined

V = Case 1: If (NRW_m / ($HDWi_m$ + $KIIIWi_m$)) > $ANRW_m$ then V = 1.

Case 2: If (NRW_m / ($HDWi_m$ + $KIIIWi_m$)) <= $ANRW_m$ then V = 0.

2.1.5 **Deduction for Off-Spec Output Water**

The Deduction for Off-Spec Output Water (DRQW) shall be calculated as follows:

$\mathbf{DRQW_m = DRQW\_WSIW_m + DRQW\_OSIW\&OSMW_m + DRQW\_BPOSMW_m}$

$\mathbf{DRQW\_WSIW_m}$	$\sum_{d=1}^{D} (DCW_d * X_d * 1 * (CCRW_m + FOMRW_m))$
$\mathbf{DRQW\_OSIW\&OSMW_m}$	$\sum_{d=1}^{D} (DCW_d * Y_d * 0.5 * (CCRW_m + FOMRW_m))$

$\mathbf{DRQW\_BPOSMW_m}$	$\sum_{d=1}^{D} (DCW_d * Z_d * 0.5 * (CCRW_m + FOMRW_m))$

where:

$DRQW_m$ = as defined previously

$CCRW_m$ = as defined previously

$FOMRW_m$ = as defined previously

m = as previously defined

DCW_d = as previously defined

D = as previously defined

X_d = Case 1: X = 1 if Day d during Billing Period m is a Day on which either a) Off-Spec Output Water based on Within Spec Input Water occur, or b) Bypass Water Output based on Within Spec Input Water occur.

Case 2: X = 0 if Day d during Billing Period m is not a Day on which either a) Off-Spec Output Water based on Within Spec Input Water occur, or b) Bypass Water Output based on Within Spec Input Water occur.

Y_d = Case 1: Y = 1 if Day d during Billing Period m is a Day on which Off-Spec Output Water due to Off-Spec Input Water and Off-Spec Mixed Water occur.

Case 2: Y = 0 if Day d during Billing Period m is not a Day on which Off-Spec Output Water due to Off-Spec Input Water and Off-Spec Mixed Water occur.

Z_d = Case 1: Z = 1 if Day d during Billing Period m is a Day on which Bypass Water Output due to Bypass Input Water and Bypass Off-Spec Mixed Water occur.

Case 2: Z = 0 if Day d during Billing Period m is not a Day on which Bypass Water Output due to Bypass Input Water and Bypass Off-Spec Mixed Water occur.

2.2 Output Payments

The Output Payment shall be computed as the sum of Component CW and Component DW. For each Billing Period m:

$$\mathbf{OPW_m = CW_m + DW_m}$$

where:

OPW_m = Output Payment (in PKR) for the Billing Period m

CW_m = Electricity Reimbursement Payment (in PKR) for the Billing Period m

DW_m = Variable O&M Cost Recovery Payment (in PKR) for the Billing Period m

m = Billing Period

2.2.1 Component CW of the Water Output Payment – Electricity Component

2.2.1.1 Electricity Reimbursement Payment for Water

The Electricity Component CW (the **"Electricity Reimbursement Payment"**) of the Net Water Output for the Billing Period m in a Contract Year n shall be calculated as follows:

If $\mathbf{AEC_m >= PEC_m}$:

$$\mathbf{CW_m = PEC_m * EP_m}$$

If $\mathbf{AEC_m < PEC_m}$:

$$\mathbf{CW_m = (AEC_m + (PEC_m - AEC_m) * V)* EP_m}$$

where:

CW_m = Electricity Reimbursement Payment (in PKR) for Billing Period m

PEC_m = Project Electricity Consumption (kWh) of the KWC in Billing Period m as determined under paragraph 2.2.1.2 below

AEC_m = Actual Electricity Consumption (kWh) of the KWC in Billing Period m

EP_m = Electricity Price (in PKR/kWh) in Billing Period m

V = 0.5

m = Billing Period

2.2.1.2 **Projected Electricity Consumption**

The Projected Electricity Consumption for the Billing Period m in a Contract Year n shall be calculated as follows:

$$\mathbf{PEC_m = (W_m * ECR_{CCn}) - ESG_m}$$

where:

PEC_m = as defined previously

W_m = Net Water Output (in m^3) during Billing Period m

ECR_{CCn} = Contracted Specific Net Electricity Consumption (in kWh/m^3) for each Contract Year n as specified in Table 2A of Attachment A

ESG_m = Contracted Specific Net Solar Generation (in kWh) for the Billing Period m. To be calculated as the aggregate Contracted Specific Net Solar Generation for the months within the Billing Period m, for each Contract Year n as specified in Table 2B of Attachment A

During C&O Period ESG will be zero (0).

2.2.2 **Component DW of Water Output Payment - Variable O&M Costs**

The Variable O&M Component DW (the **"Variable O&M Cost Recovery Payment"**) of the Output Payment for Net Water Output for a Billing Period m in a Contract Year n shall be calculated as follows:

$$\mathbf{DW_m = W_m * VOMRW_m}$$

where:

DW_m = The Variable O&M Cost Recovery Payment (in PKR) for Billing Period m

W_m = Net Water Output (in m^3) in Billing Period m

$VOMRW_m$ = Variable O&M Cost Recovery Charge for Water (in PKR/m^3) for Billing Period m as defined and stated in Attachment C (Cost Recovery Charges) to this appendix 8 and subject to indexation as per paragraph B.4 of Attachment B (Indexation / Adjustment to Cost Recovery Charges) to this appendix 8

m = as previously defined

2.3 Service Payment for Water

During the Operating Period:

The Service Payment for Water for the Billing Period m in an Operating Contract Year n shall be calculated as follows:

$$\mathbf{SPW_m = AW_m + BW_m + CW_m + DW_m - DRAW_m - DNRW_m - DRQW_m}$$

where:

SPW_m = Service Payment (in PKR) for Billing Period m

AW_m = as defined previously

BW_m = as defined previously

CW_m = as defined previously

DW_m = as defined previously

$DRAW_m$ = as defined previously

$DNRW_m$ = as defined previously

$DRQW_m$ = as defined previously

m = as defined previously

During the C&O Period:

The Service Payment for Water for the Billing Period m in the C&O Period shall be calculated as follows:

$$\mathbf{SPW_m = CW_m + DW_m - DRAW_m * 40\% - DNRW_m * 40\% - DRQW_m * 40\%}$$

where:

SPW_m = as defined previously

CW_m = as defined previously

DW_m = as defined previously

$DRAW_m$ = as defined previously

$DNRW_m$ = as defined previously

$DRQW_m$ = as defined previously

m = as defined previously

Attachment A To

Appendix 8 (Service Payment Calculations)

Agreed Values for Payment Calculation

A.1 The Contracted Specific Net Electricity Consumption ECR_{CCn} is as stated in Table 2A for each Operating Contract Year n.

Table 2A: Contracted Specific Net Electricity Consumption[17]

Contract Year n	**Contracted Specific Net Electrical Energy Consumption ECR_{CCn} (kWh/m^3)**
CY1	[ ]
CY2	[ ]
CY3	[ ]
CY4	[ ]
CY5	[ ]
CY6	[ ]
CY7	[ ]
CY8	[ ]
CY9	[ ]
CY10	[ ]
CY11	[ ]
CY12	[ ]
CY13	[ ]
CY14	[ ]
CY15	[ ]

[17] Insert figure stated in Bidding Form F-3 C (*Electricity*) of the Proposal.

The Contracted Specific Net Solar Generation ESG is as stated in Table 2B for each month and Operating Contract Year n.

Table 2B: Contracted Specific Net Solar Generation[18]

Operating Contract Year n	Contracted Specific Net Solar Generation ESG (kWh)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
CY1	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY2	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY3	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY4	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY5	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY6	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY7	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY8	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY9	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY10	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY11	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY12	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY13	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

[18] Insert figure stated in Bidding Form F-3 C (*Electricity*) of the Proposal

CY14	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY15	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

A.2 CAPITAL COST RECOVERY CHARGE FOR WATER (CCRW)

The Capital Cost Recovery Charge for Water CCRW consists of following components:

(i) Foreign Debt Principal Recovery Charge or FD_P_RC,

(ii) Foreign Debt Interest Recovery Charge or FD_I_RC,

(iii) Local Debt Principal Recovery Charge or LD_P_RC,

(iv) Local Debt Interest Recovery Charge or LD_I_RC,

(v) Foreign Equity Recovery Charge or FE_RC and

(vi) Local Equity Recovery Charge or LE_RC;

The CCRW components to be used in the calculation of Payment Component AW as stated in Attachment C (Cost Recovery Charges) subject to adjustment according to Attachment B (Indexation / Adjustment of Cost Recovery Charges) to this appendix 8.

The foreign component of CCRW, i.e. FE_RC, will be subject to indexation to the USD/PKR exchange rate as specified in Attachment B (Indexation / Adjustment of Cost Recovery Charges), to this appendix 8.

The debt interest components of CCRW, i.e. FD_I_RC and LD_I_RC, will be subject to indexation to the floating interest rates as specified in Attachment B (Indexation / Adjustment of Cost Recovery Charges), to this appendix 8.

The annual capital costs cover without limitation:

- Senior Debt service payments (interest paid on outstanding debt and principal repayment),
- returns on Equity, and
- all costs arising out of the total project budget, which includes but is not limited to:
    - construction costs;
    - owner's contingencies;
    - costs for initial inventory;
    - development costs and success fees;
    - owner's costs;
    - insurance costs during C&O Period;
    - initial working capital and any reserve accounts;
    - taxes, levies and duties;

- financing costs during construction, and
- fixed operating costs during the construction period.

A.3 PROJECTED AVAILABLE NET WATER OUTPUT

The Projected Net Water Output of KWC ANWO (in m^3) is defined to be the maximum potential net water output during a Contract Year less the Projected Loss of Net Water Output due to Unavailability during the same Contract Year period. Planned Outages are not accepted during the Summer Period.

The Projected Net Water Output ANWO during each Contract Year n is calculated as follows:

$$\mathbf{ANWOp_n = (PH_n * CAW_n / 24) - (LCWp_{nS} + LCWp_{nW}^{P} + LCWp_{nW}^{U})}$$

where:

$ANWOp_n$ = Projected Net Water Output measured at the Output Water Connection Point and Water Access Points in Contract Year n

PH_n = total hours in Contract Year n

$LCWp_{nS}$ = Projected Unplanned Outages (in m^3) during Summer Period in the Contract Year n, as per Table 3 in paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8

$LCWp_{nW}^{P}$ = Projected Planned Outages (in m^3) during Winter Period in the Contract Year n, as per Table 3 in paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8

$LCWp_{nW}^{U}$ = Projected Unplanned Outages (in m^3) during Winter Period in the Contract Year n, as per Table 3 in paragraph A.3 in Attachment A (Agreed Values for Payment Calculation) of this appendix 8

CAW_n = as previously defined

n = as previously defined

Outages allocation / distribution

For payment calculations, including Availability Payments, allocation of Unplanned Outages in Summer Period and Outages in Winter Period will be as follows:

- The Projected Loss of Net Water Output due to Planned Outages, $LCWp_{nW}^{P}$, as agreed in Table 3, must be allocated in the Winter Period of the Contract Year concerned.
- The Projected Losses of Net Water Output due to Unplanned Outages, $LCWp_{nW}^{U}$ and $LCWp_{nS}$, as agreed in Table 3, will be equally distributed over the Billing Periods m of the corresponding season (Summer Period and Winter Period) of the Contract Year concerned.
- The Projected Losses of Net Water Output due to Unplanned Outages during Summer, $LCWp_{nS}$, will be distributed throughout the two Summer Billing Periods based on the numbers of hours in each Billing Period;

- The Projected Losses of Net Water Output due to Planned Outages and Unplanned Outages during Winter, $LCWp_{nW}^{P}$ and $LCWp_{nW}^{U}$, will be distributed throughout the two Winter Billing Periods based on the numbers of hours in each Billing Period.

- The Availability Payments for the first Billing Period of the Winter Period will be based on the Projected Losses of Net Water Output during Winter Period, $LCWp_{nW}^{P}$ and $LCWp_{nW}^{U}$, distributed throughout the two Billing Periods of the Winter Period based on the number of hours in each Billing Period; and

- The Availability Payment for the last Billing Period of the Winter Period will be based on the Projected Losses of Net Water Output during Winter Period, $LCWp_{nW}^{P}$ and $LCWp_{nW}^{U}$, reconciled and adjusted at the end of the second Billing Period of the Winter Period against the actual losses of output during the whole Winter Period.

Projected Loss of Net Water Output ($LCWp_m$) in Billing Period m

The Projected Loss of Net Water Output, LCWp, in Billing Period m to be used in the Availability Payment calculation of this appendix 8 shall be calculated as follows:

- for such Billing Period m during Summer Period

$$\mathbf{LCWp_m = LCWp_{nS} * PH_m / PH_s}$$

- for such Billing Period m during Winter Period

$$\mathbf{LCWp_m = (LCWp_{nW}^{U} + LCWp_{nW}^{P}) * PH_m / PH_w = LCWp_{nW} * PH_m / PH_w}$$

where for both are:

$LCWp_m$ = as defined previously

$LCWp_{nS}$ = as defined previously

$LCWp_{nW}^{U}$ = as defined previously

$LCWp_{nW}^{P}$ = as defined previously

$LCWp_{nW}$ = Projected Loss of Net Water Output (in m^3) due to Unplanned Outages and Planned Outages during Winter Period, i.e. $LCWp_{nW}^{U} + LCWp_{nW}^{P}$

PH_m = as defined previously

PH_s = total hours in Summer Period

PH_w = total hours in Winter Period

m = as defined previously

Table 3: Projected Availability of Water

During C&O Period

Contract Year	Hours in Contract Year		Projected Available Net Water Output	Projected Loss of Net Water Output due to Unavailability (m^3)			
	Summer	Winter		Summer	Winter		
n	PH_S	PH_W	$ANWOp_n$ (m^3)	$LCWp_{ns}$	Planned, $LCWp_{nw}^P$	Unplanned, $LCWp_{nw}^U$	Total, $LCWp_n$
CY1 (1 year)	4,380	4,380	161,386,195	1,818,436	909,218	1,818,436	4,546,090
CY2 (6 months)	2,190	2,190	80,693,098	909,218	454,609	909,218	2,273,045

During Operating Period[19]

Contract Year	Hours in Contract Year		Projected Available Net Water Output	Projected Loss of Net Water Output due to Unavailability (m^3)			
	Summer	Winter		Summer	Winter		
n	PH_S	PH_W	$ANWOp_n$ (m^3)	$LCWp_{ns}$	Planned, $LCWp_{nw}^P$	Unplanned, $LCWp_{nw}^U$	Total, $LCWp_n$
CY1	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 2	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 3	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 4	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 5	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 6	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 7	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 8	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 9	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 10	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 11	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 12	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 13	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 14	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]
CY 15	4380	4380	[ ]	[ ]	[ ]	[ ]	[ ]

[19] Insert figures stated in Bidding Form F-3 A (*Projected Available NWO*) of the Proposal.

A.4 ACTUAL UNAVAILABILITY OF WATER

The Actual Loss of Water Output due to Unavailability $LCWa_m$ shall be determined as follows:

$$LCWa_m = \sum_{j=1}^{J} (UD_j / 24 * (DCW_m - DCW_j))$$

where:

$LCWa_m$ = as defined previously

DCW_m = Contracted Availability (m^3/day) for Billing Period m

UD_j = Length of actual period (in hours) of declared Unavailability for Water, as per Availability Notice, for each Period j

DCW_j = Reduced Contracted Availability of the KWC (in m^3/day) declared, as per the Unavailability Notice, in the period j, provided that DCW_j (in m^3/day) is equal or less than DCW_m;

j = each period of declared Unavailability (as per Availability Notice)

J = number of periods of declared Unavailability (as per Availability Notice) in Billing Period

For the determination of the Actual Loss of Water Output due to Unavailability LCWa, the Company notify and provide supporting data to the Independent Engineer and KW&SB all the Planned and Unplanned Outages.

If the Independent Engineer or KW&SB have grounds to believe that the Company has failed to provide the Unavailability Notice at the earliest time notice is possible in accordance with the requirements of this Agreement, the Independent Engineer or KW&SB may request the Company to, and the Company shall, provide the Independent Engineer and KW&SB with such information as may be necessary for the Independent Engineer to determine whether earlier notice by the Company was, under the circumstances, possible. If, after such investigation, the Independent Engineer determines that earlier notice was possible and the Company agrees with the determination, GoS may reduce the Availability Payments payable to the Company by an amount for such Unavailability that will not exceed one full day's Availability Payment.

If the Parties are unable to agree upon such determination, the matter in dispute shall be resolved pursuant to clause 27 of this Agreement.

Subject to approval by the Independent Engineer, Planned Outages not used in a Winter Period may be shifted to following Winter Periods, but not otherwise, which approval shall not be unreasonably withheld or delayed.

A.5. FIXED O&M PAYMENT CALCULATION

Fixed O&M Cost Recovery Charge for Water

The Fixed O&M Cost Recovery Charge for Water (**"FOMRW"**) is expressed as one level charge rate for any applicable Billing Period. The FOMRW to be used in the calculation of

Payment Component BW on the Commencement Date are as stated in Attachment C (Cost Recovery Charges), subject to adjustment according to Attachment B (Indexation / Adjustment of Cost Recovery Charges) to this appendix 8.

FOMRW is subject to indexation to the inflation rate as specified in Attachment B (Indexation / Adjustment of Cost Recovery Charges) to this appendix 8.

A.6 VARIABLE O&M PAYMENT CALCULATION

Variable O&M Cost Recovery Charge for Water

The Variable O&M Cost Recovery Charge for Water VOMRW is expressed as one level charge rate for any applicable Billing Period. The VOMRW to be used in the calculation of Payment Component DW as stated in Attachment C (Cost Recovery Charges), subject to adjustment according to Attachment B (Indexation / Adjustment of Cost Recovery Charges) to this appendix 8.

VOMRW is subject to indexation to the inflation rate as specified in Attachment B (Indexation / Adjustment of Cost Recovery Charges) to this appendix 8.

Attachment B To
Appendix 8 (Calculation of Payment)
Indexation / Adjustment of Cost Recovery Charges

B.1 GENERAL

The cost recovery charges used in paragraph 2 (Payment Calculation) shall be adjusted in accordance with the provisions of this Attachment B.

(a) Adjustments for fluctuation of the USD / PKR exchange rate:

Any change between the Reference Exchange Rate and the arithmetic average of exchange rate (**"Exchange Rate"**) for the Billing Period m shall result in an adjustment of FE_RC component of those Capital Cost Recovery Charge on a Quarterly basis. Any Exchange Rate adjustment or arithmetic average of exchange rate in Billing Period m will use the TT selling rate for Dollars expressed in Rupees, as published by the National Bank of Pakistan prevailing at the close of Wednesday that is also a Business Day, and with respect to any Wednesday that is not a Business Day, the TT selling rate for Dollars expressed in Rupees, as published by the National Bank of Pakistan prevailing at the close of the last preceding Business Day prior to such Wednesday.

(b) Indexation based on Inflation Rate National Consumer Price Index:

The FOMRW and VOMRW, as specified in Attachment A (Agreed Values for Payment Calculation) of this appendix 8, will be adjusted quarterly according to the N-CPI or if the index is not available or if the Commercial Parties agree otherwise, then another mutually agreed index, or in the event of a failure to agree then such index or method of calculation as shall be determined in accordance with the provisions of clause 27 of this Agreement.

Quarterly N-CPI values will be calculated as the average of each of the end of month values for N-CPI in the Billing Period immediately preceding the relevant Billing Period, which shall equal the sum of the month end N-CPI values in the Billing Period immediately preceding the Billing Period divided by the number of such values; provided, that if any such values for any of such Billing Period are not available, then the average of the end of month value for the most recent available three (3) months shall be used.

(c) Indexation based on Karachi Interbank Offer Rate:

Any change between the Reference KIBOR Rate and the KIBOR for the Billing Period m shall result in an adjustment of the LD_I_RC on a quarterly basis. Quarterly KIBOR values will be calculated based on the KIBOR on the Day prior to the Project Commercial Operations Date and thereafter the last Day of the previous Quarter (31st March, 30th June, 30th September or 31st December, as applicable).

(d) Indexation based on Foreign Financing Base Rate LIBOR:

Any change between the Reference LIBOR and the LIBOR for the Billing Period m shall result in an adjustment of the foreign debt interest component (FD_I_RC) of those

Cost Recovery Charges on a quarterly basis. Quarterly LIBOR values will be calculated based on the LIBOR on the Day prior to the Project Commercial Operations Date and thereafter the last Day of the previous Quarter (31st March, 30th June, 30th September or 31st December, as applicable).

The cost recovery charges subject to indexation are:

Availability Payment for Water:

- AW: Capital Cost Recovery Payment. Following component of Capital Cost Recovery Payment shall be indexed:
    - Availability Component FD_I_RC: Foreign Debt Interest Recovery Charge
    - Availability Component LD_I_RC: Local Debt Interest Recovery Charge
    - Availability Component FE_RC: Foreign Equity Recovery Charge
- Availability Component BW: Fixed O&M Cost Recovery Payment

Output Payment for Water:

- Water Component DW: Variable O&M Cost Recovery Payment

B.2 ADJUSTMENT OF THE CAPITAL COST RECOVERY CHARGE

The Capital Cost Recovery Charge or CCRW components to be used for any Billing Period m shall be calculated based on agreed values in Attachment C (Cost Recovery Charges) after adjustment in accordance with this Attachment B (Indexation / Adjustment of Cost Recovery Charges).

To determine CCRW for any Billing Period m, the value of CCRW components will be calculated and adjusted in accordance with Attachment B (Indexation / Adjustment of Cost Recovery Charges) and Attachment C (Cost Recovery Charges) as follows:

Foreign Debt Interest Recovery Charge

$$\mathbf{FD\_I\_RC_m = (FD\_I\_RC * (FIR_m / FIR_{r)}) * F_f) + (FD\_I\_RC * (1\text{-}F_f))}$$

Where:

F_f = **[●]%**[20]

$FD\_I\_RC_m$ = Foreign Debt Interest Recovery Charge in Billing Period m (PKR/m3)

FD_I_RC = Foreign Debt Interest Recovery Charge as specified in Attachment C (Cost

[20] Insert Percentage of Foreign Debt Interest Recovery Charge (FD_I_RC) that is based on LIBOR amount from Bidding Form F3-G (*Termination Payments*) of the Proposal, specified as "*Percentage of Foreign Debt Interest Recovery Charge linked with LIBOR*".

Recovery Charges) (PKR/m3)

FIR_m = The LIBOR to be applied for the Billing Period m calculated as per paragraph B.1 Attachment B,

FIR_r = The Reference LIBOR

Local Debt Interest Recovery Charge

$$LD\_I\_RC_m = (LD\_I\_RC * (LIR_m / LIR_r) * F_k) + (LD\_I\_RC * (1-F_k))$$

Where:

F_k = **[●]%**[21]

$LD\_I\_RC_m$ = Local Debt Interest Recovery Charge in Billing Period m (PKR/m3)

LD_I_RC = Local Debt Interest Recovery Charge as specified in Attachment C (Cost Recovery Charges) (PKR/m3)

LIR_m = The KIBOR to be applied for the Billing Period m calculated as per paragraph B.1 Attachment B,

LIR_r = The Reference KIBOR

Foreign Equity Recovery Charge

$$FE\_RC_m = FE\_RC * (EXR_m / EXR_r)$$

Where:

FE_RC_m = Foreign Equity Recovery Charge in Billing Period m (PKR/m3)

FE_RC = Foreign Equity Recovery Charge as specified in Attachment C (Cost Recovery Charges) (PKR/m3)

EXR_m = The USD/PKR exchange rate to be applied for the Billing Period m calculated as per paragraph B.1 Attachment B

EXR_r = The Reference Exchange Rate

B.3 ADJUSTMENT OF THE FIXED O&M COST RECOVERY CHARGE FOR WATER

The FOMRW to be used for any Billing Period m shall be calculated based on agreed values in Attachment C (Cost Recovery Charges) after adjustment in accordance with this Attachment B

[21] Insert Percentage of Local Debt Interest Recovery Charge (LD_I_RC) that is based on KIBOR amount from Bidding Form F3-G (*Termination Payments*) of the Proposal, specified as "*Percentage of Local Debt Interest Recovery Charge linked with KIBOR*".

(Indexation / Adjustment of Cost Recovery Charges).

To determine FOMRW for any Billing Period m, the value of FOMRW will be calculated and adjusted in accordance with Attachment B (Indexation / Adjustment of Cost Recovery Charges) and Attachment C (Cost Recovery Charges) as follows:

$$\mathbf{FOMRW_m = FOMRW * (IR_m / IR_r)}$$

Where:

$FOMRW_m$ = Fixed O&M Cost Recovery Charge for Water in Billing Period m (PKR/m3)

FOMRW = Fixed O&M Cost Recovery Charge for Water as specified in A.1 of Attachment C (Cost Recovery Charges) (PKR/m3)

IR_m = N-CPI as applicable for Billing Period m calculated as per paragraph B.1 Attachment B

IR_r = Reference Inflation Rate

B.4 ADJUSTMENT OF THE VARIABLE O&M COST RECOVERY CHARGE

The VOMRW to be used for any Billing Period m shall be calculated based on agreed values in Attachment C (Cost Recovery Charges) after adjustment in accordance with this Attachment B.

To determine VOMRW for any Billing Period m, the value of VOMRW will be calculated and adjusted in accordance with Attachment B (Indexation / Adjustment of Cost Recovery Charges) and Attachment C (Cost Recovery Charges) as follows:

$$\mathbf{VOMRW_m = VOMRW * (IR_m / IR_r)}$$

Where:

$VOMRW_m$ = Variable O&M Cost Recovery Charge in Billing Period m (PKR/m3)

VOMRW = Variable O&M Cost Recovery Charge as specified in A.1 of Attachment C (Cost Recovery Charges) (PKR/m3)

IR_m = as previously defined

IR_r = as previously defined

Attachment C To

Appendix 8 (Calculation of Payment)

Cost Recovery Charges

During C&O Period

Year	FD_P_RC PKR/ m^3	FD_I_RC PKR/ m^3	LD_P_RC PKR/ m^3	LD_I_RC PKR/ m^3	FE_RC PKR/ m^3	LE_RC PKR/ m^3	FOMRW PKR/ m^3	VOMRW[22] PKR/ m^3
CY 1	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	[ ]
CY 2	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	Same as CY1 in Operating Period*	[ ]

[22] Insert figures stated in Bidding Form F-3 B (*Cost Recovery Charges*) of the Proposal.

During Operating Period[23]

Year	FD_P_RC PKR/ m^3	FD_I_RC PKR/ m^3	LD_P_RC PKR/ m^3	LD_I_RC PKR/ m^3	FE_RC** PKR/ m^3	LE_RC** PKR/ m^3	FOMRW PKR/ m^3	VOMRW PKR/ m^3
CY1	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY2	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY3	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY4	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY5	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY6	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY7	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY8	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY9	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY10	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY11	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY12	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY13	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY14	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CY15	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

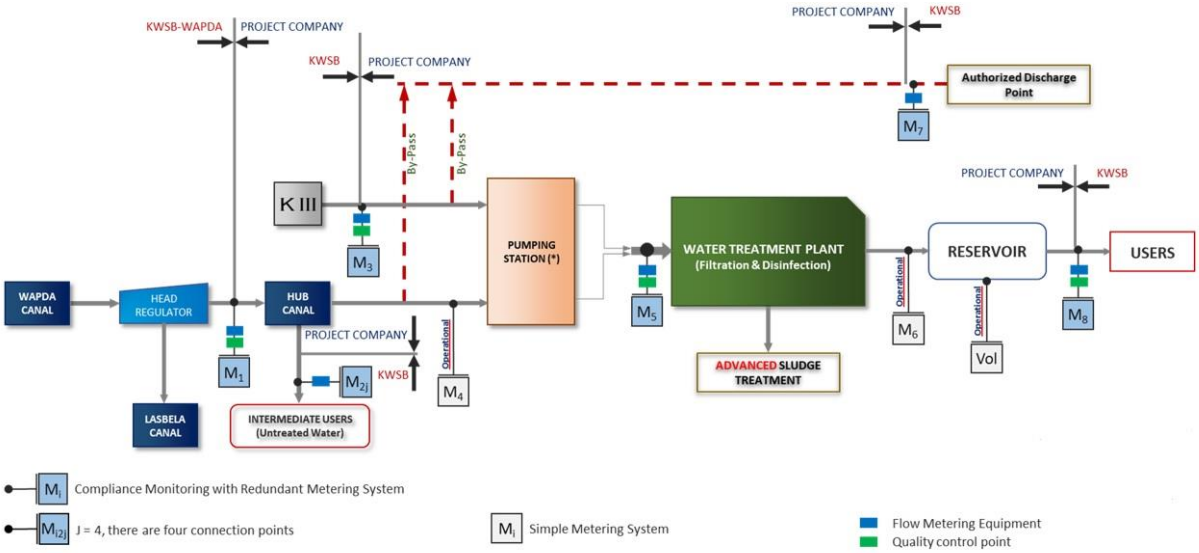
* During C&O Period CCRW components (FD_P_RC, FD_I_RC, LD_P_RC, LD_I_RC, FE_RC, LE_RC and FOMRW) will be used only for deduction for availability (DRAW), NRW (DNRW) and quality (DRQW). CCRW or Availability Payments will not be applicable during C&O Period.

**Bidders are referred to clause 8.5 of the Instructions to Bidders (Volume I (Bidding Procedure)) of the RFP.

[23] Insert figures stated in Bidding Form F-3 B (*Cost Recovery Charges*) of the Proposal.

Attachment D To

Appendix 8 (General scheme for monitoring and metering)



Attachment E
Appendix 8 (Calculation of Payment)

[Insert table in Bidding Form F3-G headed ‘Debt Repayment Profile’ submitted with Proposal]

Attachment F
Appendix 8 (Calculation of Payment)

[Insert table in Bidding Form F3-G headed ‘Equity Payment Profile’ submitted with Proposal]

APPENDIX 9: GoS PAYMENT ACCOUNT STANDING INSTRUCTIONS

[ON THE LETTERHEAD OF THE GOS]

DATE: [●]
REFERENCE: [●]
TO,
[GoS Payment Account Bank]

..……..

……

CC:

..……..

RE: STANDING INSTRUCTIONS IN RESPECT OF GOS PAYMENT ACCOUNT

Dear Sir / Madam,

1. GOS PAYMENT ACCOUNT & ISSUANCE OF STANDING INSTRUCTIONS NOTICE

1.1 We, [●] (through [●]) (the **"Account Holder"**) refer you, [INSERT BANK NAME] (a banking company established under the laws of Pakistan having its registered office located at [●]) (the **"Account Bank"**) to the following bank account established and maintained in the name of the Account Holder at the Account Bank's branch, located at [●]:

(a) Account Number [●], Account Title [●] (the **"GoS Payment Account"**);

AND, We, the Account Holder, hereby issue this notice (the **"Standing Instructions Notice"**) containing the Standing Instructions for the maintenance and operation of the GoS Payment Account and for matters relating to the same.

2. DEFINITIONS

2.1 In this Standing Instructions Notice, the following capitalized words shall bear the meaning ascribed to the same as below:

(a) **"Account Bank"** has the meaning given to it in paragraph 1 of the Standing Instructions Notice;

(b) **"Account Holder"** has the meaning given to it in paragraph 1 of the Standing Instructions Notice;

(c) **"Certified Amount"** means the amount payable by the GoS to the Company as set out in the Payment Certificate;

(d) **"Company"** means [●], a company incorporated under the laws of Pakistan, having its registered office located at [●];

(e) **"Company Payment Account"** means the account to be established and maintained by the Company, in which the Company shall receive the amounts payable by the Account Holder in accordance with the Payment Certificates;

(f) **"Concession Agreement"** means the concession agreement dated [●] between the Governor of Sindh (acting through Secretary, Local Government & Housing Town Planning Department, Government of Sindh), the Karachi Water & Sewerage Board, and the Company in respect of the Project;

(g) **"GoS Payment Account** has the meaning given to it in paragraph 1 of the Standing Instructions Notice;

(h) **"Independent Auditor"** means [●];

(i) **"Independent Engineer"** means [●];

(j) **"Payment Certificate"** means the certificate jointly issued and duly signed by the Independent Auditor and the Independent Engineer, setting out the Certified Amount;

(k) **"Project"** means the designing, building, constructing, testing, commissioning, operating, maintaining, financing, and transferring by the Company of the Karachi Water Canal to be undertaken in public-private partnership mode by the Company in terms of the Concession Agreement;

(l) **"Revocation Notice"** has the meaning given to it in paragraph 5.1(b) of the Standing Instructions Notice;

(m) **"Sponsors"** means [●];

(n) **"Standing Instructions"** means these standing instructions for the operations of the GoS Payment Account; and

(o) **"Standing Instructions Notice"** has the meaning given to it in paragraph 1 of the Standing Instructions Notice.

3. INTERPRETATION

3.1 Save where the contrary is indicated, any reference in this Standing Instructions Notice to:

(a) a paragraph or an annexure shall be construed as a reference to a paragraph of or an annexure to this Standing Instructions Notice;

(b) any instrument, memorandum, agreement, contract or document shall be construed as a reference to that instrument, memorandum, agreement, contract or document (together with any recitals or sections thereto) all as amended, varied, restated, novated or supplemented from time to time;

(i) any person shall be construed so as to include their respective administrators, successors in interest and permitted assigns from time to time;

(ii) a statute, enactment or order shall be construed as a reference to such statute, enactment or order as the same may have been, or may from time to time be,

amended or re-enacted and all subsidiary legislation and other instrument made under or deriving validity therefrom;

(iii) the singular shall include the plural and vice versa, where appropriate;

(iv) the words '*including*' and '*includes*' and any grammatical variants of those words, will be read as if followed by the words '*without limitation*;'

(v) a reference to a person shall be construed to include a juridical person;

(vi) a time of day shall be construed as a reference to Pakistan Standard Time; and

(vii) headings in this Standing Instructions Notice are for ease of reference only and shall be ignored in construing this Standing Instructions Notice.

(c) The annexures to this Standing Instructions Notice shall form an integral part of this Standing Instructions Notice.

4. THE INSTRUCTIONS IN RESPECT OF MATTERS RELATING TO THE FUNDING NOTICE (GOS)

4.1 The Account Holder instructs and authorizes the Account Bank to act as follows:

THAT, upon receipt of a Payment Certificate by the Account Bank from time to time, the Account Bank shall, within one (1) Business Day of receipt of the Payment Certificate, debit the GoS Payment Account in an amount equal to the Certified Amount and credit the same to the Company Payment Account.

5. REVOCATION AND AMENDMENT OF STANDING INSTRUCTIONS

5.1 The Standing Instructions shall remain effective until such date which is the earlier of:

(a) the date on which a written certificate, duly issued by the Independent Auditor, is received by the Account Bank from the Independent Auditor certifying that the Account Holder has fully complied with and has satisfied its payment obligations for the Project;

(b) the date on which the Standing Instructions are revoked pursuant a written revocation notice (the **"Revocation Notice"**) duly executed and confirmed by the authorized representatives of each of the Account Holder and the Company and subsequently duly issued by the Account Holder to the Account Bank instructing revocation of the Standing Instructions;

(c) the date on which a written certificate, duly issued by the Account Holder, is received by the Account Bank from the Account Holder certifying that the Concession Agreement has been terminated in accordance with the terms thereof and the Termination Payments have been made; and

(d) the date on which a written certificate, duly issued by the Account Holder, is received by the Account Bank from the Account Holder certifying that the 'GoS Service Payment SBLC' has been established in accordance with the Concession Agreement.

5.2 The Standing Instructions Notice may be amended pursuant a written notice duly executed and confirmed by the authorized representatives of the Account Holder and the Company and subsequently duly issued by the Account Holder to the Account Bank instructing amendment to this Standing Instructions Notice.

6. SEVERABILITY

6.1 If for any reason whatsoever any provision of this Standing Instruction Notice is or becomes invalid, illegal or unenforceable or is declared by any court of competent jurisdiction or any other instrumentality to be invalid, illegal or unenforceable, the validity, legality or enforceability of the remaining provisions shall not be affected in any manner, and the Account Bank and the Account Holder will negotiate in good faith with a view to agreeing upon one or more provisions which may be substituted for such invalid, unenforceable or illegal provisions, as nearly as is practicable.

7. GOVERNING LAW & DISPUTE RESOLUTION

7.1 These Standing Instructions Notice shall be governed by and construed in accordance with the laws of Pakistan and the courts of law at Karachi, Pakistan with competent jurisdiction shall entertain all disputes arising hereunder.

APPENDIX 10: INDEPENDENT APPOINTEES TERMS OF REFERENCE

Part 1: Indicative Independent Auditor Terms of Reference

The scope of work of the Independent Auditor for the Project shall include the following:

(a) Perform all actions and services set out in the Relevant Agreements to be performed by the Independent Auditor diligently and within the timelines set out therein (the **"IA Services"**).

(b) Exercise, in the performance of the IA Services, all skill, care and diligence to be expected of a properly qualified and competent professional experienced in each of the disciplines to which the IA Services relate.

(c) Cooperate with the other parties to the Relevant Agreements in respect of matters relating to the Independent Auditor for the purposes of, *inter alia*, facilitating of the Project and the Project Activities.

(d) The IA Services include:

- monitoring financial aspects;
- certification and approvals;
- issuing monthly progress reports;
- cost certification;
- expert adjudicator on financial matters relating to force majeure, terminations, project delays or other project issues as and when they arise of the Project's issues, funding mechanisms, project risks and intimate the party concerned of their responsibility as laid down in the Relevant Agreements; and
- other maters detailed in Relevant Agreements.

(e) To work in close coordination with the Independent Engineer and exchange information as required for the performance of their respective tasks.

(f) To give presentations to various Government tiers on the Financial Model and explain the impact of tariff indexations, Deductions, payments related to a Relief Event, Force Majeure Event and termination events, on the value for money. Also be in meetings of the GoS at during various approvals (if and as required).

(g) On intimation from the Company, the Financing Parties or GoS Parties, establish the occurrence of a material adverse effect on the Project and recommend based on the terms of the Relevant Agreements, a mechanism to overcome the same.

(h) Follow a system of periodic reports in such frequency and formats as determined by the Company and the GoS Parties.

(i) During the C&O Period, monitor financial progress against the Implementation Schedule.

(j) Determine, *inter alia*, the Availability Payment and Output Payment to be paid in accordance with appendix 8 of the Concession Agreement (including the Deductions).

(k) Determine, *inter alia*, the Increased Costs to be paid by the GoS in accordance with clause 20 of the Concession Agreement. In case the Increased Costs are funded by the Company, the Independent Auditor will be required to propose necessary adjustments to the Availability Payments and Output Payments (if and as applicable) in accordance with the Concession Agreement.

(l) Issue certifications to facilitate disbursement of funding from stakeholders (including equity) with respect to construction and other expenditures in accordance with the Relevant Agreements.

(m) In respect of the occurrence of a Relief Event or Force Majeure Event in accordance with the provisions of the Concession Agreement, consult with the Company and the GoS Parties in order to determine the amount of resultant compensations, if any, in accordance with the provisions of the Concession Agreement and issue necessary certifications in this respect.

(n) In respect of Termination Payments, determine the amount of resultant compensations, if any, in accordance with the provisions of the Concession Agreement and issue necessary certifications in this respect.

(o) Certify the Financing Termination Date as defined in the Concession Agreement.

(p) Issue the GoS Termination SBLC Certificate or the GoS Termination SBLC Failure Certificate (as the case may be) in accordance with clause 12 of the Concession Agreement.

(q) Issue certificate confirming the GoS Termination Secured Amount, the GoS Termination SBLC Failure Certificate and Unpaid Termination Payment Amount Certificate, each in accordance with clause 12 of the Concession Agreement.

(r) Issue the GoS Payment Account Certificate determining the GoS Payment Account Required Balance in accordance with clause 12 of the Concession Agreement.

(s) Monitor the debt-to-equity ratio of the Company and ensure it does not exceed 80:20.

(t) Monitor the shareholding percentage of each Shareholder on a quarterly basis from the Commencement Date.

(u) Endorse calculations prepared by the Company of any amounts in respect of Refinancing Gains described in clause 16.3.7 of the Concession Agreement.

(v) Issue various certificates in consultation with the Independent Engineer (where applicable) including Commencement Certificate, Handover Certificate, Mobilisation Certificate, Payment Certificates and Project Commercial Operations Certificate as more particularly described in the Concession Agreement. The Independent Auditor will rely on reports, studies, surveys, and other documents provided by the Company or its appointed consultants.

(w) In case of a failure to achieve the scheduled project milestones, issue delay notices, in consultation with the Independent Engineer, as described in the Concession Agreement.

(x) Together with the Independent Engineer, act to resolve any disputes arising due to a conflict between the clauses and appendices of the Concession Agreement.

(y) Together with the Independent Engineer, advise GoS on the financial implications of a Change in Scope requested by the Company.

(z) Together with the Independent Engineer, advise GoS on any changes, modifications, amendments, supplements or waivers to the Financing Documents, the EPC Contract, the O&M Contract or in respect of any Refinancing. The Independent Auditor will rely on the timely provision of relevant documents by the Company and will make its recommendations in accordance with clause 16.3 of the Concession Agreement.

(aa) Together with the Independent Engineer, advise GoS on any changes, modifications, amendments, supplements to the Insurance Policies.

(bb) Together with the Independent Engineer, issue the Payment Certificate in respect of invoiced Service Payments in accordance with clause 13.5 of the Concession Agreement.

(cc) Comply with the Laws of Pakistan in its performance of the IA Services.

(dd) Perform such other obligations and responsibilities as set out in the Relevant Agreements.

(ee) Perform such other obligations and responsibilities as mutually agreed between the Parties.

(ff) Perform any other action or services set out in the Independent Auditor Contract.

Independent Auditor Criteria

An international or local auditing firm (not individuals) appointed as the Independent Auditor shall meet the following criteria:

- Have the experience of undertaking a similar role in at least two (2) either i) project financed infrastructure projects or ii) PPP projects.
- Have the following permanent employees for at least one (1) year:
    - (i) team leader with at least fifteen (15) years of experience with complete knowledge and understanding of project financed infrastructure projects or PPP projects;
    - (ii) tax expert with at least ten (10) years of experience with complete knowledge of Pakistani tax law and its application to the Project;
    - (iii) auditing expert with at least ten (10) years of experience;
    - (iv) financial modelling expert with at least ten (10) years of experience;
    - (v) other experts required to perform the obligations of the Independent Auditor under the Project as specified herein.
- Provide an undertaking that the above staff shall be employed on the Project if the work is awarded to the firm. Relevant staff members must be available to attend all inspections and

meetings with the GoS officials. Any change in staff for this assignment would need to be replaced with similar experience.

- Ensure that its staff are fully familiar with project financed infrastructure projects or PPP projects and the role of the Independent Auditor in such projects. In addition, staff should be familiar with Pakistan Income Tax Ordinance, 2001, GoS public procurement regulatory framework and Relevant Agreements.

Part 2: Indicative Independent Engineer Terms of Reference

1.1 General

The scope of work of the Independent Engineer for the Project shall include the following:

(a) Perform all actions and services set out in the Relevant Agreements to be performed by the Independent Engineer diligently and within the timelines set out therein (the **"IE Services"**).

(b) Exercise, in the performance of the IE Services, all skill, care and diligence to be expected of a properly qualified and competent professional experienced in each of the disciplines to which the IE Services relate.

(c) Cooperate with the other parties to the Relevant Agreements in respect of matters relating to the Independent Engineer for the purposes of, *inter alia*, facilitating implementation of the Project and the Project Activities.

(d) Review the Relevant Agreements delivered by the Parties and all documents that are provided to it pursuant to the Relevant Agreements.

(e) Coordinate and liaise with the Parties in respect of matters that require the Independent Engineer's inputs for performance of the IE Services.

(f) As and when requested or required, consult with the parties to the Relevant Agreements and / or any other relevant stakeholders of the Project for the performance of IE Services and request (where available and applicable) any documents that are required by the Independent Engineer to perform the IE Services.

(g) As and when requested or required pursuant to this Agreement and other Relevant Agreement, review and comment on any documents provided to it pursuant to the Relevant Agreements and request further documents as may be required for performance of the IE Services.

(h) Prepare, issue, deliver, review and / or approve (as applicable) all documents contemplated to be prepared, issued, delivered, reviewed and/or approved (as applicable) by the Independent Engineer under this Agreement or the other Relevant Agreements.

(i) Visit any of the offices of the Company or any other location where relevant personnel or records of the Company are located.

(j) Comply with the Laws of Pakistan in its performance of the IE Services.

(k) In performing the IE Services, not in any way materially adversely interfere with the performance of the Company's, the Contractors' and the GoS' obligations and with the conduct of their business.

(l) Report to the Parties in case the quality standards and quality control provisions are not maintained on the Site.

(m) Perform all such duties and obligations that are to be performed by the Independent Engineer under the Relevant Agreements.

(n) Perform functions, including issuance of directions to the Company or its Contractors, in respect of the emergency decommissioning of the KWC, as may be required by the Relevant Agreements.

(o) Perform its duties in respect of insurance claims and proceeds, as set out in the Concession Agreement.

(p) Perform functions in respect of a Change in Scope, as set out in the Concession Agreement.

(q) Perform the respective roles and duties that are to be performed by the Independent Engineer upon termination of the Concession Agreement or upon expiry of the Concession Period.

(r) As and when requested or required, attend / visit, during normal working hours, any place where work is being carried out in respect of any equipment or material to be incorporated into the KWC, with full opportunity to inspect, examine, measure or test any such works, equipment or material.

(s) As and when requested or required, certify any delays in the achievement of the Project Commercial Operations Date (including identifying the party responsible for such delay) and coordinate with the Independent Auditor in respect of matters relating to the same.

(t) Consult with the Parties in respect to the sufficiency and / or insufficiency of the insurance proceeds required to repair, replace, reinstate or rectify the relevant loss or damage to the KWC in accordance with the Concession Agreement.

(u) Upon receipt of an invoice in relation to the C&O Activities, certify to all Parties of the completion of the relevant milestone under the EPC Contract.

(v) Be present at and observe performance of all Test Procedures under appendix 5 of the Concession Agreement or provide for authorized representatives to perform the foregoing functions.

(w) Provide operational recommendations in risk management reports to the Parties, from time to time, during the Concession Period.

(x) Upon receipt of a notice of Change in Law from the Company pursuant to the Concession Agreement, as and when requested or required, confirm occurrence of the Change in Law and certify the consequent financial impact, in accordance with the Concession Agreement.

(y) Inspect the KWC at the time of handing over thereof by the Company to the GoS and perform functions in respect of such handing over as provided in the Concession Agreement.

(z) Present to the Parties as and when required on the progress of the Project and other milestones specified in the Implementation Schedule.

(aa) Pursuant to the terms of the License Agreement, review and approve the status report submitted by the Company, on an annual basis, on the occurrence and status of occupations, thefts, encroachments and Encumbrances arising from time to time on the Site to ensure compliance by the Company of its obligations to protect the Site from such encroachments under the Relevant Agreements.

(bb) Issue various certificates in consultation with the Independent Auditor, including Commencement Certificate, Handover Certificate, Mobilisation Certificate, Payment Certificate and Project Commercial Operations Certificate as more particularly described in the Concession Agreement. The Independent Engineer will rely on reports, studies, surveys, and other documents provided by the Company or its appointed consultants.

(cc) In case of a failure to achieve the scheduled project milestones, issue delay notices, in consultation with the Independent Auditor as described in the Concession Agreement.

(dd) Together with the Independent Auditor, act to resolve any disputes arising due to a conflict between the clauses and appendices of the Concession Agreement.

(ee) Together with the Independent Auditor, advise the GoS on the technical implications of a Change in Scope requested by the Company.

(ff) Together with the Independent Auditor, advise the GoS on any changes, modifications, amendments, supplements or waivers to the Financing Documents, EPC Contract, O&M Contract or in respect of any Refinancing. The Independent Engineer will rely on the timely provision of relevant documents by the Company and will make its recommendations in accordance with clause 16.3 of the Concession Agreement.

(gg) Together with the Independent Auditor, advise GoS on any changes, modifications, amendments, or supplements to the Insurance Policies.

(hh) Together with the Independent Auditor, issue the Payment Certificate in respect of invoiced Service Payments in accordance with clause 13.5 of the Concession Agreement.

(ii) Perform such other obligations and responsibilities as set out in the Relevant Agreements.

(jj) Perform such other obligations and responsibilities as mutually agreed between the Parties.

(kk) Perform any other action or services set out in the Independent Engineer Contract.

1.2 <u>Proposed Construction Documents Review Phase</u>

With respect to the review and approval of Proposed Construction Documents, the IE Services shall include the following:

(a) Review and approve the adequacy of primary data collected for the Project, including topographical surveys, geo-technical and sub-soil investigations, hydrological investigation and any other surveys, investigations and analyses conducted to prepare the Proposed Construction Documents.

(b) Review and approve the condition survey of existing utilities & their relocation design, and Proposed Construction Documents prepared and submitted by the Company to the Independent Engineer for the construction of various components of the Project, including the pipeline, canal, pumping stations, rising mains, Treatment Plant and Reservoir, Solar Plant, civil structures, aqueducts, bridges, estimates, reports and other deliverables with regard to adequacy, completeness, optimality and capability of design to perform as required in anticipated operating conditions and to meet the technical requirements specified in the Concession Agreement.

(c) Identification of Project design features or any major equipment component that does not appear to meet the design or performance requirements or fails to adhere to the technical specifications provided in the Concession Agreement.

(d) Provide an opinion on the quality of the designs with respect to their effect on the anticipated service life of the KWC, the degree of maintenance needed to meet performance requirements and long-term availability over the Concession Period.

(e) Comply with the design parameters set out in appendix 1 of the Concession Agreement.

(f) Review and approve the reports prepared and submitted by the Company or its Contractors, with respect to the Implementation Schedule, the Operating and Maintenance Procedures, canal closure, safety and management plan, and water diversion plan.

(g) Determine that adequate provisions have been made for the following in the Proposed Construction Documents:

(i) design;

(ii) material sourcing;

(iii) material transportation equipment;

(iv) utilities;

(v) equipment procurement;

(vi) construction; and

(vii) testing.

(h) Review and comment on the consistency of all Relevant Agreements.

(i) Review the available Approvals or applications for Approvals.

(j) Review and comment on the utilities' arrangements for the Project, including (without limitation) the water supply and Electricity supply.

(k) Review and approve the adequacy and reasonableness of the Project coordination and monitoring systems.

(l) Review the safety measures proposed for the construction of the facilities and their compliance with the safety regulations.

(m) Review, audit, comment and approve the working methodology submitted by the Company regarding the construction of Project infrastructure in densely populated areas to avoid disturbance to traffic and public.

(r) Report to the GoS Parties in case the quality standards and quality control provisions are not maintained on the Site.

1.3 <u>Environmental and Social Matters</u>

Concerning the environmental and social matters under the Project, the IE Services to be performed by the Independent Engineer shall include the following:

1.3.1 Before the start of operations: review for compliance with the Legal Requirements, including the E&S Standards:

(a) the ESIA to be prepared by the Company in accordance with the Concession Agreement (and drafts and revisions of the same); and

(b) the ESMS and associated programs to be prepared by the Company in accordance with the Concession Agreement (and drafts and revisions of any of the same) and, where any such assessment or plan is not compliant, recommend changes to address any shortcomings.

1.3.2 During the C&O Activities, at least visit the Site monthly to:

(a) review environmental and social management, monitoring and reporting undertaken by the Company, including implementation of mitigation measures, which shall include but not be limited to:

(i) labour and working conditions,

(ii) access to water and any grievances in relation to water availability, made by the Settlements;

(iii) potential impacts to agriculture and livestock from changes in soil moisture;

(iv) development and implementation of a Biodiversity Action Plan as required;

(v) solid and hazardous waste management, storage, treatment and disposal, including sub-contractor practices;

(vi) noise level compliance at nearby sensitive receptors;

(vii) treated effluent quality and receiving water quality;

(viii) emergency response procedures;

(ix) other required environmental, health, and safety management practices;

(x) Stakeholder Engagement Plan and Grievance Redress Mechanism; and

(xi) health and safety procedures;

(b) undertake independent verification field monitoring of the Company's compliance with its environmental and OHS requirements; and

(c) inspect the Site, review grievance logs and interview representatives of Affected Communities,

in each case, as needed to ascertain whether the Company's activities are in compliance with the Legal Requirements, including the E&S Standards.

1.3.3 On a semi-annual basis during the first two (2) years of the Operating Period, and on an annual basis for another three (3) years thereafter:

(a) review environmental and social management, monitoring and reporting undertaken by the Company;

(b) undertake independent verification field monitoring of the Company's compliance with its environmental and OHS requirement; and

(c) inspect the Site, review grievance logs and interview representatives of affected communities,

in each case, as needed to ascertain whether the Company's activities are in compliance with the Legal Requirements, including the E&S Standards.

1.3.4 Within sixty (60) Days following the end of the first three (3) years of the Operating Period, the Independent Engineer shall issue a report indicating whether:

(a) the Company has performed the C&O Activities and is conducting the O&M Activities in accordance with the Legal Requirements, including the E&S Standards, and has in place adequate procedures and practices to manage environmental and social risks and impacts; and

(b) the GoS and any relevant Competent Authority is adequately equipped to monitor and enforce, and is effectively monitoring and enforcing, the Parties' environmental and social obligations under the Concession Agreement.

If both the foregoing conditions are met, there will be no need for further annual review. If at least one of the two foregoing conditions is not met, the Parties will in good faith agree on a supplementary scope of work to be carried out by the Independent Engineer for a period up to the duration of the Project.

1.4 Supervision Services during the C&O Period

During the C&O Period, the IE Services to be performed by the Independent Engineer shall include the following:

(a) Supervise the C&O Activities in detail and to approve the materials, formworks, and workmanship of the C&O Activities on a daily and fulltime basis. As stated in the Concession Agreement, the Independent Engineer shall have no authority to relieve the Company of any of its duties or to impose additional obligations.

(b) Review and approve the construction manuals and operation and maintenance manuals prepared and submitted by the Company. The Service Payments will be made upon Independent Engineer's certification, with final approval of the Independent Auditor.

(c) Supervise / approve the C&O Activities, including material testing, water sampling, water quality testing, equipment installation, facility integration, treatment process testing, and review the water quality and treatment testing results and to order special tests of water quality and / or completed works, and / or order removal and substitution of substandard material, equipment and / or work as required.

(d) Review and approve work methodology of each component of the C&O Activities.

(e) Review quality assurance and quality control during the C&O Period.

(f) Identify construction delays, if any and recommend to the GoS the remedial measures to expedite the progress of the C&O Activities.

(g) Review and approve shop drawings for each component of the Project Activities prepared and submitted to Independent Engineer by the Company.

(h) Review the "*Construction Drawings*" and "*as-built*" drawings for each component of the Project Activities prepared and submitted to Independent Engineer by the Company.

(i) Review the safety measures provided for the Project workers.

(j) Review the adequacy and operational effectiveness of the canal diversion / bypass program.

(k) Determine any extension of the Implementation Schedule, to which the Company is entitled and notify the GoS in writing accordingly.

(l) Review compliance by the Company of its obligations under the Concession Agreement.

(m) Have a review period not exceeding twenty-one (21) days, or as otherwise stated in the Concession Agreement, calculated from the date on which the Independent Engineer receives a document or a notice from the Company (the **"Review Period"**).

(n) Within the Review Period, give a notice to the Company:

  (i) of 'no-objection,' which may include comments concerning minor matters which will not substantially affect the Project Activities; or

(ii) that the Company fails, to the extent stated, to comply with the requirements of the Independent Engineer or as otherwise stated in the Concession Agreement, with reasons.

If the Independent Engineer gives no notice within the Review Period, it shall be deemed to have given a notice of no-objection to the Company.

If the Independent Engineer instructs that further documents are reasonably required from the Company to demonstrate that the Project Activities or design comply with the Concession Agreement, the Company shall prepare and submit the same promptly to the Independent Engineer at the Company's cost.

If the Independent Engineer gives a notice that the Company fails to comply with the requirements of the Independent Engineer or those stated in the Concession Agreement, the Company shall revise the documents, resubmit them to the Independent Engineer in accordance with this clause, and the review period shall be calculated from the date that the Independent Engineer receives the documents.

For performance testing, the Independent Engineer shall:

(a) Review test procedures developed by the O&M Contractor and confirm compliance with applicable test codes and standards and with testing criteria specified in the Concession Agreement and appendix 5 thereto;

(b) Review the quality control reports, water testing results and testing reports and results in accordance with appendix 5 of the Concession Agreement.

(c) Review test reports prepared by Company or the Company's testing consultant; and

(d) Make visits to the Site to verify that the C&O Activities, including testing requirements, have been completed and thereafter sign and issue the Project Commercial Operations Certificate.

1.5 <u>Commissioning Supervision Services</u>

During the commissioning phase, the IE Services to be performed by the Independent Engineer shall include the following:

(a) Supervise and approve 'as-built records' of the execution of the C&O Activities, as prepared by the Company, showing the exact as-built locations, sizes and details of the C&O Activities. As stated in the Concession Agreement, the Independent Engineer shall have no authority to relieve the Company of any of its duties or to impose additional obligations.

(b) Require as-built records before the beginning of the testing on completion of the C&O Activities, but also updated as-built records to the extent that any construction and / or rehabilitation activities are executed by the Company during and /or after the testing.

(c) Review and approve the Operating and Maintenance Procedures prepared by the Company. The Operating and Maintenance Procedures shall include enough detail to ensure the operation, maintenance and performance of the KWC to comply with the

key performance indicators included in the Concession Agreement and following the 'Performance Guarantees' specified in appendix 5 of the Concession Agreement. The Operating and Maintenance Procedures shall also allow to operate, maintain, dismantle, reassemble, adjust and repair the KWC as necessary, including an inventory of spare parts.

(d) Detect errors, omissions, ambiguities, inconsistencies, inadequacies or other defects in the C&O Activities and issue the necessary notices of no-objection.

(e) Review the test programmes submitted by the Company to carry out the tests on completion, as specified in appendix 5 of the Concession Agreement.

(f) Give a notice to the Company stating the extent to which the testing programme does not comply with the Concession Agreement or the Independent Engineer's requirements. Within fourteen (14) days after receiving this notice, the Company shall review the test programme to rectify any non-compliance. If the Independent Engineer gives no such notice within fourteen (14) days after receiving the test programme (or the revised programme), the Independent Engineer shall be deemed to have given a notice of no-objection. The Company shall not commence the tests until a notice of no-objection is given, or is deemed to have been given, by the Independent Engineer.

(g) Issue the Project Commercial Operations Certificate after checking the results and workability of the KWC after the prescribed tests.

Independent Engineer Criteria

An international or local engineering firm (not individuals) appointed as the Independent Engineer shall meet the following criteria:

- Have the experience of undertaking a similar role in at least two (2) either i) project financed infrastructure projects; or ii) PPP projects.

- Have the experience of supervising at least two (2) bulk water supply projects which included the construction of a pipeline or canal.

- Have the experience of supervising at least two (2) water sector projects involving the construction of pumping stations and water treatment plants.

- Have the experience of supervising at least one (1) solar project. (Note: this is applicable in case the Company plans to develop a Solar Plant).

- Have the following permanent employees for at least one (1) year:

  (i) team leader with at least twenty (20) years of experience with complete knowledge and understanding of water projects, project financed infrastructure projects and PPP projects;

  (ii) hydraulic expert with at least twenty (20) years of experience;

  (iii) civil engineering expert with at least fifteen (15) years of experience;

  (iv) water treatment expert with at least fifteen (15) years of experience;

  (v) mechanical expert with at least fifteen (15) years of experience;

  (vi) contract management expert with at least ten (10) years of experience;

  (vii) electrical power supply / renewable energy expert with at least ten (10) years of experience (Note: the renewable energy expert is required in case the Company plans to develop a Solar Plant); and

  (viii) other experts required to perform the obligations of the Independent Engineer under the Project as specified herein.

- Provide an undertaking that the above staff shall be employed on the Project if the work is awarded to the engineering firm. Relevant staff members must be available to attend all inspections and meetings with the GoS officials. Any change in staff for this assignment would need to be replaced with similar experience.

- Ensure that its staff are fully familiar with project financed infrastructure projects or PPP projects and the role of the Independent Engineer in such projects. In addition, the staff should be familiar with FIDIC conditions of contract, GoS public procurement regulatory framework, and the Project Agreements.

- Ensure that its staff have at least a minimum bachelor's degree in the relevant engineering field with a specialization in water sector projects.

APPENDIX 11: LICENSE AGREEMENT

LICENSE AGREEMENT

between

(1) THE KARACHI WATER AND SEWERAGE BOARD

- and -

(2) [*THE COMPANY*]

relating to
KARACHI HUB WATER CANAL PROJECT

Dated [●]

THIS LICENSE AGREEMENT is made on [●], 2022 (the **"Signing Date"**), at Karachi, Pakistan.

BETWEEN

(1) **KARACHI WATER AND SEWERAGE BOARD,** a statutory body constituted pursuant to section 3 of the Karachi Water and Sewerage Board Act, 1996, with its office located at 9th Mile, Karsaz, Karachi, Pakistan (**"KW&SB"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns); and

(2) **[*COMPANY*],** a [●] company incorporated under the Laws of Pakistan whose registered office is located at [●] (the **"Company"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns).

(KW&SB and the Company are hereinafter collectively referred to as the **"Parties"** and individually as a **"Party"**).

RECITALS

A. **WHEREAS**, the Governor of Sindh, acting through the [Local Government & Housing Town Planning Department, Government of Sindh] (the **"GoS"**) and the Parties have entered into a concession agreement dated [●] (the **"Concession Agreement"**);

B. **WHEREAS**, in terms of the Concession Agreement, KW&SB has agreed to grant a license to the Company in respect of the Site for the purposes of carrying out the Project Activities;

C. **AND WHEREAS**, the Parties are now entering into this Agreement to set out the terms and conditions relating to the use of the Site by the Company and the rights and obligations of the Parties with respect thereto.

NOW THEREFORE, in consideration of the mutual covenants contained herein, the Parties agree as follows:

1. DEFINITIONS AND INTERPRETATION

1.1 Definitions

Unless specified otherwise herein in this Agreement (including the Recitals), all capitalized terms shall have the meanings assigned to them under the Concession Agreement. In addition, the following terms shall have the following meanings, unless the context otherwise requires:

"Agreement" means this License Agreement, as amended, and supplemented from time to time;

"Company" has the meaning given to it in the Preamble;

"Concession Agreement" has the meaning given to it in Recital A;

"Encumbrance" means any encumbrance on the Site (or part thereof), including but not restricted to mortgage, charge, pledge, lien, hypothecation and/or any security interest, assignment, privilege, or priority of any kind having the effect of security or other such

obligations and shall include without limitation physical encumbrances and encroachments thereon;

"GoS" has the meaning given to it in Recital A;

"KW&SB" has the meaning given to it in the Preamble;

"License" has the meaning given to it in clause 2.1.1 of this Agreement;

"License Period" has the meaning given to it in clause 2.1.1 of this Agreement;

"Parties" has the meaning given to it in the Preamble;

"Party" has the meaning given to it in the Preamble;

"Preamble" means the preamble of this Agreement;

"Recitals" means the recitals of this Agreement;

"Signing Date" has the meaning given to it in the Preamble; and

"Site" means the site on which the Project is to be implemented, comprising of the immovable property, including the rights-of-way, on which the KWC is to be rehabilitated, constructed, installed, and erected in accordance with the terms of the Concession Agreement, as demarcated in the map attached in appendix 1 (*Technical Specifications*) of the Concession Agreement.

1.2 Interpretation

The rules of construction and interpretation set forth in clause 1.2 of the Concession Agreement shall apply, *mutatis mutandis*, to this Agreement.

2. RIGHT TO ACCESS, LICENSE AND RELATED MATTERS

2.1 Right to Access and License of the Site

2.1.1 KW&SB grants to the Company, commencing from the Mobilisation Date (upon the physical handing over of the possession of the Site by KW&SB to the Company) and until the issuance of the Handover Certificate (the **"License Period"**), a license in respect of the Site for the purposes of carrying out the Project Activities in accordance with the Concession Agreement (the **"License"**).

2.1.2 Subject to clause 3.1, the License granted in terms of clause 2.1.1 shall terminate without the need for any action to be taken by the Parties on expiry of the License Period.

2.1.3 KW&SB shall provide the Company such assistance as may be reasonably requested by the Company to enjoy the License, provided always that the Company is in compliance with all Legal Requirements and the provision of any assistance by KW&SB (including delay or omission to provide such assistance) shall not relieve or absolve the Company of its obligations under this Agreement or the Concession Agreement.

2.1.4 The Company shall ensure that, during the License Period, KW&SB, any relevant Competent Authority, the Independent Appointees and each of their representatives, officers, employees, and agents shall have the right to access the Site to exercise their rights under the Law and perform their obligations under the Concession Agreement, provided, however, such access shall be subject to any reasonable requirements of the Company regarding safety and security of the KWC.

2.1.5 During the Mobilisation Period, the Parties acknolwdge and agree that KW&SB shall be operating and maintaining the KWC, and the Company shall be carrying out the Mobilisation Activities. The Parties shall coordinate their respective activites in the Mobilisation Period so as not to interfere with each other, provided always, that during the Mobilisation Period, KW&SB's operations and maintenance activities shall take priority over the Mobilisation Activities of the Company.

2.1.6 This Agreement shall be duly executed by the Parties and all costs, fees, expenses, duties, charges, and taxes relating to the same shall be borne by the Company. Notwithstanding anything contained herein or the Concession Agreement, the Parties hereby acknowledge and confirm that no right, title, interest, benefit or otherwise is granted to the Company under this Agreement which may attract the registration requirement under the Laws. However, in the event it is envisaged that this Agreement is a registrable instrument with the relevant Competent Authority under the Laws, all costs, fees, expenses, duties, charges, and taxes relating to the registration of this Agreement shall be borne by the Company.

2.2 Title and Use of Site

2.2.1 KW&SB represents and warrants that it has the power and authority to grant the License to the Company for the Project Activities during the License Period, provided the title to the Site shall always vest with KW&SB.

2.2.2 The Company undertakes, covenants and agrees that it shall only use the Site solely for the purposes of undertaking the relevant Project Activities in accordance with the requirements of the Concession Agreement.

2.3 No Sale or Creation of Encumbrance

The Company shall not part with, dispose of, sell, lease, sub-lease, license or sub-license or create any Encumbrance of any nature whatsoever on the whole or any part of the Site and shall not place or create nor permit any Contractor or other person claiming through or under the Company to place or create any Encumbrance over all or any part of the Site, or on any rights of the Company therein or under this Agreement.

2.4 Protection of Site from Encroachments

2.4.1 For the duration of the Mobilisation Period, KW&SB shall be responsible for and shall protect the Site from all occupations, thefts, encroachments, and Encumbrances, and shall ensure the security of the Site.

2.4.2 For the duration of the License Period (excluding the Mobilisation Period), the Company shall:

(a) be fully responsible for and shall protect the Site from, in each case, any and all occupations, thefts, encroachments and Encumbrances;

(b) develop a security protocol for security of the Site and arrange for (at its own cost and expense) appropriately trained and qualified security personnel to undertake the security of the Site;

(c) immediately upon becoming aware, notify KW&SB and the Independent Engineer, of any occupations, thefts, encroachments and Encumbrances on the Site, and KW&SB shall, upon receipt of such notification, provide reasonable assistance to the Company in procuring police assistance for removal of trespassers and/or encroachments on the Site, provided however, the provision of any assistance by KW&SB (including delay or omission to provide such assistance) shall not relieve or absolve the Company of its obligations under this Agreement or the Concession Agreement; and

(d) submit an annual report intimating to KW&SB and the Independent Engineer either: (i) occurrence and status of occupations, thefts, encroachments, and Encumbrances on the Site in the relevant year (if any); or (ii) confirming that the Site is free from any occupations, thefts, encroachments and Encumbrances in the relevant year of the License Period.

2.4.3 The Company undertakes, covenants and agrees that it shall: (a) for the Mobilisation Period, remain liable for any Claims and/or damage to the Site or the KWC caused by it or the Contractors or any of their representatives, officers, employees and agents; and (b) for the C&O Period, remain liable for any Claims and/or damage to the Site or the KWC.

3. BREACH AND TERMINATION

Any breach or default by a Party of its obligations under this Agreement shall be dealt with in accordance with the terms of the Concession Agreement. This Agreement shall stand automatically terminated on the expiry of the License Period.

4. REPRESENTATIONS AND WARRANTIES

4.1 KW&SB's Representations and Warranties

KW&SB hereby represents and warrants to the Company that it has the power and authority to:

(a) grant the License to the Company; and

(b) enter into and deliver this Agreement, and that this Agreement forms the valid, binding, and enforceable obligations of KW&SB.

4.2 Company's Representations & Warranties

The Company hereby represents and warrants to KW&SB that:

(a) it has the power and authority to enter into and deliver this Agreement and that this Agreement forms the valid, binding, and enforceable obligations of the Company; and

(b) the execution and performance of this Agreement by the Company does not violate any Law or any other obligations to which the Company is subject.

5. NOTICES

5.1 Notices

The provisions of clause 30 of the Concession Agreement shall be incorporated by reference into this Agreement and apply, *mutatis mutandis*, hereto.

6. GOVERNING LAW AND DISPUTE RESOLUTION

6.1 Governing Law

This Agreement and any non-contractual obligations arising out of or in connection with it shall be governed by and construed in accordance with the Laws of Pakistan.

6.2 Dispute Resolution

The provisions of clause 27 of the Concession Agreement shall be incorporated by reference into this Agreement and apply, *mutatis mutandis*, hereto.

7. MISCELLANEOUS

7.1 Partial Invalidity and Severability

If for any reason whatsoever, any provision of this Agreement is, or becomes invalid, illegal or unenforceable, or is declared by any court of competent jurisdiction or any other instrumentality to be invalid, illegal or unenforceable, the validity, legality or enforceability of the remaining provisions of this Agreement shall not be affected in any manner, and the Parties shall negotiate in good faith with a view to agreeing upon one or more provisions which may be substituted for such invalid, unenforceable or illegal provision(s), as nearly as is practicable.

7.2 Amendment

No amendment or modification of this Agreement shall be valid and effective unless agreed to by the Parties, confirmed by the GoS, and evidenced in writing.

8. ORIGINALS

8.1 Number of Originals

This Agreement shall be executed in two (2) originals.

IN WITNESS WHEREOF, the Parties, intending to be legally bound, have caused this Agreement to be executed by their duly authorised representatives as of the date first written above.

KARACHI WATER AND SEWERAGE BOARD

Signature .....

Name
(block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name
(block capitals) .....

Witness signature .....

Witness name
(block capitals) .....

THE COMPANY

Signature .....

Name
(block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name
(block capitals) .....

Witness signature .....

Witness name
(block capitals) .....

APPENDIX 12: ENVIRONMENT, HEALTH AND SAFETY REQUIREMENTS

PART–I - ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The Environmental and Social Impact Assessment (ESIA) shall be prepared by the Company in accordance with the following minimum criteria:

(a) The Environmental and Social Impact Assessment shall address all environmental and social risks and impacts of the Project, including ancillary and associated facilities, as presented in the terms of reference specified in part 3 of this appendix 12. The Environmental and Social Impact Assessment must comply with the Legal Requirements, including E&S Standards, and be prepared by a competent professional with experience in similar projects in the region and the application of E&S Standards.

(b) The Company shall undertake specific surveys to confirm in the Environmental and Social Impact Assessment the location of the species *commiphora wightii* (*Gugal/Mukul* tree) and its status as a critical habitat and identify relevant avoidance / mitigation measures.

(c) If the Environmental and Social Impact Assessment confirms the presence of and potential impacts to the *commiphora wightii* (*Gugal/Mukul* tree), the Company shall develop a Biodiversity Action Plan, in alignment with IFC Performance Standard 6, to avoid impacts to the *commiphora wightii* (*Gugal/Mukul* tree) and other conservation significant species if residual impacts are determined (such as, *manis crassicaudat249ndianian pangolin*).

(d) The Environmental and Social Impact Assessment shall identify any areas where additional land use along the right of way is required temporarily during the C&O Activities and any subsequent mitigation measures, such as compensation, for planned or unplanned temporary land use during the C&O Activities shall be aligned with the IFC Performance Standard 5.

(e) Protected area managers and secretariats for the internationally recognized areas shall be consulted in preparation of the Environmental and Social Impact Assessment to ensure consistency with the management plans of such areas and to enhance the conservation aims and effective management of the area.

PART II – ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSYTEM

The Environmental and Social Management System shall be established by the Company and provide for the following:

(a) An overarching policy that states the E&S principles, including reference to applicable aspects of E&S Standards, to effectively manage risks and impacts during the Concession Period.

(b) Organizational capacity and competency to implement the ESMS, defining key E&S roles and responsibilities, assigning staff with appropriate skills and expertise, and training staff in the management of E&S risks and impacts.

(c) A risk assessment procedure to identify potential negative E&S risks and impacts, and the appropriate strategies to address these issues.

(d) A management program defining mitigation and performance improvement measures and actions that address the E&S risks and impacts, including monitoring activities, and the

timelines and responsibility for each task. The management program shall consist of a documented combination of operational procedures, practices, plans and relevant supporting documents that further develop and detail the plans and measures defined in the ESIA (not all plans/procedures would be needed as a Condition Precedent if not necessary at the start of the Mobilization Activities or C&O Activities (as the case may be); definition of plans must be at least thirty (30) Days before needed). The program shall comply with the Environmental and Social Requirements, and cover at minimum:

(i) Waste Management: standard operating procedures to manage solid and hazardous waste, during the concession period through handling, sorting, recycling and/or disposal of different materials, including (a) materials suitable for combustion, (b) hazardous and toxic substances, (c) other materials unsuitable for combustion, and (d) recyclable materials, whether undertaken by the Company, its contractors or sub-contractors. Where companies are to be contracted for the management, treatment and disposal of solid and hazardous wastes, the Company shall only contract such companies that have the required legal and valid permits.

(ii) Biodiversity Action Plan (BAP): with the aim for no-net losses for any impacts identified to natural habitat values and net-gain outcomes for any critical habitat values. The BAP shall be developed in consultation with the Sindh Wildlife Department, Government of Sindh and Sindh Forest Department, Government of Sindh. The BAP shall also outline additional programs to enhance the conservation aims and effective management of the protected areas the KWC shall operate within and to meet requirements set out in paragraph 20 of IFC Performance Standard 6.

(iii) Canal Decommissioning Plan, including detailed information on quantities, sources, and transportation of materials to be used to infill the disused canal, and further information on future use of the disused canal, including access by the public, and associated risks of decommissioning.

(iv) Energy conservation and resource management to minimize impacts of the Project Activities on resources and promote efficient use of water and other resources.

(v) Wastewater Management to manage effluents from the treatment plant according to Good International Industry Practices and based on the type and characteristics of wastewater, including maximization of recycling and treatment and disposal to meet the Legal Requirements.

(vi) Soil Management Plan: including measures to manage excavated soils such as separation and storage, minimising vegetation clearance, working strip rehabilitation and soil re-use.

(vii) Pollution Prevention and Spill Response and Hazardous Materials Management, including plans and procedures for the handling and storage of hazardous chemicals (including those used for disinfection) and for the mitigation of excessive dust, air emissions and of noise pollution, including reduction measures, monitoring, and corrective actions to achieve compliance with the E&S Standards.

(viii) Water Management: develop a plan to monitor water quality delivered to communities, released to the city of Karachi from the water treatment plant of the KWC and used for

PV panel cleaning. Water quality to meet the required national and international standards, with management measures to be developed in the event of noncompliance.

(ix) Occupational Health and Safety (OHS): the Company, Contractors and subcontractors shall ensure safe working conditions for their employees, including staff training, job safety instructions and measures to ensure workplace safety and mitigate OHS risks. Such requirements, at a minimum, shall include:

(A) Job- and task-specific hazard analysis and controls for all activities.

(B) Safety training for all personnel in their language, covering hazards and safety protocols of their jobs.

(C) Special training for specific hazards: handling of hazardous chemical, exposure to pathogens and vectors, in excavations, with electricity, in water, in enclosed space, alongside the open water canal, fire and explosion etc.

(D) Provision of personal protection equipment (PPE), requirements for use of PPE, and enforcement of PPE use.

(E) OHS monitoring implemented by accredited professionals. Arrangements in place to manage OHS incidents, including first aid arrangements, emergency response plans, including provision for emergency medical treatments, and system for reporting and acting on 'near misses'.

(F) Recording incident statistics, including total work hours, lost time incidents, major injuries, fatalities, etc.

(x) Safety management including health and safety for the community around all Project facilities at the Site, with specific measures to monitor access to the open section of the KWC and protect against accidental slips and falls, and unauthorized entry. Safety management shall also include emergency preparedness and response, and life and fire safety. Emergency preparedness and response plan shall specify responsibilities of the parties and the relevant authorities, procedures to minimize the harm of any potential accident and ensure that appropriate response equipment and materials are in place. The plan shall also include provisions for continual updates, including drills to test the effectiveness.

(xi) Contractor / sub-contractor management: to manage EHS planning and performance of Contractors/sub-contractors, including at a minimum:

(A) Inclusion of relevant E&S Management Program requirements in contracts/subcontracts (OHS requirements shall be adopted by all Contractors/subcontractors as applicable).

(B) Clear assignment of EHS responsibilities for the Company, Contractors and sub-contractor.

(C) Contractor / sub-contractors reporting adequate information to allow the Company to evaluate the need for corrective actions and provide relevant data and information to the required authorities.

(D) Verification of training and/or proper credentials for Contractor / sub-contractor managers and staff responsible for EHS management.

(xii) External communication protocol, Stakeholder Engagement Plan and the Grievance Redress Mechanism[24]: to receive and address the Stakeholders' grievances. The Grievance Redress Mechanism shall be easily accessible, understandable, and sufficiently advertised to the Stakeholders, and ensure the confidentiality of a person raising a complaint.

(xiii) Code of conduct to avoid gender-based violence among the workforce, including Contractors and sub-contractors, and towards the Affected Communities, and definition of differentiated training to workers' supervisors and managers on its implementation.

(xiv) Traffic and Pedestrian Safety Plan: setting out construction and operation management measures, including safe movement of traffic during construction, operation and decommissioning, and allowing safe access to communities and crossing of the pipeline/canal.

(xv) Security Personnel Management Plan: a common plan for personnel hired or contracted by the Company or KW&SB, including Contractors/sub-contractors. The plan shall be based on the Company's assessment of the risks posed by its security arrangements for workers, the public and Affected Communities, and shall include a code of conduct for security personnel in line with applicable E&S Standards. The code of conduct shall: aim to ensure that security personnel are screened for implication in past abuses and adequately trained in the use of force and appropriate conduct toward communities, the public, and workers; include a mechanism to raise grievances related to the conduct of security personnel, an assurance that any incidents will be properly investigated, and that the Company does not sanction use of force in relation to the Project, except when used for preventive and defensive purposes and in proportion to the nature and extent of the threat.

PART III – ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT TERMS OF REFERENCE

1. Introduction

The KW&SB aims to engage the private sector on a Public Private Partnership (PPP) basis for the rehabilitation of the KWC that supplies part of the Karachi water supply system.

The KWC is a twenty-two kilometres (22 km) canal that conveys water from the Hub Dam to the Treatment Plant located in Manghopir-Karachi. The KWC was originally designed to treat 100 MGD (5.26 m^3/s) of water coming from the Hub Dam. Presently, the KWC's capacity is limited to around 75 MGD (3.95 m^3/s). The successful implementation of the Project will enhance its capacity by around 25

[24] Specific requirements for stakeholder engagement can be found in Performance Standards 1, see also IFC's publication: Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets. Specific requirements for grievance mechanisms can be found in Performance Standards 2, 4, 5, and 7. For additional guidance on grievance mechanisms, see IFC's publications: Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets (IFC, 2007) and Addressing Grievances from Project-Affected Communities (IFC, 2009).

MGD (1.32 m^3/s), to reach the total expected capacity of 100 MGD (5.26 m^3/s). The Project entails the following:

- rehabilitation of eleven kilometres (11 km) of the existing KWC;
- construction of a nine point eight kilometres (9.8 km) new pipeline in the last stretch;
- upgrade of Hub pumping station (to achieve 100 MGD; 5.26 m^3/s);
- connection with the K-III canal at the Hub pumping station during drought periods.
- upgrade of the two point two kilometres (2.2 km) rising mains that connect the pumping station with the Treatment Plant;
- upgrade of the Treatment Plant, moving from 80 (4.21 m^3/s) to 100 MGD (5.26 m^3/s);
- SCADA and metering system, including telecommunications;
- a new Solar Plant to optimize energy requirements with a two point five kilometres (2.5) km distribution line; and
- E&S mitigation measures.

The water supply scheme for the city of Karachi from the Hub Dam was planned and executed in the late 70s and commissioned in 1981. The scheme relies on the availability of water received from the upstream catchment after rains. There have been instances when due to drought conditions in the Hub Dam catchment area, the water levels in the reservoir were so low that water could not be supplied to the city. The WAPDA Canal (also known as main Hub canal) offtakes from the Hub Dam and travels approximately eight point three kilometres (8.3) km in a south-westerly direction. This eight kilometres (8 km) section of the canal and the Hub Dam itself is owned, operated and maintained by the Water and Power Development Authority of Pakistan (WAPDA), a federal agency in Pakistan.

The Hub Dam consists of an embankment dam and a large water storage reservoir, constructed on the Hub river for the purpose of supplying municipal, industrial and irrigation water to Sindh and Balochistan provinces. The WAPDA Canal from the Hub Dam bifurcates into two (2) branches at about eight kilometres (8 km) downstream from the dam at a Head Regulator into: (i) the Lasbela canal which flows west towards Balochistan and the (ii) KWC which continues for twenty-two kilometres (22 km) in a south-westerly direction towards the KW&SB pumping station and Treatment Plant, as shown in Figure 1. The twenty-two kilometres (22 km) section of the canal is owned, operated, and maintained by KW&SB.

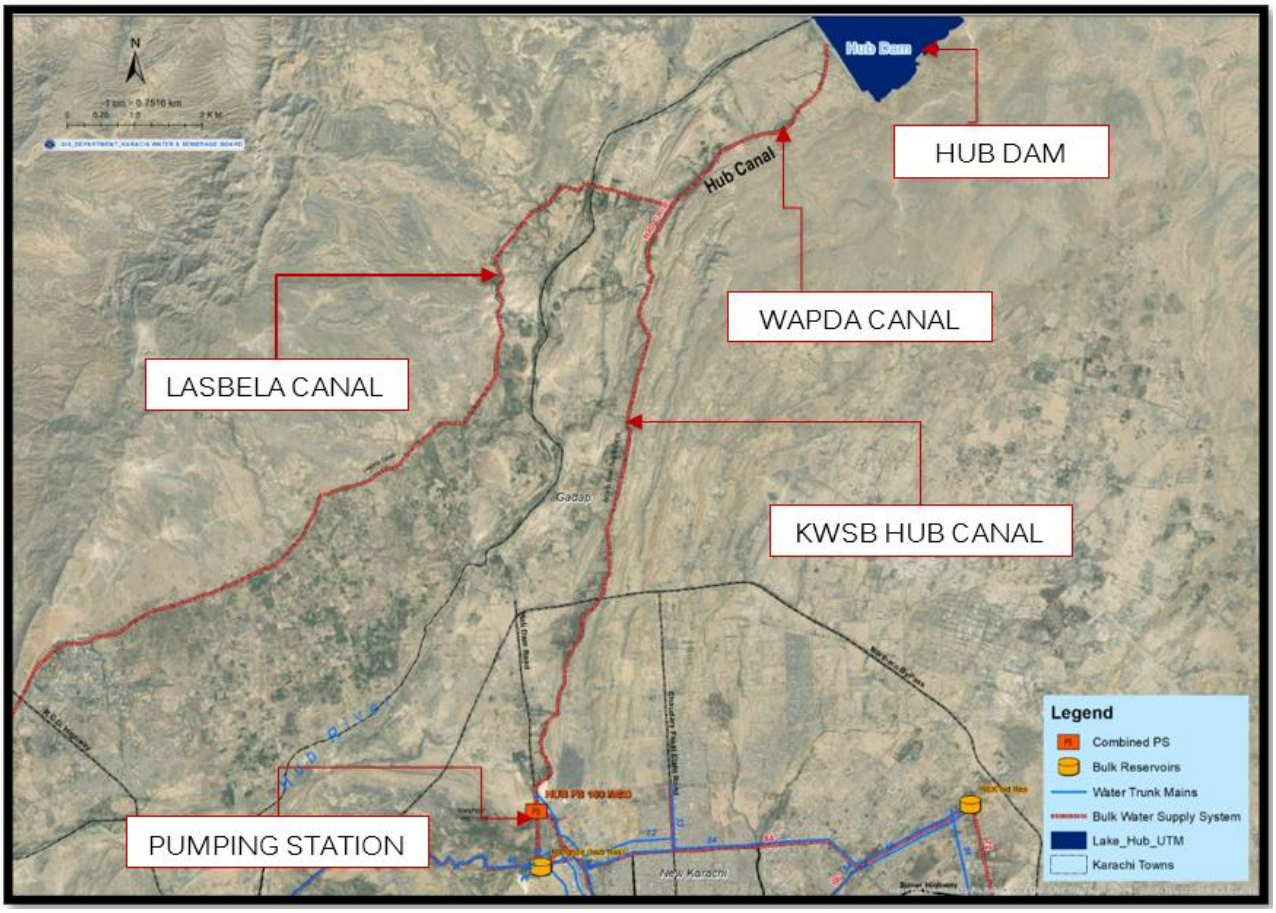


Figure 1. Project location north of the City of Karachi.

The Project includes the rehabilitation of the twenty-two kilometres (22 km) long KWC from the Head Regulator (bifurcation point) up to and including the rehabilitation of the pumping station, rising mains and the Treatment Plant. In addition, the Project includes the development of a Solar Plant to be located on KW&SB land adjacent to the Treatment Plant. The KWC requires rehabilitation due to damage, cracking and significant seepage losses. The eleven (11) aqueducts within the KW&SB-owned portion of the canal (Figure 2) show visible cracks and leaks which contribute flow to seasonal watercourses flowing west towards the Hub river.

The current condition of the KWC causes leakage and seepage of water from the conveyance infrastructure (aqueducts and canal) into the surrounding environment. Studies carried out during the scoping stage indicate that seepage may be contributing to soil moisture, and to the development of vegetated areas, particularly on the west side of the canal in the direction of the Hub river valley.

The rehabilitation of the KWC would require the complete disruption of flow in the KW&SB canal and to the Treatment Plant, representing a significant portion of Karachi's water supply or the provision of costly diversion works. To avoid disrupting Karachi's water supply, alternatives involving pipelines which can be built within the canal right-of-way (RoW) while the canal continues to convey water to the Treatment Plant have been studied. The preferred alternative is a hybrid configuration although a full alternatives assessment will be required as part of the Project ESIA.

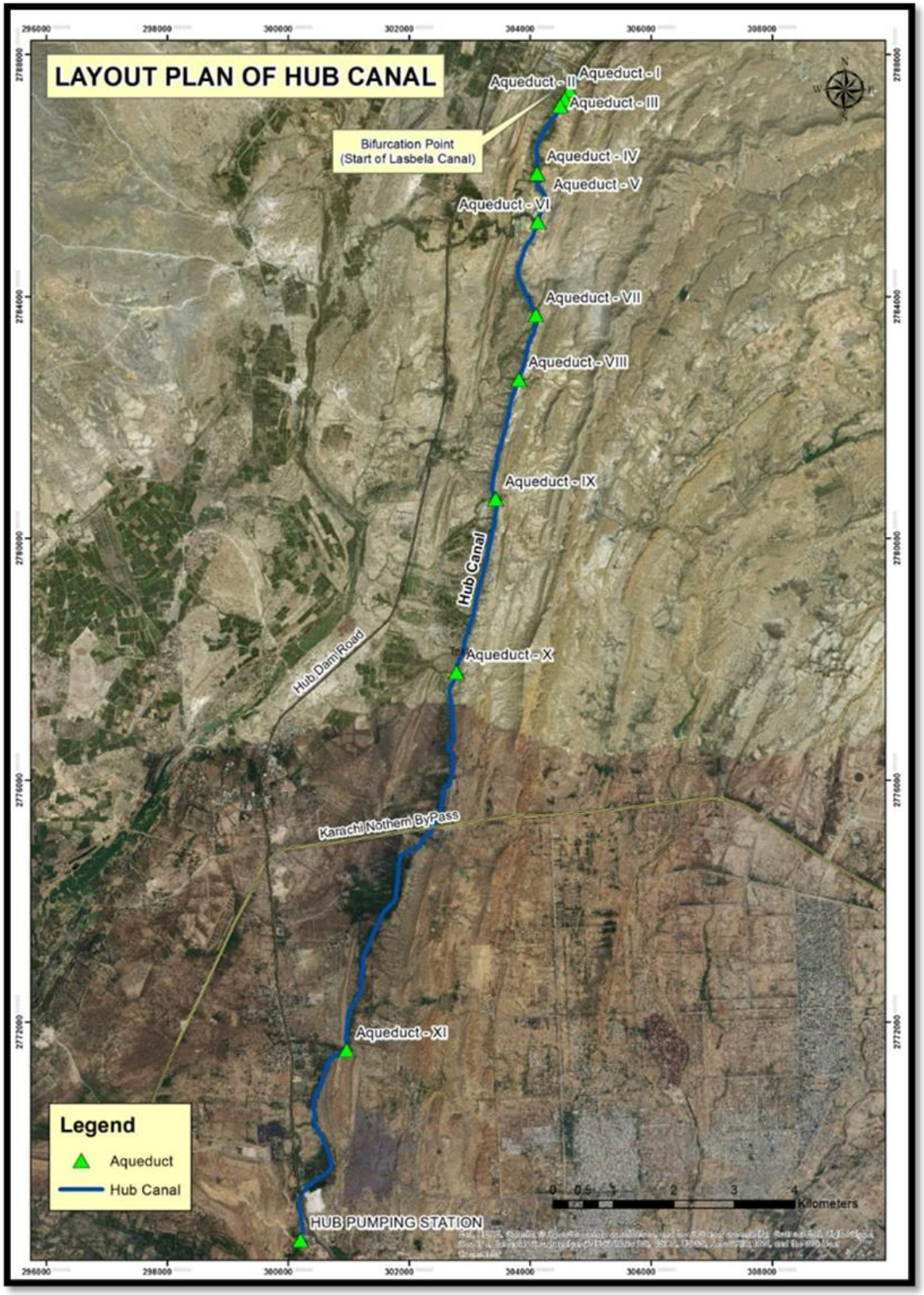


Figure 2. KW&SB Hub Canal layout with location of aqueducts.

A detailed outline of the Project components will be provided to the successful ESIA consultant.

2. Overview

KW&SB is seeking to appoint an environmental and social consultant (the **"Consultant"**) to provide and undertake the Environmental and Social Impact Assessment (ESIA) for the Project to meet IFC Performance Standards, Good International Industry Practices (GIIP), Asian Development Bank's Safeguard Policy Statement (2009), and other relevant standards.[25]

The aim is to gather all relevant data concerning the environmental and social baselines, evaluate the impacts of the Project, to assess the impacts as per the relevant national and international requirements and guidelines, and develop mitigation, and management plans to enable these impacts to be avoided or minimized to an acceptable level.

These ToRs describe the minimum requirements for the development of the ESIA under the Project. The applicable provincial legislation in Sindh, applicable national legislation, Asian Development Bank's Safeguard Policy Statement (2009), and the IFC Performance Standards should be used to establish minimally acceptable conditions for satisfying the requirements of the ESIA for the Project.

The Company will be required to complete an ESIA and detailed ESMP that is fully compliant with IFC's sustainability framework and Performance Standards, World Bank Group General EHS Guidelines, World Bank Group EHS (sector specific) Guidelines for Water and Sanitation, ADB's environmental and social safeguard standards i.e. SPS 2009, local environmental and other relevant legislation notified by provincial and federal governments in order to obtain environmental approvals from the Sindh Environmental Protection Agency, Government of Sindh and other relevant agencies, as described herein and the E&S Scoping Report.

The basic format for the ESIA document that should be followed is:

- Table of Contents;
- Acronyms and Abbreviations;
- Executive Summary;
- Project Description and Justification;
- Regulatory Framework;
- Environmental and Social Setting (baseline);
- Assessment of Impact, including cumulative impacts;
- Stakeholder Engagement and Public Consultation;
- Mitigation and Monitoring Measures;
- Environmental and Social Management Plan;

[25] When referring to E&S, this includes also assessment and management of labour and working conditions including workers' rights and occupational health and safety (OHS) risks and impacts

- Appendices.

The tasks and responsibilities described in the ToRs are indicative only and cannot be considered as a complete and comprehensive description of the expected consultancy services. It is rather the Consultant's responsibility to critically review the outlined ToRs and propose a complete scope of work, detailed and thorough enough in the Consultant's own professional judgment to achieve KW&SB's objectives and meet national and international standards, requirements and good practices.

In general, the ESIA must identify and address:

- Applicable environmental standards, norms, and international requirements set forth in national, local and international law, along with the IFC Performance Standards and ADB standards.

- Identification of Project Stakeholders and undertake broad Stakeholder engagement, including dissemination of relevant Project information and gathering of feedback. Develop a Stakeholder Engagement Plan (SEP), which will systematically assess and map Stakeholders, develop engagement methods for each, record all interactions and plan ongoing engagement throughout the Project lifecycle. A Grievance Redress Mechanism will also be developed as part of the SEP to track, respond and monitor all complaints and grievances.

- Detailed description of all phases of the Project from feasibility studies to Site preparation, construction, operations to closure. This should also include an assessment of alternatives including the technically feasible alternatives as well as the proposed Project.

- Develop a baseline of all E&S aspects within the relevant project Area of Influence (the **"pAoI"**), which will include primary data collection, along with the use of relevant secondary data sources.

- Describe the methodology used to assess impacts, and identify all direct, indirect and cumulative impacts and their significance level. Detail all mitigation measures to be implemented to address unavoidable impacts and include details of how mitigation can reduce impact levels, with a final residual impact rating provided.

- A detailed description of all relevant plans related to the proposed project Area of Influence, for example, engineering and Site preparation plans, operations and decommissioning or closure, environmental management, and mitigation in whatever form these may take.

- Uncertainty and how that uncertainty will be addressed through monitoring and contingency plans as may be needed to reduce risk of adverse impacts in the future.

- Specific commitments, including who is responsible, what will be done, when and how it will be monitored, reported, and audited to confirm that commitments are met.

Throughout the life of the Project, other consultants and professional advisors will be providing services to the KW&SB and the Project, and the Consultant shall be expected to refer the work product of these other parties where relevant. The Consultant while submitting the proposal agrees to cooperate and coordinate its activities with those other parties (e.g., technical, legal, financial consultants and contractors involved in the Project) so as to provide support in case of any queries in future and not to interfere with the overall smooth progress of the Project.

3. Table of Contents of the ESIA

A general table of contents for the ESIA shall be provided in the report. The table of contents shall be organized in such a manner as to facilitate the use of the ESIA by reviewers and project implementers. At a minimum, the table of contents shall include the following:

- Acronyms and Abbreviations;
- Executive Summary;
- General Information;
    - Objectives and Justification;
    - Project Proponents;
- Project Description and Alternatives Description;
- Legal and Regulatory Framework;
    - National Legislation;
    - Provincial and Local Legislation;
    - International Requirements and Conventions;
    - Institutional Arrangements;
- Environmental and Social Setting/Baseline;
    - Physical Environment;
        - Geology;
        - Soils;
        - Water Resources and Quality;
        - Air Quality;
        - Climate and Meteorology;
        - Noise and Vibration;
        - Landscape and Visual Amenity;
    - Biological Environment;
        - Protected Areas;
        - Vegetation/Flora;
        - Terrestrial Wildlife/Fauna and Habitat;

        - Endangered or Threatened Species and Habitat;
    - Social-Economic-Cultural Environment;
        - Demographics;
        - Livelihoods and Income;
        - Land Use and Ownership;
        - Health and Education;
        - Infrastructure and Utilities;
        - Archaeology and Cultural Heritage Ecosystem Services;
- Assessment of Impacts;
- Mitigation and Monitoring Measures;
- Environmental and Social Management Plan;
- Stakeholder Engagement;
- Roles and Responsibilities;
- References;
- Appendices;
    - Stakeholder Engagement and Public Consultation;
    - Technical Support Studies;
    - Maps and Plans;
    - Other Special Studies if needed.

4. Scope of Work

The ESIA Consultant shall undertake the following work:

- Propose a specialized team of experts required to undertake the ESIA study;
- Review all available existing information on environmental and social baseline conditions and potential impacts related to the Project, and ancillary and associated facilities, including the E&S Scoping Report and technical studies related to the Project that will be made available to the Consultant;
- Review, analyse and provide the policy, legal, and administrative framework for this Project as part of the ESIA report;

- Undertake an E&S desk-based, and early review of available primary and secondary data, to focus on key issues / impacts;

- Clearly define the Project's area of influence, including ancillary and supporting facilities that are part of the Project, and the area of influence related to 'associated facilities;'

- Design E&S relevant field based social and environmental baseline studies;

- Conduct Site visits, with the team of specialized experts, and baseline studies, covering the whole spectrum of analysis and modelling relevant to the construction and operation of the Project. Such studies should also include formal and informal discussions/meetings with local communities, government entities and other key stakeholders, in each project affected area / influence area (municipality level and district level). Consultations will enable both verification of the information reviewed from existing sources about the Project's social and environmental context, an initial screening of likely environmental and social impacts and sensitivities, and for all relevant stakeholders to be informed about the Project. Any contact or interviews for preparation of baselines or social assessment should be planned and carried out in a culturally appropriate manner, in a language acceptable and used by the communities. Consultations shall be held in the national and / or relevant local language (or with translation). During the COVID pandemic, close consideration should be given to prevention of infection to stakeholders and the Project teams.

- Based on the above, prepare an ESIA report consistent with the applicable national and international standards (see following sub-sections);

- Design, carry out, and document the public / Stakeholder consultations and engagement throughout the ESIA process. This will lead to preparation of: (i) the Project's grievance redress mechanisms and channels; and (ii) a Stakeholder Engagement Plan (SEP), annexed to the ESIA main report. Men, women and vulnerable groups/persons [26] should be included in the Stakeholder identification and analysis. This will ensure the impacts and mitigation measures are properly consulted with affected communities and any received feedback incorporated into the design, mitigation and management measures.

- The ESIA should include Environmental and Social Management Plans (ESMPs) in compliance with the applicable requirements, which may include but not limited to:

    - Project E&S standards based on applicable local, Asian Development Bank's, and the World Bank's requirements;

    - Environmental and Social Monitoring Program and Key Performance Indicators (KPI);

    - Waste Management Plan;

    - Biodiversity Action Plan;

[26] This disadvantaged or vulnerable status may stem from an individual's or group's race, color, sex, language, religion, political or other opinion, national or social origin, property, birth, or other status. KW&SB should also consider factors such as gender, age, ethnicity, culture, literacy, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources.

- Canal Decommissioning Plan;
- Energy Conservation and Resource Management Plan;
- Wastewater Management Plan;
- Soil Management Plan;
- Pollution Prevention and Spill Response and Hazardous Materials Management Plan;
- Water Management Plan;
- Occupation Health and Safety Plan and procedures;
- Safety Management Plan;
- Contractor / Sub-Contractor Management Plan;
- External Communication Protocol, Stakeholder Engagement and Grievance Mechanism;
- Code of Conduct to Avoid Gender Based Violence;
- Traffic and Pedestrian Safety Plan;
- Security Personnel Management Plan; and
- Emergency Preparedness and Response Plan (EPRP).

Issue all disclosure documents in (include local languages) and English for web disclosure and hard copy distribution to the public (add any detailed of distribution requirements).

The Consultant shall comply at any time with the relevant national and international data protection law and regulations.

5. Acronyms and Abbreviations

All acronyms and abbreviations used in the ESIA must be clearly and succinctly defined and described in this section.

6. Executive Summary

A general summary of the ESIA shall be provided in this section. The summary shall be written using a vocabulary that can be easily understood by the public. It shall include at a minimum the following information about the project from the ESIA:

- Objectives and Justification;
- Location;
- Project Proponents;
- Project Description;

- Project Alternatives;
- Environmental and Social Setting/Baseline;
- Evaluation of Impacts;
- Mitigation and Monitoring Measures;
- Environmental and Social Management Plan;
- Issues raised by stakeholders and any outstanding issues.

7. General Information

7.1 Introduction

A brief overview of the Project, including who is developing the Project, where it is located and the current stage of development. Further information to include who is developing the ESIA and the purpose of the document.

7.2 Project Objectives and Justification

7.2.1 **Objectives:**

A statement of the general and specific objectives (purpose) of the proposed Project.

7.2.2 **Project Justification:**

Provide a justification for the proposed Project (need) highlighting the benefits of the Project, including to surrounding communities and the economic development of the region and country.

8. Legal and Regulatory Framework

This section of the ESIA shall define the legal framework under which the ESIA is being completed and international safeguards or standards used, including the IFC Performance Standards (2012), World Bank Group's general and industry specific EHS Guidelines to be used a benchmark, and ADB's standards. This section should include:

- Information that demonstrates rights and access such as land ownership and rights-of-way, etc., with written authorization and mapping across all identified population settlements.
- Applicable environmental standards, norms and requirements set forth at the international, national, regional and / or local levels.
- Required regulatory approvals and / or permits for all stages and their status.
- Applicable land use requirements.
- Institutional arrangements including relevant government agencies and key players in the ESIA approval process, along with those that will be responsible for monitoring oversight.

It is recommended to use Good International Industrial Practices as well as the following good practice guidance:

- Stakeholder Engagement: A Good Practice Handbook for Companies doing Business in Emerging Markets (IFC, 2007);
- IFC's Good Practice Note on Managing Contractor's Environmental and Social Performance (2017);
- Workers' accommodation: processes and standards: A guidance note by IFC and the EBRD" (IFC and EBRD, 2009);
- IFC's Good Practice Handbook: Use of Security Forces: Assessing and Managing Risks and Impacts (2017); and
- UN Voluntary Principles on Security and Human Rights.

9. Project Description

This section shall include the following: a full description and location of the proposed Project and associated infrastructure and reasonable alternatives, including ancillary facilities and operations such as the camp / housing for construction (if applicable) and operation phases, borrow and disposal areas, sanitary services, waste disposal and transportation infrastructure. It shall include at a minimum:

9.1 Project Location

- The general location of the Project and associated activities in terms of:
    - Political-administrative location (region, district, town and other relevant political administrative units) with accompanying location map;
    - Means of Site access;
    - Latitude and longitude of Project area;
    - Maps of Project area at a scale of no less than 1:50,000;
    - All drawings should present scale and key coordinates.

9.2 Project Description

9.2.1 General

9.2.1.1 Type and nature of the Project:

- Type (in this case rehabilitation and upgrade of water supply canal/conveyance system, rehabilitation and upgrade of Treatment Plant, new Solar Plant, etc.).
- Capacity (MGD and m3/s) for the water conveyance system and Treatment Plant components, MW for the Solar Plant, KV for the interconnection line of the Solar Plant, etc.).

- Diagrams and drawings, general plan for the facilities, showing the location and layout of all Project components and their relationship to each other.

- Project operations: Description of how the Project would operate (seasonally, monthly, daily, hourly, as appropriate).

- Design details for each component of the Project, dimensions, materials of construction and configuration.

- Other works: describe additional works not covered above.

- Design Drawings for Project facilities: Plan (overhead view), Elevations (front view), Profiles (side view), Sections.

9.2.2 **Site Access**

Identify all new and existing roads to be used (including closed roads that will be reopened, and temporary roads if applicable), traffic volume, operating speeds and trip times, detailed information on any roads to be constructed or upgraded (including on-Site roads).

9.2.3 **Construction phase and schedule**

- Indicative schedule for each phase of construction for all Project and ancillary facilities including, but not limited to: mobilisation, road construction and improvements, land clearing, drilling, blasting (if required), borrow and spoil disposal, erosion and sediment control, excavation and subgrade preparation, foundation preparation, concrete work, construction or installation of each Project facility and stabilization of disturbed areas.

- Waste management for each Project component (demolition and spoil material etc.).

- Labour during construction: Number and type of employees (local and non-local) by field of expertise (days per week, hours per day, shifts per day).

- Raw materials to be used for construction: indicate the amounts per day, month, storage and disposal, include an inventory of chemical, toxic or hazardous substances and their storage, safety aspects regarding transportation and handling of hazardous substances and materials (including sourcing of aggregates from nearby quarries, water for construction etc.).

- Construction camp (if applicable): description of the camp including but not limited to: a map showing all facilities at a legible scale appropriate to the size of the Project and in compliance with "Workers' accommodation: processes and standards: A guidance note by IFC and the EBRD" (IFC and EBRD, 2009).

9.2.4 **Operation phase**

9.2.4.1 Operation information:

- Activities and equipment and machinery to be used during operations, including preventive and corrective maintenance);
- Labour during operations (number and type of employees (local and non-local) by field of expertise (days per week, hours per day, shifts per day);
- Overall energy requirements and sources;
- Inventory of chemical, toxic or hazardous substances used during operations and storage safety aspects regarding transportation and handling and any other relevant information;
- Waste management, i.e., screened debris carried by the canal, Treatment Plant sludge, solid, liquid, and hazardous waste streams, as relevant;
- Solar Plant cleaning and maintenance activities, and
- Public safety and security requirements.

9.2.5 **Closure and Decommissioning Phase**

- Describe activities that will be required when the Project nears the end of its service life, including contact with regulatory agency(ies) to obtain the environmental guidelines to carry out the closure or decommissioning. Closure and decommissioning (or rehabilitation) shall include at least a general 'Restoration and Closure Plan,' recognizing that terms of closure may be very different when this phase approaches. The description of restoration measures should include the size of the area to be restored as well as potential restoration measures.
- Plans for the decommission of system components, including disposal of potentially hazardous wastes incorporated into components.

9.2.6 **Project Alternatives**

- All Project alternatives that are reasonable and feasible and meet the purpose and need for the proposed Project shall be identified and summarized in this section (and evaluated in the ESIA, as appropriate).
- In addition to the proposed Project, such alternatives include alternative water supply sources, alternative conveyance systems, alternative routing or configuration of elements of the Project, alternative size and output capacity, and alternative plans for construction, operation and decommissioning of the facilities, including best practices that may avoid and / or reduce the adverse impacts to the physical, biological or social-economic-cultural environments.
- The ESIA should also describe potential alternative uses of any future unused sections of the canal.

- The ESIA should also describe alternative ways to clean PV panels to minimize water usage for this purpose.

10. Environmental and Social Setting/Baseline Conditions

Based on information available from secondary data sources such as existing literature and government data, along with primary data collection conducted specifically for the feasibility studies of the ESIA. Indicate the direct and indirect and cumulative impact areas of influence for physical, biological, and social-economic-cultural impacts and basis for defining area. This section shall include at a minimum, the following information:

Physical Environment

10.1 Geology and Soils

- Description of the geology, surficial geology and soils and characteristics at all Project component locations and in the area of influence, including a geological map of the Project area and area of influence of the Project.
- Topography and slope conditions and geomorphology.
- Seismicity and stability characteristics.
- Describe geologic hazards within the Project area.
- The ESIA shall describe baseline soil resources, project geotechnical and geophysics reports and make use of maps, tables and accompanying narrative text to describe the soils within the project Area of Influence, with particular attention to canal RoW and future pipeline alignment corridor and areas that will potentially be impacted by stoppage of canal water seepage during operations and compaction during construction (e.g. types of soils, capacity and uses, fertility and potential uses of the land for agriculture, stability and permeability, erosion and sedimentation potential, quantity and quality available for revegetating and restoring the disturbed area at time of closure etc.).

10.2 Water Resources

10.2.1 Surface water

- Include names and locations on maps of all permanent and intermittent streams, rivers, wetlands, lakes, and reservoirs (as applicable) within the area of influence of the Project.
- Describe flows in intermittent and permanent streams, ponds, and irrigation channels, located in and around the Site and seasonal fluctuations, as applicable including flood conditions.
- Delineation of watersheds and water drainage patterns within the Project area and in the area of influence of the Project, using for example, cadastral/aerial/remote sensing satellite imageries (mapping) and runoff characteristics of watersheds.

10.2.2 **Groundwater**

Provide a map of ground water wells in the area and identify and describe aquifers and underground waters, the hydrogeologic characteristics, groundwater potential yield (if groundwater might be required for the Project), water table levels (dry and rainy season) (for the purposes of this particular Project, secondary data will be sufficient) and groundwater quality. If no groundwater quality data is available for nearby wells that might be impacted by C&O Activities, baseline groundwater quality data will be required.

10.2.3 **Surface water and groundwater standards**

Describe the surface water and groundwater standards applicable to the Project (including national standards and international standards (e.g., World Bank/IFC General Environmental Health and Safety Guidelines).

10.3 Air Quality

Air quality monitoring baseline should be undertaken for the Site, and any sensitive off-Site locations which may be impacted by the Project. The minimum suite of air quality parameters that will be monitored are those that are expected to be affected by the Project's development.

The ESIA Report is expected to provide a classification of Site environment (e.g., degraded or non-degraded airshed), establish present background air pollutants, applicable ambient air quality limits for the area.

10.4 Climate and Meteorology

Available baseline information for weather and climate related data shall be collected and shall include at a minimum the following:

- Source of data (meteorological station(s) from which climatological data have been obtained, information should include data from the Pakistan Meteorological Department and WAPDA);
- Temperature variations;
- Relative humidity;
- Solar radiation and evaporation rates;
- Rainfall (total precipitation, rainfall intensity and duration by month);
- Wind rose (Wind direction and speed, twenty-four (24) hourly data)
- Climate change impact scenarios to be analysed in three (3) time frames (short-term, medium-term and long-term) while keeping in view the design life of the Project components.

10.5 Noise and Vibration

Noise, and if applicable vibration, monitoring baseline should be undertaken at the Site, and

any sensitive off-Site locations which may be impacted by the Project. Provide a classification of the Site environment, establish existing background noise levels, and identify applicable noise limits and location of boundary to a level sufficient for the development of mitigation measures envisaged and to assess the future expected noise, and if applicable vibration, levels during operations, especially from the Treatment Plant. The ESIA shall include location of monitoring stations, daytime, and night-time noise levels (measured in decibels) and an inventory of existing noise sources.

10.6 Solid, Liquid and Hazardous Waste

Determine the expected types and amounts of waste streams from Project related activities. Map local disposal options and associated quality requirements, including the permitting status of local landfills and their compliance with international standards and guidelines. Assess local recycling capacity for wastes generated by the Project (including the potential for old canal demolition waste), and any needs, longer term, for building local capacity (including wastes from the Treatment Plant, canal cleaning, etc.).

10.7 Landscape and Visual Amenity

Based on the Site visit, identify general landscape and topography conditions within the area of influence. In addition, based on Site assessment and consultations with relevant entities, identify any key visual receptors which could be impacted (touristic sites, villages, key archaeological/cultural sites, etc.) by the Project.

Biological Environment

The ESIA shall provide detailed information on the location and condition of species, ecosystems and habitats in the Project area and the Area of Influence, considering the following:

Identify relevant conservation stakeholders and consult with them in the identification of priority biodiversity values (refer to the E&S Scoping and include others as appropriate). Include a section in the ESIA that describes which conservation stakeholders were contacted, how they were contacted and how their views were considered in the identification of priority values.

Identify a set of priority biodiversity values (species and habitats) based on the criteria of Irreplaceability and Vulnerability (see IFC Performance Standards Guidance Note GN6 para. GN13). The following factors should be considered:

- Map all KBAs, IBAs, other recognized areas of high biodiversity value (e.g., Ramsar sites, World Heritage Sites, protected areas etc.) within the Area of Influence of the Project.
- For each priority biodiversity value, identify a discrete management unit (DMU), if one could be identified (e.g., Area of Occupancy – AOO). Otherwise, indicate the Extent of Occupancy (EOO).
- Ensure that birds, mammals, reptiles / amphibians, fish, and plants are surveyed and sampled using best practices and considering any seasonal survey requirements.

10.8 Vegetation/Flora

- Vegetation mapping of terrestrial and wetland habitats (as applicable) for the Project areas, and any other area affected by the Project.

- Identify and map any endangered and threatened species according to the IUCN Red List (International and National) and species of local conservation concern (refer to the E&S Scoping Report)

- Species present (abundance, density, status, plant communities, presence of invasive species, etc.).

- Conduct a survey and identify and map areas that are at high risk for invasive species encroachment. These areas will be subject to specialized mitigation measures if required.

10.9 Wildlife/Fauna

- Fauna, including Avifauna (including status, i.e., resident, endemic, migratory, endangered, and threatened species according to the IUCN Red List (International and National) and local species of conservation concern, life history, and seasonal use, mating and/or breeding areas, Key Biodiversity Areas (i.e., Hub Dam Ramsar site), and IBAs according to BirdLife International.

- Conduct surveys of aquatic fauna in wetlands, streams, and ponds, as relevant (waterbodies may become seasonal as a result of the Project when seepage stops).

- The extent of the above will not be limited to the Project footprint, and will include its pAoI, based on the ecological requirements of the species potentially to occur. This pAoI will be clearly defined prior to the fieldwork and agreed together with IFC, ADB, and relevant stakeholders (Sindh Wildlife Department and others as relevant).

- It will provide a description on the times of surveys, providing a justification for the methods (sampling) undertaken using relevant literature, and the species groups targeted. Any limitations to the survey are to be described. The ESIA must include the raw data in Annexes.

10.10 Endangered or Threatened Species and Habitats

- The previous sections should identify all species in the Project area. This section should include the endangered and threatened range-restricted and migratory species occurring in / or the vicinity of the Project (pAoI) and determine the extent of any Critical Habitat (refer to the E&S Scoping report for Critical Habitat discussion).

- The ESIA will confirm the presence natural and modified habitats as per IFC PS6 and its Guidance Note (GN). As a minimum, descriptions of the different habitat types identified (including photographs) are to be included as well as justification of the classification of the habitat types as being either natural or modified. A map should also be produced for the Project area and pAoI defining the areas of natural and modified habitats. A table is also to be included that defines the areas of habitats and

total areas (in hectares) of natural and modified habitats within the Project area and pAoI.

- Evaluate the priority biodiversity values (species and habitats) for Critical Habitat per IFC's PS6 criteria (see GN6 paragraphs 69-97).

- For Critical Habitat Species, prepare a Biodiversity Action Plan in collaboration with Sindh Forest and Wildlife Department, Government of Sindh that complies with IFC Performance Standard 6.

Habitats

- Through mapping, identify the extent of the study area that is either Modified, Natural or Critical Habitat per IFC PS6 definitions. Calculate the amount of Modified or Natural Habitat to be removed (in hectares) and identify this figure in the ESIA. Through mapping, identify habitat types and calculate the amount (in hectares) of each habitat type to be removed by direct and indirect impacts.

Socio-Economic-Cultural Environment

10.11 Demographics

Building on the exiting information gathered in the scoping report, identify human settlements, including the following information for each settlement: population size, gender, and age distribution, cultural characteristics, religion, ethnicity and language. The Consultant shall conduct detailed representative household surveys in all relevant population settlements in order to obtain quantitative indicators in all mentioned demographic aspects.

The preliminary list of settlements identified in the scoping report is presented in the following table:

Table 1.

#	Village Name	Land rights	Estimated population
1	Haji Noor Mohd Goth	Permanent	300
2	Haji Ibrahim Goth (Deh Jam Chakra)	Landless	7000
3	Haji Gul Mohd Goth	Permanent	30000
4	M. Murad Brohi Village (Haji Abdul Rehman)	Permanent	500
5	Maharaj Goth	Landless	150
6	Patai Brohi Goth	Permanent	290
7	Allah Dino	Permanent	96

10.12 Livelihoods and Income

Description of all income generating activities performed by PAP household members, including detailed account of the following aspects:

- Activities performed by PAP household members by basic demographic characteristics in all identified settlements, including both formal and informal sources.

- Qualitative description of the most common income generating activities in the identified settlements, including the analysis of recent changes in the structure of livelihood resources in the areas, as well as prospective analysis and likely projected evolution based on stakeholder consultation.

- Estimated average income per household and provision of relative poverty measurement indicators (e.g., percentage over average national, regional and local income levels).

- Description of commuting and travelling habits by PAP associated to livelihood and income generating activities.

10.13 Land Use and Ownership

Actual and potential land use showing location, size, and proximity within and surrounding the Project area, including land use maps, and to extent possible, integrated into one map. Population centres, including information and locations of schools, cemeteries, religious buildings, other public buildings, housing (including housing density), commercial areas, agricultural lands, forested lands, protected areas and environmentally sensitive areas, tourism and recreation areas, recreation facilities, eco-cultural-tourist locations, culturally sensitive areas, food plains and water bodies, and other land uses as appropriate. Consultations with relevant local entities should be undertaken as applicable to determine any additional land uses not recorded onsite (e.g., land uses for other utilities maintenance) as well as to verify above information.

10.14 Health and Education

Identify all public health infrastructure elements available and accessible by PAP and provide survey-based indicators on current health status, including the identification of communicable diseases, as well as disabilities present in the area. The Project developer shall collect specific information on current and pass incidence levels of COVID-19 in the Project area, including mortality rates. Identify all available education facilities accessible in the area and those attended by PAP, by level of education (primary, secondary, etc.). Provide survey-based indicators on the level of education of PAP, as well as schooling rates for all household members. This shall also include detailed account, broken down by basic demographic characteristics of literacy rates,

10.15 Infrastructure and Utilities

For each human settlement identified in the previous section, describe the infrastructure in or serving the settlement, including the following information: transportation infrastructure, roads, airports, railways and ports, pipelines, public, drinking water supplies and treatment, wastewater treatment, locations of transmission and distribution lines (if applicable), locations of microwave towers and/or antennae (if applicable), energy infrastructure, fuel storage facilities etc.

10.16 Archaeological and Cultural Heritage

Identify all cultural, archaeological, ceremonial, and historic resources within the area of influence, and including the following information: site survey and review of secondary data by an archaeology and cultural heritage expert to ascertain the presence of any archaeological and historical remains within the Project site, as well as tangible and intangible cultural heritage items. Any sites of importance should be recorded and delineated appropriately and their implications for the Project assessed. In addition, consultation should be undertaken with relevant authorities as applicable to determine if there any additional requirements which the Project is required to consider.

10.17 Ecosystem Services

Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Based on the framework used for the Millennium Ecosystem Assessment (2006), ecosystem services are organized into four types:

- Provisioning services, which are the products people obtain from ecosystems (for example these may include food, freshwater, timber, fibres, medicinal plants). The KWC provides a source of fresh water to the communities living in the Project Affected Area that are not connected to the Karachi or other water distribution networks. These communities are highly dependent on the KWC water. The KWC water is used for drinking (both human and for livestock), domestic use (washing and bathing, etc.). There are significant differences across settlements in the specific ways in which the KWC water is accessed and used.

- Regulating services, which are the benefits people obtain from the regulation of ecosystem processes (for example, regulating services can be surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards). Regulating services provided by the KWC and seepage include a source of water for communities and crops during periods of prolonged drought. Water losses through seepage in the KWC and aqueduct structures constantly contribute streamflow to the seasonal streams flowing under the aqueducts and moisture and water to the surrounding areas.

- Cultural services, which are the non-material benefits people obtain from ecosystems (for example, these could be natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment). In particular, the use of green recreational areas around the KWC shall be investigated in detail (camping and picnics and for recreational and leisure activities).

- Supporting services, which are the natural processes that maintain the other services (such as soil formation, nutrient cycling, and primary production). Particularly, the Company shall investigate the potential ecosystem services stemming from seepage from the KWC, in terms of soil moisture levels, vegetation supporting grazing and fodder for livestock and possible agricultural benefits (cropland) in the surrounding areas.

Carry out an ecosystem's services review for the Project area and area of influence and assess which ecosystem services will be impacted by the Project, as per the methodology presented in

the World Resources Institute's Weaving Ecosystem Services into Impact Assessment, A Step-by-Step Method (2013).

10.18 Development of E&S Constraints and Red Flag Mapping

Based on the outcomes of the scoping and baseline studies above, constraint analysis mapping should be undertaken, and which will need to be considered by the KW&SB and the Company during the development of the Detailed Engineer Design phase of the Project (including the Alternatives Analysis). This constraint analysis could include for example, biodiversity or socio-economic related aspects within the Site to be avoided, sensitive receptors which need to be avoided, or require buffer or set-back zones, etc.

11. Assessment of Impacts

The ESIA shall provide information on potential impacts (direct, indirect, induced and cumulative) and the magnitude and frequency of potential impacts on the physical, biological, socio-economic, and cultural environments resulting from construction, operation and closure of the proposed Project and alternatives.

The assessment shall use standardized predictive methods, such as models for example, to determine the specific range of impacts on environmental and socio-economic resources. A methodology section will describe the methods used to determine the impacts and their significance. The ESIA shall identify which impacts are significant and the criteria used to make this judgment. Critical data input from Project description and environmental setting analysis projecting the conditions in the environmental setting in the absence of the proposed Project shall be used as the baseline upon which potential impacts are predicted.

The ESIA shall also identify sources of data used in the analysis and the uncertainties associated with the outputs of each method used.

The assessment of impacts will be carried out for all Project phases (pre-construction, construction, operations, closure, and decommissioning, as applicable).

<u>Physical Environment Impacts</u>

Potential impacts to the physical environment shall be described, including but not limited to the following:

11.1 Geology and Soils

Potential impacts to geologic resources and potential effects on the Project facilities shall be described including but not limited to the following:

- Geologic hazards and potential effects on facility;
- Changes in topography and drainage patterns;
- Soils: Potential impacts to soil resources shall be described including but not limited to the following: soil quality, structure and moisture (from eliminating seepage, from trenching excavations and placement of pipeline, from compaction due to heavy machinery and construction activities), contamination (accidental spills of fuel, oil or

other hazardous substances), disposal of component parts of photovoltaic cells, Impacts on use Erosion, slope alteration, vegetation removal and drainage patterns, sediment accumulation and transport, sediment and hazardous waste removal and disposal;

- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope and duration in context.

11.2 Water Quality and Resources

Potential impacts to surface water and groundwater resources shall be described, including but not limited to the following:

- Location of all stream crossings by rights-of-way and access roads;
- Bank erosion (surface water discharges, stream crossings and dredging);
- Quality: Effects of Project construction and operation on water quality parameters in surface water and groundwater, including the results of any water quality modelling (if appropriate);
- Description of effects due to runoff, erosion, and sedimentation from roads, disturbed areas, and stream crossings, including sources, receiving waters, and effects on physical, chemical, and biological parameters;
- Description of impact from wastewater discharges (if applicable);
- Quantification of water to be used for PV panel cleaning at the Solar Plant and description of impact;
- Spills and accidents (chemical, hazardous waste and fuel spills, containment failures);
- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope, and duration in the context of the Project.

11.3 Air Quality

Potential impacts to air shall be described including but not limited to the following:

- Impacts on ambient air quality;
- Sensitive receptors (e.g., communities, schools, water bodies, ecosystems etc.);
- Greenhouse gas generation (GHG);
- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope, and duration in the context of the Project.

11.4 Climate and Meteorology

This section should include the potential effects of severe weather events on the Project (floods, prolonged periods of drought etc.) as well as the projected impacts of climate change on the Project.

This section should also describe the potential impacts of the Project on climate change, including the benefits or positive impacts due to GHG emissions reductions from the Solar Plant that is associated with the Project (i.e., how the Project contributes to climate change mitigation).

11.5 Noise and Vibration

Potential impacts from noise shall be described, including but not limited to the following:

- Noise modelling (if required), potential noise levels at different representative sites in the Project area and in communities near the Project area;
- Potential vibration due to blasting (if applicable) and movement of heavy equipment, and related damage to materials and structures;
- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope and duration in the context of the Project.

11.6 Solid, Liquid and Hazardous Waste

Provide a description of impacts from solid, liquid and hazardous waste discharges, accidental spills and accidents or impacts on capacity of local land fill facilities.

11.7 Landscape and Visual Amenity

Potential impacts to Visual Amenity or Aesthetic Resources, including light pollution, shall be described as including but not limited to the following:

- Impacts on visual resources and landscapes (viewsheds, historically and/or culturally significant landscapes etc.).
- Increases in light contamination.
- Overall assessment of significance of direct, indirect and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope and duration in the context of the Project.

Biological Environment Impacts

Potential impacts to biological resources shall be described, including but not limited to the following:

11.8 Vegetation/Flora and Associated Habitats

- Describe and quantify alterations in vegetative cover due to deforestation, permanent or temporary, other vegetative type conversions, direct vegetative removal, indirect

vegetation impacts (e.g., by dust and air contaminants), increased road access leading to destruction of existing vegetative cover (land use changes), spread of noxious or invasive species.

- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope, and duration in the context of the Project.

11.9 Wildlife/Fauna and Associated Habitats

Describe and quantify alterations in terrestrial wildlife populations due to the following (aquatic fauna, not considered applicable to the Project):

11.9.1 **Wildlife/Terrestrial Fauna**

- Loss of habitat and breeding areas due to changes in vegetation cover/wetlands loss (as applicable).
- Disturbance of breeding areas due to Project construction, operation, and maintenance, recreational use, and human settlement associated with the Project (e.g., noise, vibration, illumination, vehicular movement).
- Loss or contamination of drinking water for wildlife species.
- Poisoning (e.g., air emissions, direct contact with toxic waste/substances).
- Animals attracted to garbage and food waste at construction camps or onsite facilities.
- Increased hunting (by workers for example).
- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project, based upon analysis of magnitude, frequency, scope, and duration in the context of the Project.

11.9.2 **Aquatic Fauna**

- Loss of aquatic habitat and breeding areas when seepage stops (as applicable).

11.10 Endangered or Threatened Species and/or Habitats

- Describe and quantify impacts to endangered or threatened species, or critically endangered (CR) or endangered (EN) habitats.
- Individual species (with special emphasis on endemic, rare, threatened, and endangered species).

11.11 Protected Areas

- Describe any impacts to Protected Areas and overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed project based

upon analysis of magnitude, frequency, scope and duration in the context of the Project (if applicable).

Social-Economic-Cultural Impacts

The ESIA shall assess potential positive and negative impacts to the socio-economic environment and cultural heritage including but not limited to the following:

11.12 Socio-Economic Impacts

- Building on the existing information gathered in the scoping report, detailed assessment of the limitation of access to canal water for basic consumption and domestic needs for around eight thousand (8,000) inhabitants from six (6) different communities.

- Impact of rehabilitation on soil moisture and agricultural yield in the vicinity of the KWC because of the elimination of seepage. This shall include in depth studies to determine the agricultural water demand to address the dependence of agricultural land on seepage water.

- Although no land acquisition or resettlement impacts are expected along the corridor of the Project, some identified narrower areas, in which the existing right of way seems to have been compromised will need to be taken into consideration before the commencement of the work. In case that assets are affected, the Company shall prepare an assessment of physical and economic displacement impacts in the framework of a simplified Resettlement and Livelihood Restoration Plan (RLRAP), in accordance with the IFC´s Performance Standard 5, and ADB's Safeguard Policy Statement (2009).

- Mobility restrictions during the Concession Period for local population (see section 8.10.1)

- Impacts on public health. COVID-19 risks as communicable respiratory diseases will most likely be the most significant concern for potential interactions between the workforce and community members.

- Assessment of other expected impacts over the affected communities:

    - Affected individual incomes.

    - Direct employment at the Project.

    - Indirect employment generated by Project Activities.

    - Employment opportunities for local residents.

    - Other economic activities stimulated in the community because of the Project.

    - Reduction in quality of life for residents from visual and noise impacts.

    - Change in crime rates (substance abuse, prostitution, etc.).

    - Change in character and social cohesion of community because of displacement and other impacts.

- Potential hazard to the public from KWC components resulting from accidents or natural catastrophes and how these events will affect reliability.
- Overall community acceptance of the Project.
- Impacts over community recreational facilities and leisure activities.

- Assessment of impacts over the labour force of the Project and the staff engaged in operation of the KWC:
  - Substitution of part of the current KW&SB staff by Company's personnel.
  - Impacts on worker health and safety, with particular attention to accommodation conditions and characteristics of workers' camps.
  - Identification of hazardous jobs and number of workers exposed with duration of exposure.
  - Occupational diseases due to exposure to dust and other Project-related activities such as handling of explosives, solvents, petroleum products, (if applicable) etc.
  - Identification of physical risks and safety aspects.
  - Potential for fires.
- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope and duration in the context of the Project.

11.13 Infrastructure and Utilities

11.13.1 **Transportation infrastructure**

This section of the ESIA addresses impacts on transportation and traffic patterns on existing roads. The impacts of new and existing roads and interventions over them on the surrounding environment and land use should be addressed in those respective sections. The ESIA shall assess potential impacts to transportation systems, including but not limited to the following:

- Potential mobility restrictions during the Concession period, particularly in some specific settlements where villagers are highly dependent on the auxiliary road along the KWC. Investigation of crossing paths used by villagers to access the opposite side of the KWC that could be also temporarily affected.
- Potential changes to traffic patterns, densities, and traffic safety issues in the area affected by the Project.
- A determination of vehicular traffic density in the Project area (before, during, and after the proposed activities).
- Potential for traffic accidents.

- Congestion.
- Noise.

11.13.2 **Increased Pressure on Public Services**

- Public health infrastructure:
    - Increased need for public health infrastructure;
    - Alterations to public health infrastructure;
- Communications infrastructure:
    - Increased need for communications infrastructure;
    - Alterations to communications infrastructure;
- Energy infrastructure:
    - Increased need for energy infrastructure;
    - Alterations to energy infrastructure;
- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope and duration in the context of the Project.

11.14 Archaeology and Cultural Heritage

Impacts over cultural heritage elements are unlikely in the framework of the Project. Nonetheless, the Company shall assess and provide further details on the following aspects in the ESIA:

- Cultural heritage, archaeological, paleontological, religious, historic resources;
- Destruction during construction;
- Damage and alteration;
- Removal from historic location;
- Introduction of visual or audible elements that diminish integrity;
- Neglect that causes deterioration;
- Loss of medicinal plants;
- Loss of access to traditional use areas;
- Impacts to previously inaccessible resources from development/improvement of roads;

- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope and duration in the context of the Project.

11.15 Ecosystem Services

- Impacts to the ecosystem services identified in baseline section;

- Overall assessment of significance of direct, indirect, and cumulative impacts for all phases of the proposed Project based upon analysis of magnitude, frequency, scope and duration in the context of the Project.

11.16 Cumulative Impacts

Cumulative impacts are those that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present, or reasonably foreseeable future activities.

The cumulative impacts will be assessed by identifying other applicable projects, such as construction and upgrade of electricity generation, and transmission, distribution facilities or other infrastructure projects in the local area (i.e., within twenty kilometres (20 km) of the proposed Project) that have been approved or are currently underway.

Use IFC's Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets as Guidance (2013).

12. Mitigation and Monitoring Measures

Identify mitigation measures as per the Mitigation Hierarchy. Specifically, these should include the following:

- Avoidance measures;

- Minimization measures;

- Restoration measures;

- Compensation/offset measures.

This section of the ESIA must include measures designed to mitigate potential adverse impacts to physical, biological, and social-economic-cultural resources from construction, operation and closure of the proposed Project and alternatives. These shall include measures to avoid and prevent, and if needed, to reduce or minimize adverse impacts and, where residual impacts remain, compensate / offset for risks and impacts to workers, Affected Communities, and the environment, according to the mitigation hierarchy shown in the following figure. The Project proponent must include measures considered to be "best practices" in the design of all alternatives.

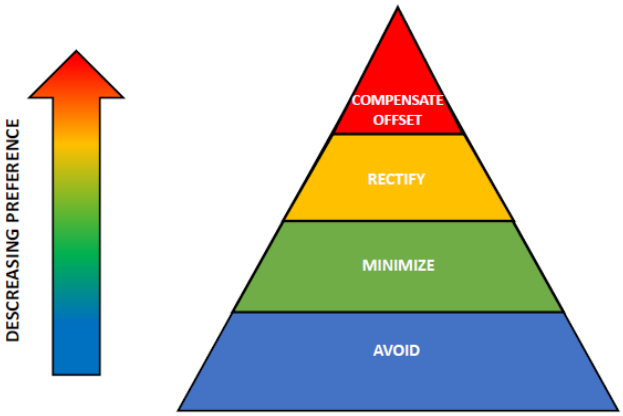


Figure 3. Mitigation hierarchy

Either herein and / or in the Environmental and Social Management Plan (ESMP) section, proposed mitigation shall be described in auditable terms and at a level of detail sufficient to demonstrate its effectiveness in addressing the concern or performance criterion, including its anticipated level of effectiveness and/or measurable performance, and design specifications.

The monitoring plan must include monitoring throughout the life of the Project for each potential mitigation to confirm the effectiveness of the measure and support contingency plans to provide assurance that the Project, at the Site preparation, construction, operation, expansion, and closure stages will meet applicable environmental and legal requirements and fall within the limits of impacts deemed acceptable upon approval of the ESIA. Some important items to address in the mitigation plan and associated monitoring plans include, but are not limited to the following:

13. Environmental and Social Management Plan

The ESIA shall include an Environmental and Social Management Plan to prevent, mitigate and monitor each impact identified in the ESIA. Plans will describe actions to be taken in sufficient detail to provide a basis for subsequent auditing of compliance with commitments made in the ESIA process, including who is responsible, how and when it will be implemented, what will be done and what results will be achieved, why it is being done, and how to know whether it is effective in addressing the underlying concerns. The Environmental and Social Management Plan shall have the following elements:

13.1 Overview of Environmental and Social Management Plan Organization and Policy

Describe the Project management and how environmental management and organization relates to overall Project responsibility. Describe the personnel and performance accountability system for design, operation, maintenance and closure for implementation of mitigation and monitoring measures.

Describe the environmental policy that will govern the Project throughout its implementation, including at least the objectives, scope, commitment to continuous improvement, control and environmental monitoring and good relationship with neighbouring populations and countries, as well as the commitment to internal controls such as compliance and environmental monitoring and routine audits.

Identify the persons responsible for the implementation of mitigation measures in each phase.

13.2 Mitigation and Monitoring Plans

The Consultant will develop detailed Environmental, Social, Health and Safety Management Plans ("ESMP" or "ESHS MP") that identify for each impact the mitigation, monitoring and management measures to be taken during the various phases of the Project (construction, operations, decommissioning) to avoid, reduce, mitigate, or compensate for adverse environmental, social, and health and safety impacts.

For each identified impact the Consultant will establish:

- A set of mitigation measures that will include feasible measures to prevent significant adverse impacts or reduce them to acceptable levels. Such measures will involve technical requirements, guidelines or procedures and practices to be implemented during design, construction, operation and decommissioning phase of the Project;

- A set of monitoring requirements that ensure that the identified mitigation measures are considered, implemented properly and are sufficient measures for protecting the environment and environment resources, local communities, and workers.

In addition, as part of the ESMP, the Consultant shall also identify the proposed ESMS structure, as applicable, that will be followed for the project. The ESMS requirements will be included in detail for all the parties involved, including, the Sponsor(s), the EPC Contractor, and the O&M Contractor.

This ESMS shall be aligned with the principles of ISO 14001 and OSHAS 18001/ISO 450001 and include the necessary Elements, Programs and Management Plans and Procedures to manage the identified Project risks. As part of the ESMS, management plans will be developed in line with the applicable requirements for the key aspects identified in the ESIA such as, but not limited to pollution prevention (noise, dust, fuels, hazardous materials), biodiversity management, solid and liquid waste, flora and fauna, water management, occupational health and safety, transportation management, security management, emergency response, labour and supply chain management.

The Consultant will develop an outline management structure which will ensure the implementation of all the required mitigation and/or monitoring activities is achievable. This will include recommended training activities, and any additional management tools, etc.

13.2.1 Stakeholder Engagement Plan

The Consultant will develop a Stakeholder Engagement Plan ("SEP") as a standalone document in line with the IFC's requirements. The SEP should recognize that Stakeholder engagement is an ongoing process that involves Stakeholder analysis & planning, disclosure and dissemination of information, consultation & participation, grievance mechanism and on-going reporting to affected communities. In line with the requirements of IFC, the SEP must be developed and scaled to the Project risks and impacts and be tailored to the characteristics and interests of the Affected Communities and key Stakeholders.

The Consultant should build the SEP based on the environmental and social impact assessment outcomes considering local settings. The SEP should be developed to include the following:

- Introduce the SEP and include information on the purpose and scope;
- Include information on legislative and international requirements;
- Identify all Project related stakeholders influenced by the Project to include central governmental entities, local governmental entities, NGOs, local communities and CBOs; academic and research institutions; private sector companies; media organizations; and most important any vulnerable groups if applicable;
- Evaluate Project related Stakeholders to understand their priorities and relevance to the Project;
- Define the Project's approach to stakeholder engagement (post ESIA study, during construction and operations). Priority should be given to identification of engagement mechanisms that are: (i) culturally appropriate, (ii) scaled to the Project risks and impacts, (iii) tailored to the characteristics and interests of the Stakeholder group's language preferences, and decision-making process;
- Identify the objective of undertaking such consultation activities for each Stakeholder group;
- Identify the phase of involvement of Stakeholders. This will include: (i) summary of Stakeholder consultations and engagement undertaken as part of the ESIA (scoping process, baseline, impact assessment, mitigation, etc.) and (ii) future engagement including both disclosure of the ESIA and post-ESIA phase to be implemented through the project duration to include four distinct phases – planning, construction, operation, and decommissioning;
- Include information on monitoring requirements including frequency of all engagement activities and reporting;
- A detailed grievance / project complaints mechanism that is responsive and facilitates establishing and facilitating the resolution of Stakeholders' concerns and grievances.

Within the SEP, the Consultant shall describe the process by which PAPs and interested people can express their grievances for consideration and redress, in accordance with national law and the applicable international standards, and with IFC´s Performance Standard 1. The process shall be free of any cost for users, and it will be implemented through an understandable and transparent consultative approach that is culturally appropriate and readily accessible. The GRM should ensure it can receive both external and internal grievances. The GRM should be designed to address complaints of gender-based violence between employees / contractors and members of the community. The Consultant shall describe a least the following elements of the GRM.

- Establishment of Grievance Committee, appointment of members and functioning rules;
- Eligibility criteria for grievances;

- Reception and registration of grievances;
- Referral process;
- Development, communication, and implementation of proposed responses.

A separate GRM shall be defined and implemented for the engagement of workers regarding possible health and safety occupational risks.

14. Appendices

These shall be numbered and referenced throughout the text and include, but not be limited to:

14.1 Technical Supporting Documents

- Including maps, plans, charts and figures in the sequence mentioned in the ESIA document;
- Zoning maps with resources and results of impacts;
- Special Studies if relevant but not readily accessible;
- Detailed materials on predictive tools/models and assumptions used for the assessment but too detailed for the body of the ESIA;
- Detailed survey reports (e.g., birds and other vegetation/fauna surveys) and the associated raw data.

14.2 References

Include a section with all references, (books, articles, technical reports, and other information sources) cited in the various chapters of the ESIA study with full biographic references, and the following conventional procedures cited in the literature: author, year, title, source, number of pages, and city of publication or issuance or webpages accessed on [*date*].

15. Non-technical Summary

The Consultant shall prepare a Non-Technical Summary ("NTS") report, which concisely discusses meaningful information on the project, its environmental and social footprint and impacts, significant findings and recommended actions in easily understandable (non-technical) language. The section will include a summary of the ESIA undertaken (project description, baselines, impact analysis and mitigation measures for the environmental, social and health and safety negative and positive impacts) and a summary of the stakeholder engagement process.

16. Schedule

The anticipated schedule for the ESIA is as follows:

TASK	DELIVERABLE	PROPOSED DATE *[Add Dates]*
1	Site Survey Priority List; kick-off meeting	
2	ESIA Methodology	
3	Scoping Report, follow-up meeting	
1	Policy, Legal, and Administrative Framework	
2	Project Description	
3	Analysis of Alternatives	
4	Environment and Social Baseline Conditions	
5	E&S Constraints Report	
6	Draft of ESIA Report, follow-up meeting	
8	Environmental, Social, Health and Safety Management Plans	
8	Stakeholder Engagement Plan	
9	Non-Technical Summary	
10	Final ESIA, final meeting	

17. Staffing and key personnel

The ESIA shall be prepared by an independent Consultant that has no conflict of interest with the Project. The Consultant is expected to appoint a team of specialists that will carry out the necessary investigations to gather, review and compile all relevant data and to consult with stakeholders. The Consultant shall provide and maintain all key experts throughout the assignment; any changes are subject to prior approvals by the KW&SB. The Consultant's team is expected to have experts who are familiar with the local area and have the appropriate language skills and should include local experts wherever possible.

It is expected that the Consultant will undertake field work for all the relevant specialist studies. In addition, collection of baseline data and surveys will be undertaken to enable a robust assessment appropriate to the nature and scale of the Project. The spatial and temporal extent of the baseline surveys will be determined through professional judgment and industry best practice. Data will be relevant to inform decisions about Project location, design, construction, operation, and mitigation measures. This section will indicate the accuracy, reliability, and data sources. Baseline information will be supported with figures and maps where possible.

The Consultant's team is expected to include the following core staff:

- Project Director: a consultant with experience in undertaking ESIA's in accordance with IFC's and ADB's standard, with excellent communication skills and minimum fifteen (15) years of professional experience.

- Environmental Specialist: with experience of delivering ESIA's against international standards and best practice, and minimum ten (10) years of professional experience.

- Social Specialist: with minimum ten (10) years' experience in management of labour, community health and safety, land acquisition, livelihood restoration issues, design and implementation of stakeholder engagement and community development plans, conflict resolution and community relations issues with indigenous peoples, if applicable.

These will be supported by a team of selected specialists appropriate to the Project, and with appropriate language skills, who will cover as a minimum the following areas:

- Air quality measurements and modelling;

- Soils, geology, hydrogeology and topography/landscape;

- Hydrology, hydrogeology and water quality measurements;

- Biodiversity (flora & fauna);

- Community health, safety and security;

- Socio-economic analysis, resettlement/land acquisition, stakeholder engagement;

- Gender and GBV;

- Archaeological, historical and cultural heritage; and

- Resource management including solid and hazardous materials and waste management.

SIGNATURE PAGES

IN WITNESS WHEREOF, the Parties, intending to be legally bound, have caused this Agreement to be executed by their duly authorised representatives as of the date first written above.

GOVERNOR OF SINDH, THROUGH THE SECRETARY, LOCAL GOVERNMENT & HOUSING TOWN PLANNING DEPARTMENT, GOVERNMENT OF SINDH

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

.....

Witness signature .....

Witness name (block capitals) .....

KARACHI WATER AND SEWERAGE BOARD

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name
(block capitals) .....

Witness signature .....

Witness name
(block capitals) .....

THE COMPANY

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

Witness signature .....

Witness name (block capitals) .....

VOLUME IV
EQUITY FUNDING AND UTILIZATION AGREEMENT

between

(1) THE GOVERNOR OF SINDH
(THROUGH THE LOCAL GOVERNMENT & HOUSING TOWN PLANNING DEPARTMENT, GOVERNMENT OF SINDH)

(2) [SPONSORS][1]

- and -

(3) [THE COMPANY]

relating to the
KARACHI HUB WATER CANAL PROJECT

Dated [●]

Drafting Notes:

1. ***Items highlighted in green in the draft EFU Agreement (including the appendices) will be inserted prior to signing and (where stated) extracted from the relevant document referenced in the footnotes.***

2. ***This Agreement shall be updated accordingly if the Sponsor is a single entity.***

3. ***Concept of "Project Accounts" and related provisions in the EFU Agreement will be appropriately updated if (subject to State Bank of Pakistan special permission) the Company is not permitted to establish foreign currency accounts or where the Company elects not to establish foreign currency accounts.***

[1] Details as per Bidding Form T4 or T5 (as applicable) of the Proposal

CONTENTS

1. DEFINITIONS AND INTERPRETATION 2
2. FUNDING OBLIGATIONS 10
3. FUNDING MECHANISM 14
4. UTILIZATION 17
5. PROJECT ACCOUNTS AND ACCOUNT BANK 18
6. GOS EQUITY ACCOUNT AND GOS EQUITY ACCOUNT STANDING INSTRUCTIONS 20
7. CLASS A AND CLASS B SHARES AND RELATED MATTERS 22
8. REPRESENTATIONS AND WARRANTIES 28
9. COVENANTS 30
10. OBLIGATIONS CONTINUING 32
11. TERMINATION 32
12. NOTICE 32
13. SUCCESSORS AND ASSIGNS 33
14. INDEMNITY 34
15. PARTIAL INVALIDITY, SEVERABILITY AND AMENDMENT 34
16. GOVERNING LAW AND DISPUTE RESOLUTION 34
17. COUNTERPARTS 36

APPENDIX 1: PART I – FORM OF FUNDING NOTICE FOR SPONSOR 37

APPENDIX 1: PART –II - FORM OF FUNDING NOTICE FOR GOS 40

APPENDIX 2: NOTICES 43

APPENDIX 3: FORM OF GOS EQUITY ACCOUNT STANDING INSTRUCTIONS 44

APPENDIX 4: FORM OF COST OVERRUNS DEMAND NOTICE 49

APPENDIX 5: FORM OF DEED OF ACCESSION 50

SIGNATURE PAGES 52

This **EQUITY FUNDING AND UTILIZATION AGREEMENT** is made on [●], 2022 at Karachi, Pakistan.

BETWEEN:

(1) **THE GOVERNOR OF SINDH** (through Secretary, Local Government & Housing Town Planning Department, Government of Sindh) having its office located at Local Government Department, Ground Floor, Tughlaq House, Sindh Secretariat, Karachi, Pakistan for and on behalf of the Government of Sindh (the **"GoS"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors and assigns);

(2) **[SPONSORS]**, (hereinafter referred to as the **"Initial Sponsors"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns)[2]; and

(3) **[COMPANY]**[3], a company incorporated under the Laws of Pakistan whose registered office is located at [●] (the **"Company"** which expression shall, unless excluded by or repugnant to the context, be deemed to include its successors in interest, administrators and permitted assigns).

RECITALS:

A The GoS, the Karachi Water and Sewerage Board (KW&SB) and the Company entered into the Concession Agreement for the Project.

B This Agreement is to be executed together with the Concession Agreement setting out, *inter alia*, the terms and condition of funding of costs associated with the Project.

NOW THEREFORE, in consideration of the mutual covenants contained herein, the Parties agree as follows:

[2] Details as per Bidding Form T4 or T5 (as applicable) of the Proposal.

[3] Insert name of company to be incorporated by the Sponsors.

1. DEFINITIONS AND INTERPRETATION

1.1 Definitions

Unless specified otherwise herein, in this Agreement (including the recitals), all capitalized terms shall have the meanings assigned to them under the Concession Agreement (*as defined below*). In addition, the following terms shall have the following meanings, unless the context otherwise requires:

"Account Bank" means a banking company or financial institution incorporated under the Laws of Pakistan appointed with the written consent of the Parties;

"Agreement" means this Equity Funding and Utilization Agreement, as amended and supplemented from time to time;

"Approved Budget" means the Approved EPC Budget and the Approved Non-EPC Budget, as approved in accordance with clause 2.5.2.1;

"Approved EPC Budget" means the budget, prepared on the basis of the Base Case Financial Model, duly approved in accordance with clause 2.5.2.1, that sets out the payments to be made by the Company to the EPC Contractor for each Approved EPC Milestone, as may be amended from time to time in accordance with clause 2.5.4;

"Approved EPC Milestone" means the relevant EPC Milestone completed by the EPC Contractor in accordance with the EPC Contract in each case to the satisfaction of the Independent Engineer;

"Approved EPC Payment Amount" means the amounts to be paid to the EPC Contractor in respect of the Approved EPC Milestone after adjusting for disbursement of debt by the Financing Parties (if applicable) in terms of the Financing Documents, as verified and certified by the Independent Appointees;

"Approved First Funding Amount" means the Approved Sponsor First Funding Amount and the Approved GoS First Funding Amount;

"Approved Funding Amount" means the Approved Sponsor Funding Amount or the Approved GoS Funding Amount (as applicable), where each amount is determined by the Independent Auditor prior to issuance of each Funding Notice on the basis of: (a) the Funding Ratio; and (b) (where applicable) after adjusting for debt disbursement by the Financing Parties in terms of the Financing Documents for funding the relevant Expenditure provided that in no event shall any contribution by the GoS of the Approved GoS Funding Amount exceed (in aggregate) the GoS Equity Amount or result in the GoS holding more than [●][4] of the issued and paid-up share capital of the Company;

[4] Insert maximum percentage determined on basis of Proposal, not to exceed 49%.

"Approved GoS First Funding Amount" means such amount as certified by the Independent Appointees in accordance with the Approved Budget and set out in the First Funding Notice;

"Approved GoS Funding Amount" means: (a) the Approved GoS First Funding Amount; and (b) each Approved GoS Subsequent Funding Amount, provided the sum of (a) and (b) shall in no event exceed the GoS Equity Amount or result in the GoS holding more than [●][5] of the issued and paid-up share capital of the Company;

"Approved GoS Subsequent Funding Amount" means such amount as certified by the Independent Appointees in accordance with the Approved Budget and set out in each Subsequent Funding Notice;

"Approved Sponsor First Funding Amount" means such amount as certified by the Independent Appointees in accordance with the Approved Budget and set out in the First Funding Notice;

"Approved Sponsor Funding Amount" means the Approved Sponsor First Funding Amount and each Approved Sponsor Subsequent Funding Amount;

"Approved Sponsor Subsequent Funding Amount" means such amount as certified by the Independent Appointees in accordance with the Approved Budget and set out in each Subsequent Funding Notice;

"Approved Non-EPC Budget" means the budget, prepared on the basis of the Base Case Financial Model, duly approved in accordance with clause 2.5.2.1, that sets out payments to be made by the Company for Non-EPC Expenditures, as may be amended from time to time in accordance with clause 2.5.4;

"Arbitration" has the meaning given to it in clause 16.4.1.1;

"Arbitrators" has the meaning given to it in clause 16.4.1.1;

"Award" has the meaning given to it in clause 16.4.4;

"Class A Equity Subscription Account (PKR)" means a deposit account denominated in Pakistani Rupees titled "Class A Equity Subscription Account (PKR)" that is to be opened and maintained by the Company at the Designated Branch of the Account Bank and notified in writing to the GoS and the Independent Auditor;

"Class A Equity Subscription Account (USD)" means a deposit account denominated in United States Dollars titled "Class A Equity Subscription Account (USD)" that is to be opened and maintained by the Company at the Designated Branch of the Account Bank in accordance with Legal Requirements and notified in writing to the GoS and the Independent Auditor;

"Class A Shares" means shares of the Company designated as 'class A shares' issued to the Sponsors from time to time in compliance with the Legal Requirements, provided, however,

[5] Insert maximum percentage determined on basis of Proposal, not to exceed 49%.

where the Approved Sponsor Funding Amount is Funded in USD, the Class A Shares will be registered on a repatriable basis by the State Bank of Pakistan or the authorized dealer, as applicable;

"Class B Dividends" means, to the extent the Electricity Reimbursement Payment (as defined in appendix 8 of the Concession Agreement) is not reduced by element 'V' (if applicable), the amount by which the Electricity Reimbursement Payment would have been reduced shall be considered a Class B Dividends;

"Class B Equity Subscription Account" means a deposit account denominated in Pakistani Rupees titled "Class B Equity Subscription Account" that is opened and maintained by the Company at the Designated Branch of the Account Bank and notified in writing to the GoS and the GoS Account Bank;

"Class B Shares" means shares of the Company designated as 'class B shares' issued to the GoS or its nominee(s) from time to time;

"Commitment Percentage" means, in respect of:

(a) [*insert sponsor name*], [●]%; and

(b) [*insert sponsor name*], [●]%;[6]

"Concession Agreement" means the concession agreement between the GoS, the Karachi Water and Sewerage Board and the Company dated [●] relating to the Project;

"Cost Overrun" mean, at any time, the amount (if any) of the Project Costs that will be payable to achieve the Project Commercial Operations Date that exceeds or is projected to exceed the Project Cost in the Initial Approved Budget, as determined from time to time by the Independent Appointees;

"Cost Overruns Demand Notice" has the meaning given to it in clause 2.2.3;

"Deed of Accession" means a deed of accession substantially in the form set out in appendix 5;

"Designated Branch" means the designated branch of: (a) the Account Bank that is designated by the Company in respect of the Project Accounts; and (b) the GoS Account Bank that is designated by the GoS in respect of the GoS Equity Account;

"Dispute" means a dispute, controversy, difference or claim between the Parties arising out of or in relation to this Agreement or the Parties' performance or non-performance of this Agreement;

"EFU Effective Date" means the date of this Agreement;

[6] Details as per Bidding Form T4 or T5 (as applicable) of the Proposal.

"EPC Advance Payment" means the one-time sum payable to the EPC Contractor by the Company as advance in accordance with the EPC Contract and the Approved EPC Budget;

"EPC Milestone" means each payment milestone (including specified conditions or milestones under the EPC Contract for release of the EPC Advance Payment) as set out in the Approved EPC Budget and the EPC Contract;

"EPC Payments" means the EPC Advance Payments and any amounts payable to the EPC Contractor by the Company in accordance with the Approved EPC Budget in respect of each Approved EPC Milestone; provided, that any amounts which are to be retained from the EPC Contractor and are to be paid after expiry of the relevant retention period in accordance with the Approved EPC Budget, shall also be construed as an EPC Payment;

"Expenditures" means the EPC Payments and the Non-EPC Expenditures;

"First Funding Notice" means the written notice to be issued by the Company to each Funding Party (with a copy issued and delivered to the other Funding Party, the GoS Account Bank, the Account Bank and the Independent Appointees) pursuant to clause 3.1, in the form and substance attached hereto:

(a) in case of such notice being issued to the Sponsors, at part 1 of appendix 1;

(b) in case of such notice being issued to the GoS, at part 2 of appendix 1;

"Fund", "Funding" and its grammatical variations, means:

(a) in case of the GoS, subscription by the GoS to the Class B Shares by crediting (in Pakistani Rupees) the Class B Equity Subscription Account, from time to time, with the Approved GoS Funding Amount; and

(b) in case of the Sponsors:

(i) subscription by the Sponsors to the Class A Shares by crediting (in Pakistani Rupees) the Class A Equity Subscription Account (PKR), from time to time, with the Approved Sponsor Funding Amount to be funded in Pakistani Rupees;

(ii) subscription by the Sponsors to the Class A Shares by crediting (in United States Dollars) the Class A Equity Subscription Account (USD), from time to time, with the Approved Sponsor Funding Amount to be funded in United States Dollars;

(iii) provision of Sponsor Loan by the Sponsors by crediting (in Pakistani Rupees) the Class A Equity Subscription Account (PKR), from time to time, with the Approved Sponsor Funding Amount to be funded in Pakistani Rupees; or

(iv) provision of Sponsor Loan by the Sponsors by crediting (in United States Dollars) the Class A Equity Subscription Account (USD), from time to time,

with the Approved Sponsor Funding Amount to be funded in United States Dollars;

"Funding Account" means:

(a) in case of the GoS, the Class B Equity Subscription Account; and

(b) in case of the Sponsors, the:

(i) Class A Equity Subscription Account (PKR); and

(ii) Class A Equity Subscription Account (USD);

"Funding Notice" means the First Funding Notice and each Subsequent Funding Notice (as applicable);

"Funding Parties" means the GoS and the Sponsors, and **"Funding Party"** means any of them;

"Funding Period" means the period commencing from the Commencement Date and ending on the Day immediately preceding the Project Commercial Operations Date;

"Funding Ratio" means the ratio of: (a) the Approved Sponsor Funding Amount, to (b) Approved GoS Funding Amount to be Funded by the respective Funding Parties pursuant to a Funding Notice, which ratio:

(a) shall be determined by the Company, with approval of the Independent Auditor, prior to issuance of a Funding Notice to ensure that at no time the GoS holds more than [●][7] of the paid-up share capital of the Company; and

(b) shall not fall below [●];[8]

"GoS Account Bank" means a scheduled bank in Pakistan with a minimum credit rating of at least 'AA-' as rated by VIS or an equivalent rating by PACRA;

"GoS Account Instructions Revocation Date" has the meaning given to it in clause 6.2.2;

"GoS Equity Account" means the Pakistani Rupee denominated account of the GoS to be opened and maintained at the Designated Branch of the GoS Account Bank, details of which shall be notified in writing by the GoS (and confirmed by the GoS Account Bank) to the Company, the Sponsors and the Independent Appointees;

"GoS Equity Account Standing Instructions" means the standing instructions issued by the GoS to the GoS Account Bank in accordance with this Agreement and substantially in the form and content attached hereto at appendix 3;

[7] Insert maximum percentage determined on basis of Proposal, not to exceed 49%

[8] Ratio to be updated based ratio of GoS Equity Amount against Sponsor Funding Amount, each as stated in the Proposal.

"GoS Equity Amount" means the amount not exceeding [●][9], to be Funded by the GoS in accordance with this Agreement and which in no circumstances results in the GoS holding more than [●][10] of the paid-up share capital of the Company;

"Initial Approved Budget" means the first Approved EPC Budget and the first Approved Non-EPC Budget prepared on the basis of the Base Case Financial Model and approved in accordance with clause 2.5.2.1, including any revision thereto permitted only for acceleration of progress of the C&O Activities pursuant to clause 2.5.4;

"Initial Project Cost" means the Project Cost as set out in the Base Case Financial Model;

"Initial Sponsor(s)" has the meaning given to it in the preamble of this Agreement;

"Lead Developer" means [●];[11]

"Lead Investor" means [●];[12]

"New Sponsor" means any transferee to whom any Class A Shares have been transferred in accordance with clause 7.7;

"Non-EPC Expenditures" means all expenditures to meet the Projects Costs excluding the EPC Payments;

"Operating Account" has the meaning given to it in clause 2.5.5;

"Operating Costs" means all operating costs and expense incurred or to be incurred by the Company other than as set out in the Initial Approved Budget;

"Parties" means the GoS, the Sponsors and the Company, and **"Party"** means any of them;

"Performance Security Cost" has the meaning given to it in clause 2.4.1;

"Project Account Profits" has the meaning given to it in clause 5.4.1;

"Project Accounts" means the Class A Equity Subscription Account (PKR), Class A Equity Subscription Account (USD) and the Class B Equity Subscription Account;

"Project Costs" means (without double-counting), any costs or expenses relating to the Project as set out in the Financial Model stated in Pakistani Rupees, which costs and expenses may include one or more of the following:

(a) capital costs;

---

[9] Insert GoS Equity Amount as specified in Bidding Form F1.
[10] Insert maximum percentage determined on basis of Proposal, not to exceed 49%
[11] Details as per Bidding Form T4 or T5 (as applicable) of the Proposal

[12] Details as per Bidding Form T4 or T5 (as applicable) of the Proposal

(b) costs and expenses in respect of the design, engineering, procurement, manufacture, construction, rehabilitation, commissioning, testing and completion of the KWC;

(c) financing costs;

(d) costs of Taxes imposed on or payable by the Company;

(e) fixed operating costs during the C&O Period; and

(f) all other costs and expenses incurred in connection with the Project during the C&O Period in accordance with the Financial Model;

including any increase in costs and expenses stated in (a) to (f) above due to devaluation of the Pakistani Rupees or increase in the base rate applicable to borrowing from a Finance Party, but excluding any Operating Costs;

"Proposed Budget" has the meaning given to it in clause 2.5.1;

"Proposed EPC Budget" has the meaning given to it in clause 2.5.1.2;

"Proposed Non-EPC Budget" has the meaning given to it in clause 2.5.1.1;

"Proposed Utilization Statement" has the meaning given to it in clause 4.2.1;

"Quarter" means each three (3) Month period during the Funding Period;

"Rejected Amounts" has the meaning given to it in clause 4.2.3.2;

"Required First Funding Date" has the meaning given to it in clause 3.1.5;

"Required Funding Date" means any of the Required First Funding Date or the Required Subsequent Funding Date, as applicable;

"Required Subsequent Funding Date" has the meaning given to it in clause 3.2.4;

"Sponsor Funding Amount" means [●][13];

"Sponsor Loans" means Sponsor Equity advanced by any Sponsor in the form of loans to the Company, in each case:

(a) in accordance with this Agreement;

(b) compliant with the Subordination Terms and Legal Requirements; and

[13] This amount will be the total equity commitment of the Sponsors (excluding Cost Overruns) set out in the Proposal. Maximum Foreign Equity and Maximum Local Equity stated in Bidding Form F3-G.

(c) where the Sponsor Loan is Funded in United States Dollars, the United States Dollar amounts contributed as Sponsor Loan shall be as set out in the registration of Sponsor Loan issued by the authorized dealer or the State Bank of Pakistan;

"Sponsor Pre-Funded Equity Amount" has the meaning given to it in clause 3.3.1;

"Sponsors" means one or more Initial Sponsor(s) or any New Sponsor;

"Subordination Terms" means such subordination terms and conditions for Sponsor Loans as may be specified by the GoS and the Independent Auditor;

"Subsequent Funding Notice" means the written notice (excluding the First Funding Notice) to be issued by the Company to each Funding Party (with a copy issued and delivered to the other Funding Party, the GoS Account Bank, the Account Bank, the Independent Appointees) pursuant to clause 3.2, in the form and substance attached hereto:

(a) in case of such notice being issued to the Sponsors, at part 1 of appendix 1;

(b) in case of such notice being issued to the GoS, at part 2 of appendix 1;

"Transfer Criteria" means:

(a) the transferee:

(i) is not an Adverse Person;

(ii) is not a defaulter of any bank or financial institution; and

(iii) in the sole opinion of the GoS, complies with the relevant qualification and evaluation criteria for such outgoing Sponsor as set out at the prequalification and bidding stage of the Project; and

(b) the transfer of shareholding is in compliance with the applicable Legal Requirements;

"Transferring Sponsor" has the meaning given to it in clause 7.4.1.2;

"Utilization", "Utilize" and its grammatical variations, means utilization of the Approved Funding Amount by the Company in accordance with the Approved Budget, including:

(a) in respect of Non-EPC Expenditures, in accordance with the Approved Non-EPC Budget; and

(b) in respect of EPC Payments, in accordance with the Approved EPC Budget;

"Unutilised Amounts" has the meaning given to it in clause 4.2.1.2; and

"Utilization Statement Certificate" has the meaning given to it in clause 4.2.3.

1.2 Interpretation

1.2.1 The rules of construction and interpretation set forth in clause 1.2 of the Concession Agreement shall apply, *mutatis mutandis*, to this Agreement.

2. FUNDING OBLIGATIONS

2.1 Funding Amount

2.1.1 The GoS undertakes and agrees, subject to the terms of this Agreement, to Fund the Approved GoS Funding Amount up to an amount not exceeding the GoS Equity Amount.

2.1.2 Each Sponsor undertakes and agrees, subject to the terms of this Agreement, to Fund the Sponsor Funding Amount in proportion to its Commitment Percentage by way of:

2.1.2.1 subscription to the Class A Shares; and / or

2.1.2.2 a Sponsor Loan to the Company,

provided, however, any Funding by the Sponsor under this clause 2.1.2 shall be subject to minimum shareholding requirements under clause 7.4.4 and not result in the GoS holding more than [●][14] of the issued and paid-up share capital of the Company.

2.1.3 If any Sponsor fails to Fund its respective Commitment Percentage of the Sponsor Funding Amount, in terms of this Agreement, the Lead Investor shall be liable to Fund the same within three (3) Business Days of the Required Funding Date, provided that, where the Lead Investor is required to Fund the Commitment Percentage of a Sponsor in terms of this clause 2.1.3, the Funding by the Lead Investor shall in no event result in the Lead Developer holding less than ten percent (10%) of the issued and outstanding share capital of the Company as required by clause 7.4.4.2.

2.1.4 If the Lead Investor fails to fund any amount in terms of clause 2.1.3 or the Lead Developer (at any time) holds less than ten percent (10%) of the issued and outstanding share capital of the Company, each such event shall constitute a Company Event of Default.

2.1.5 The Sponsors' obligation to fund the Sponsor Funding Amount is in addition to its other obligations under this Agreement.

2.2 Commitment to Fund Cost Overrun

2.2.1 Each Sponsor undertakes and agrees, subject to the terms of this Agreement, to fund any Cost Overrun that may from time to time arise in accordance with this clause 2.2, in proportion to its Commitment Percentage.

[14] Insert maximum percentage determined on basis of Proposal, not to exceed 49%

2.2.2 Any Cost Overruns shall be funded by the Sponsors, or the Lead Investor under clause 2.2.4 (as the case may be), by way of:

2.2.2.1 subscription to the Class A Shares;

2.2.2.2 a Sponsor Loan to the Company; and/or

2.2.2.3 availing financing under the Financing Documents,

provided, however, any Funding by the Sponsor under this clause 2.2.2 shall be subject to minimum shareholding requirements under clause 7.4.4 and not result in the GoS holding more than [●][15] of the issued and paid-up share capital of the Company.

2.2.3 The Company shall immediately notify the Independent Auditor and the GoS after it becomes aware that a Cost Overrun exists or is projected to occur within the next ninety (90) Days of such determination. Following any such notification, or if at any time the Independent Auditor notifies the Company that a Cost Overrun exists or is likely to occur within the next ninety (90) Days, the Independent Auditor may, at any time or from time to time, by giving a notice in writing to the Sponsors, in the form and substance attached hereto as appendix 4, demand the Sponsors to provide funds to the Company equal to the Cost Overrun amount specified in the demand (the **"Cost Overruns Demand Notice"**) in proportion to their respective Commitment Percentage.

Each Cost Overruns Demand Notice shall specify the Cost Overrun amount incurred or likely to be incurred within the next ninety (90) Days. The Independent Auditor has the right to revise a Cost Overruns Demand Notice at any time after issuance where the Independent Auditor is of the view that the Cost Overrun amount as set out in the relevant Cost Overruns Demand Notice would be insufficient. Within seven (7) Days from the date of the Cost Overruns Demand Notice (unless otherwise agreed by the Company and the Independent Auditor), the Sponsors shall be obliged to pay the funds specified in the Cost Overruns Demand Notice to the Company by crediting (as may be applicable) the Class A Equity Subscription Account (PKR) and Class A Equity Subscription Account (USD).

2.2.4 If any Sponsor fails to fund its respective Commitment Percentage of the Cost Overrun, in terms of this Agreement, the Lead Investor shall be liable to fund the same within ten (10) Days of the Cost Overruns Demand Notice, provided that, where the Lead Investor is required to fund the Cost Overruns in terms of this clause 2.2.4, the funding by the Lead Investor shall in no event result in the Lead Developer holding less than ten percent (10%) of the issued and outstanding share capital of the Company as required by clause 7.4.4.2.

2.2.5 If the Lead Investor fails to fund any amount in terms of clause 2.2.4, or the Lead Developer (at any time) holds less than ten percent (10%) of the issued and outstanding share capital of the Company, each such event shall constitute a Company Event of Default.

[15] Insert maximum percentage determined on basis of Proposal, not to exceed 49%

2.2.6 The GoS shall not be required to fund any Cost Overruns.

2.2.7 The Sponsors' obligation to fund the Cost Overruns is in addition to its other obligations under this Agreement.

2.3 Equity Subscription for Mobilisation Activities

2.3.1 Each Sponsor undertakes and agrees to provide all funding required to undertake the Mobilisation Activities. Any such funding by the Sponsors shall, subject to verification and confirmation by the Independent Appointees in terms of clause 3.1.2, be treated as Sponsor Pre-Funded Equity Amount and adjusted from the Approved Sponsor First Funding Amount in accordance with clause 3.1.2. The Sponsors' obligation to fund the Mobilisation Activities is in addition to its other obligations under this Agreement.

2.3.2 In the event the Concession Agreement is terminated prior to the Scheduled Commencement Date, the GoS shall make payment for the actual cost (as certified by the Independent Appointees) incurred in respect of any Mobilisation Activities, which under no circumstances shall exceed United States Dollars Five Hundred Thousand only (USD 500,000/-).

2.3.3 The GoS shall make payment under clause 2.3.2 to the Company, on or prior to the date falling ninety (90) Days from the Termination Date.

2.4 Commitment to Fund Performance Security Cost

2.4.1 Each Sponsor undertakes and agrees to fund all costs, expenses, fees and other charges of any nature, in each case, associated with the issuance, maintenance and encashment of the Performance Securities in proportion to its Commitment Percentage (**"Performance Security Cost"**).

2.4.2 If any Sponsor fails to fund its respective Commitment Percentage of the Performance Security Cost, in terms of this Agreement, the Lead Investor shall be liable to fund the same within ten (10) Days of the date such amount is payable.

2.4.3 If the Lead Investor fails to fund any amount in terms of clause 2.4.2, such event shall constitute a Company Event of Default.

2.4.4 The GoS shall not be required to fund any Performance Security Cost.

2.4.5 The Sponsors' obligation to fund the Performance Security Cost is in addition to its other obligations under this Agreement.

2.5 Review and Approval of Proposed Budget

2.5.1 Within ten (10) Days of the Mobilisation Date, the Company shall prepare, and submit to the Independent Auditor (with a copy (being certified by the Company to be true and correct) simultaneously provided to each of the Parties and the Independent Engineer) for its approval, a budget based on the Base Case Financial Model:

2.5.1.1 setting out the projected amount of the Non-EPC Expenditures to be incurred by the Company in each quarter during the Funding Period (the **"Proposed Non-EPC Budget"**); and

2.5.1.2 setting out the EPC Advance Payment and EPC Payments payable to the EPC Contractor upon completion of an Approved EPC Milestone during the Funding Period (the **"Proposed EPC Budget"**),

(collectively clauses 2.5.1.1 and 2.5.1.2 referred to as the **"Proposed Budget"**).

2.5.2 Within thirty (30) Days of receipt, the Independent Auditor and the GoS shall review the Proposed Budget, and the Independent Auditor (following consultation with the GoS and the Independent Engineer), shall either:

2.5.2.1 approve the Proposed Budget comprising of the:

(a) Proposed Non-EPC Budget; and

(b) Proposed EPC Budget; or

2.5.2.2 reject the Proposed Budget and convey their comments / observations (if any) to the Company, provided, that, the Independent Auditor may only refuse to approve the Proposed Budget (or any part thereof) if the same:

(a) causes an increase in the Initial Project Cost; and

(b) increases the total amounts allocated in the Base Case Financial Model for any Expenditures.

2.5.3 The Company shall (at its own cost and expense) re-submit the revised Proposed Budget no later than five (5) Days from receipt of the rejection, comments or observations under clause 2.5.2.2, and the approval process under this clause 2.5 shall be repeated until all comments and observations are addressed and the Proposed Budget has been approved.

2.5.4 The Company shall propose a revision to the Approved Budget to account for any changes to the Financial Model, any Cost Overruns or any change that may be required to accelerate the progress of the C&O Activities in which case the approval process under this clause 2.5 shall be repeated, provided that, notwithstanding any changes to the Financial Model or the Approved Budget, the GoS' obligation to fund the Approved GoS Funding Amount shall not exceed the GoS Equity Amount.

2.5.5 All Operating Costs incurred by the Company prior to the Project Commercial Operations Date shall be funded by the Company through the Service Payments, the Sponsors or the Financing Parties in terms of the Financing Documents by directly crediting a separate account (other than a Project Account) established by the Company for this purpose (the **"Operating Account"**). The obligation of the Sponsors to fund the Operating Costs shall be in addition to their other obligations under this Agreement.

2.5.6 The GoS shall not be required to fund any Operating Costs.

3. FUNDING MECHANISM

3.1 First Funding Notice

3.1.1 The Company shall be entitled to issue the First Funding Notice to each of the Funding Parties upon satisfaction of each of the following conditions:

3.1.1.1 the Company has established the Project Accounts with the Account Bank, as confirmed and acknowledged by the Account Bank;

3.1.1.2 issuance of the Commencement Certificate and achievement of Commencement Date under the Concession Agreement;

3.1.1.3 the GoS has established the GoS Equity Account with the GoS Account Bank and has delivered the GoS Equity Account Standing Instructions to the same, as confirmed and acknowledged by the GoS Account Bank;

3.1.1.4 the GoS has credited funds in the GoS Equity Account in cash in Pakistani Rupees in an amount equal to the GoS Equity Amount, as confirmed by the GoS Account Bank; and

3.1.1.5 the Company has procured the approval of the Proposed Budget in accordance with clause 2.5.

3.1.2 The First Funding Notice shall be accompanied by a certificate of the Independent Appointees certifying the following (as set out in the First Funding Notice):

3.1.2.1 the Approved Sponsor First Funding Amount;

3.1.2.2 the Approved GoS First Funding Amount; and

3.1.2.3 the Sponsor Pre-Funded Equity Amount.

3.1.3 Additionally, issuance of the First Funding Notice to the GoS shall be subject to receipt by the GoS of the:

3.1.3.1 Independent Auditor's certificate, certifying that:

(a) the Approved Sponsor First Funding Amount stands Funded and that such Funds have been credited to (as may be applicable) the Class A Equity Subscription Account (PKR) and Class A Equity Subscription Account (USD);

(b) that there is no subsisting Company Event of Default as confirmed in writing by the Company; and

(c) any Cost Overruns have been funded in terms of clause 2.2.

3.1.3.2 in respect of funding of EPC Payments only, a certificate, each, from the Independent Engineer and the Independent Auditor, verifying and certifying:

(a) the Approved EPC Milestone; and

(b) the Approved EPC Payment Amount.

3.1.4 Upon Funding the Approved Sponsor First Funding Amount (less Sponsor Pre-Funded Equity Amount) by the Sponsors, a certificate will be obtained by the Company from the Independent Auditor certifying that the Approved Sponsor First Funding Amount (less Sponsor Pre-Funded Equity Amount) stands Funded and that such Funds have been credited to (as may be applicable) the Class A Equity Subscription Account (PKR) and Class A Equity Subscription Account (USD).

3.1.5 The First Funding Notice shall set out the date (the **"Required First Funding Date"**) by which each Funding Party shall Fund the Approved First Funding Amount, which date shall be:

3.1.5.1 in case of a First Funding Notice issued to the Sponsors, five (5) Business Days following the date of receipt by the Sponsor of the First Funding Notice; and

3.1.5.2 in case of a First Funding Notice issued to the GoS, five (5) Business Days following the date of receipt by the GoS Account Bank of the First Funding Notice.

3.1.6 Subject to clause 2.1 and in accordance with this Agreement, each Funding Party, undertakes and agrees to Fund the Approved First Funding Amount (pursuant to the First Funding Notice) on or prior to the Required First Funding Date.

3.2 Subsequent Funding Notice

3.2.1 The Company shall be entitled to issue a Subsequent Funding Notice to each of the Funding Parties upon satisfaction of the following condition:

3.2.1.1 all the conditions for issuance of the First Funding Notice under clause 3.1.1 have been satisfied and are subsisting.

3.2.2 Each Subsequent Funding Notice shall be:

3.2.2.1 approved and certified by the Independent Appointees; and

3.2.2.2 accompanied by the certificates of the Independent Appointees certifying the following (as set out in the Funding Notice):

(a) the Approved GoS Subsequent Funding Amount;

(b) the Approved Sponsor Subsequent Funding Amount; and

(c) the Sponsor Pre-Funded Equity Amount (if applicable).

3.2.3 Additionally, each Subsequent Funding Notice to the GoS shall be accompanied with the:

3.2.3.1 Independent Auditor's certificate, certifying that:

(a) the Approved Sponsor Funding Amount (less Sponsor Pre-Funded Equity Amount) stands Funded and that such Funds have been credited to (as may be applicable) the Class A Equity Subscription Account (PKR) and Class A Equity Subscription Account (USD);

(b) that there is no subsisting Company Event of Default as confirmed in writing by the Company; and

(c) any Cost Overruns have been funded in terms of clause 2.2.

3.2.3.2 in respect of funding of EPC Payments only, a certificate, each, from the Independent Engineer and the Independent Auditor, verifying and certifying:

(a) the Approved EPC Milestone; and

(b) the Approved EPC Payment Amount.

3.2.3.3 the Utilization Statement Certificate issued by the Independent Auditor.

3.2.4 Each Subsequent Funding Notice shall set out the date (the **"Required Subsequent Funding Date"**) by which each Funding Party shall Fund its relevant Approved Subsequent Funding Amount, which date shall be:

3.2.4.1 in case of a Subsequent Funding Notice issued to the Sponsors, five (5) Business Days following the date of receipt by the Sponsors of the Subsequent Funding Notice; and

3.2.4.2 in case of a Subsequent Funding Notice issued to the GoS, five (5) Business Days following the date of receipt by the GoS Account Bank of the Subsequent Funding Notice.

3.2.5 Subject to clause 2.1 and in accordance with this Agreement, each Funding Party, severally, undertakes and agrees to Fund its relevant Approved Subsequent Funding Amount (pursuant to each Subsequent Funding Notice) on or prior to the Required Subsequent Funding Date.

3.3 Adjustment of the Sponsor Pre-Funded Equity Amount

3.3.1 Prior to Funding by the Sponsors, the Approved Sponsor First Funding Amount shall be adjusted to account for funds already pre-funded by the Sponsors as Sponsor Equity in the Company prior to the Required First Funding Date in accordance with the Approved Budget including in respect of Mobilisation Activities (if any) (the **"Sponsor Pre-Funded Equity Amount"**), as determined and certified by the Independent Appointees.

3.3.2 To the extent the Sponsor Pre-Funded Equity Amount is not fully adjusted from the Approved Sponsor First Funding Amount, it shall be adjusted from the succeeding Approved Sponsor Subsequent Funding Amounts (in accordance with clause 3.2) till the Sponsor Pre-Funded Equity Amount has been fully adjusted.

4. UTILIZATION

4.1 Utilization

4.1.1 The Company undertakes and agrees that Utilization shall solely be for the purposes of meeting the relevant Expenditures in accordance with the Approved Budget.

4.2 Preparation, Review and Certification of Utilization Statement

4.2.1 Prior to issuance of each Subsequent Funding Notice under clause 3.2, the Company shall prepare a statement in respect of the preceding Approved Funding Amount:

4.2.1.1 confirming that all Approved Funding Amounts have been Utilized; and

4.2.1.2 disclose with reasonable justification any Approved Funding Amounts that have not been Utilized (**"Unutilised Amounts"**),

(the **"Proposed Utilization Statement"**).

4.2.2 The Company shall submit the Proposed Utilization Statement to the Independent Auditor (with a copy (being certified by the Company to be true and correct) simultaneously provided to each of the Parties) for its review and certification.

4.2.3 Within five (5) Days of receipt, the Independent Auditor shall review the Proposed Utilization Statement in respect of the preceding Approved Funding Amount and shall either:

4.2.3.1 approve the Proposed Utilization Statement and certify, *inter alia*, that:

(a) preceding Approved Funding Amount has been Utilized by the Company for Expenditures in accordance with the Approved Budget; and

(b) reasonable justification has been provided for any Unutilized Amounts,

(the **"Utilization Statement Certificate"**); or

4.2.3.2 reject the Proposed Utilization Statement, provided that, the Independent Auditor may only refuse to approve the Proposed Utilization Statement (or any part thereof) if:

(a) the preceding Approved Funding Amount has not been Utilized by the Company for Expenditures in accordance with the Approved Budget; or

(b) reasonable justification has not been provided for any Unutilized Amounts (the **"Rejected Amounts"**).

4.2.4 The Company shall (at its own cost and expense) re-submit the revised Proposed Utilization Statement no later than five (5) Days from receipt of the rejection, and the approval process under this clause 4.2 shall be repeated until the Proposed Utilization Statement is in form and substance acceptable to the Independent Auditor and Utilization Statement Certificate has been issued.

4.2.5 The Company shall provide the Independent Auditor with all relevant information required by the Independent Auditor for its review and certification under this clause 4.2.

4.2.6 The Approved Funding Amount set out in any Subsequent Funding Notice shall not be reduced by the Unutilized Amounts and such Unutilized Amounts shall remain available in the designated Company account to meet relevant Expenditures. Any Rejected Amounts shall be reduced from the Approved GoS Funding Amount set out in any Subsequent Funding Notice and any resulting shortfall shall be considered as a Cost Overrun to be funded by the Sponsors in accordance with clause 2.2.

5. PROJECT ACCOUNTS AND ACCOUNT BANK

5.1 Project Accounts Establishment and Opening

5.1.1 It is a condition precedent to the issuance of each Funding Notice that the Company open and maintain each of the Project Accounts at the Designated Branch within five (5) Days of the EFU Effective Date.

5.2 Class A Equity Subscription Account

5.2.1 All contributions of: (a) the Sponsor Funding Amount in respect of Class A Shares and Sponsor Loans (to be Utilized in accordance with the Approved Budget); and (b) Cost Overruns (as specified in the Cost Overruns Demand Notice) shall, in the first instance, be deposited in (as may be applicable) the Class A Equity Subscription Account (PKR) and Class A Equity Subscription Account (USD).

5.3 Class B Equity Subscription Account

5.3.1 All subscriptions by the GoS to the Class B Shares shall be deposited in the Class B Equity Subscription Account from the GoS Equity Account in accordance with the GoS Equity Account Standing Instructions, to be Utilized in accordance with the Approved Budget.

5.4 Profit

5.4.1 The Project Accounts shall each bear profit / mark-up in the currency in which the account is denominated at such rate as may from time to time be agreed between the Company and the Account Bank, such profit / mark-up to be credited to such account at such time or times as may be agreed from time to time between the Company and the Account Bank (the **"Project Account Profits"**). All Project Account Profits shall be utilized for the purposes of the Project.

5.5 No Overdraft

5.5.1 The Company shall not be entitled to request that any withdrawal be made from the Project Accounts if such withdrawal would cause such Project Account to become overdrawn. To the extent that any withdrawal would, if made in full, cause any Project Account to become overdrawn, such withdrawal shall be made up to such an amount which would not result in that Project Account becoming overdrawn.

5.6 No Other Accounts

5.6.1 The Company hereby agrees and undertakes that other than the Project Accounts, the Company shall not open or maintain any bank, deposit, savings or other account or sub-account except:

5.6.1.1 the Operating Account;

5.6.1.2 as otherwise permitted by the GoS; and

5.6.1.3 as may be permitted by the Financing Documents.

5.7 Bank Charges

5.7.1 The Company shall pay to the Account Bank such transaction charges and fees (if any) as the Company may from time to time agree with the Account Bank.

5.8 No other Credits or Withdrawal

5.8.1 No payments to, or withdrawals from, any Project Account shall be made except as expressly permitted by this Agreement.

5.9 Account Bank

5.9.1 The Funding Parties agree to appoint the Account Bank to act as the account bank for the purposes of this Agreement.

5.9.2 The Account Bank is not a trustee or fiduciary of the Parties in connection with this Agreement. Neither is the Account Bank an agent or trustee for the Company or any of the other Parties. The nature of the Account Bank's role shall be mechanical and

administrative and to strictly act in accordance with, in respect of the Project Accounts, the Project Accounts Standing Instructions.

5.9.3 The Account Bank shall be entitled to (without any further obligation on the Account Bank to make any verifications, certifications or inspections) rely on the Company's confirmations and statements contained in the Funding Notice for purposes of satisfying itself that the relevant conditions precedent have been fulfilled. Further, the Account Bank's responsibility and liability in respect of maintenance and operation of the Project Accounts in accordance with this Agreement shall be limited to the Account Bank acting strictly in accordance with the Project Accounts' Standing Instructions.

5.9.4 Any Party may, without liability to disclose or account, engage in any kind of financial, trust or commercial business with the Account Bank and its associates and affiliates.

6. GOS EQUITY ACCOUNT AND GOS EQUITY ACCOUNT STANDING INSTRUCTIONS

6.1 The GoS Equity Account

6.1.1 The GoS hereby agrees and undertakes to the other Parties to:

6.1.1.1 establish and maintain the GoS Equity Account with the GoS Account Bank and credit the same with funds in an amount up to the GoS Equity Amount; and

6.1.1.2 issue the GoS Equity Account Standing Instructions to the GoS Account Bank,

in each case of clauses 6.1.1.1 and 6.1.1.2 above, in accordance with the Concession Agreement and this Agreement.

6.1.2 Until the GoS Account Instructions Revocation Date, all amounts credited to the GoS Equity Account shall be utilized for the purposes of Funding by the GoS of the Approved GoS Funding Amount from time to time following issuance of a Funding Notice and for any withdrawals permitted under clause 6.2.6.

6.2 GoS Equity Account Standing Instructions

6.2.1 The GoS Equity Account shall be operated and maintained through the GoS Equity Account Standing Instructions.

6.2.2 The GoS Equity Account Standing Instructions shall remain effective, in each case, until the date which is the earlier of (the **"GoS Account Instructions Revocation Date"**):

6.2.2.1 the date on which GoS has satisfied its obligation to the Fund the Approved GoS Funding Amounts in accordance with this Agreement, as certified by the Independent Auditor;

6.2.2.2 the date on which the GoS Equity Account Standing Instructions are revoked pursuant to a notice issued by the GoS to the GoS Account Bank instructing revocation of the GoS Equity Account Standing Instructions (or any part thereof) provided that such notice shall be only effective if the same is also duly signed by the authorized representatives of the Parties; or

6.2.2.3 the Termination Payment Date.

6.2.3 The GoS Equity Account Standing Instructions may be amended at any time pursuant to a notice issued by the GoS to the GoS Account Bank instructing amendment of the GoS Equity Account Standing Instructions (or any part thereof) and the same shall be confirmed and acknowledged by the GoS Account Bank, provided that such notice shall be only effective if the same is also duly signed by the authorized representatives of the Parties.

6.2.4 The GoS shall procure that the GoS Account Bank acts on the GoS Equity Account Standing Instructions from time to time in accordance with the terms thereof.

6.2.5 The GoS shall procure that, through the GoS Equity Account Standing Instructions, the GoS Account Bank (in respect of each Funding Notice issued by the Company to the GoS) debits from time to time the Approved GoS Funding Amount (from the GoS Equity Account) and credits the same to the Class B Equity Subscription Account, in each case, in accordance with clause 3.1 and clause 3.2.

6.2.6 Until the GoS Account Instructions Revocation Date, no withdrawal from the GoS Equity Account may be made by the GoS, except for:

6.2.6.1 funding the Approved GoS First Funding Amount pursuant to a First Funding Notice issued to the GoS in accordance with clause 3.1;

6.2.6.2 funding the Approved GoS Subsequent Funding Amount pursuant to a Subsequent Funding Notice issued to the GoS from time to time in accordance with clause 3.2;

6.2.6.3 withdrawal of any profit/mark-up accrued on the GoS Equity Account; and

6.2.6.4 funding any Termination Payments payable to Company under the Concession Agreement.

6.2.7 Subject to clauses 6.2.2 and 6.3, the GoS hereby undertakes that the GoS Equity Account shall be maintained with the GoS Account Bank until such time that the GoS has fully Funded the GoS Equity Amount in accordance with the terms of this Agreement.

6.3 GoS Account Bank

6.3.1 The GoS hereby agrees to appoint the GoS account bank to act as the GoS Account Bank for the purposes of this Agreement.

6.3.2 The GoS Account Bank is not a trustee or fiduciary of the Parties in connection with this Agreement. Neither is the GoS Account Bank an agent or trustee for the Company or any of the other Parties. The nature of the GoS Account Bank's role shall be mechanical and administrative and to strictly act in accordance with, in respect of the GoS Equity Account and the GoS Equity Account Standing Instructions.

6.3.3 The GoS Account Bank shall be entitled to (without any further obligation on the GoS Account Bank to make any verifications, certifications or inspections) rely on the Company's confirmations and statements contained in the Funding Notice for purposes of satisfying itself that the relevant conditions precedent have been fulfilled. Further, the GoS Account Bank's responsibility and liability in respect of maintenance and operation of the GoS Equity Account in accordance with this Agreement shall be limited to the GoS Account Bank acting strictly in accordance with the GoS Equity Account Standing Instructions.

6.3.4 Any Party may, without liability to disclose or account, engage in any kind of financial, trust or commercial business with the GoS Account Bank and its associates and affiliates.

7. CLASS A AND CLASS B SHARES AND RELATED MATTERS

7.1 Class A Shares & Class B Shares

7.1.1 Upon Funding of the Approved GoS Funding Amount by the GoS from time to time in accordance with this Agreement, the Class B Shares shall be issued by the Company in accordance with the Laws in the name of GoS or its nominee(s) and the GoS shall be entitled to Class B Dividends in respect of such Class B Shares.

7.1.2 Upon Funding by the Sponsors of their respective proportion of the Sponsor Funding Amounts, from time to time, in accordance with this Agreement, the Company shall issue Class A Shares in accordance with the Laws.

7.1.3 The Company shall not (and each of the Sponsors agrees to procure that the Company shall not) create any classes of shares in the Company other than Class A Shares and Class B Shares without approval of the GoS.

7.1.4 The Company shall not (and each of the Sponsors agrees to procure that the Company shall not) offer for subscription Class B Shares to any person other than the GoS or its nominee(s), save as otherwise provided in this Agreement.

7.1.5 The Company shall not (and each of the Sponsors agrees to procure that the Company shall not) offer for subscription Class A Shares to any person other than the Sponsors, save as otherwise provided in this Agreement.

7.2 GoS Board Observers

7.2.1 Upon Funding of the Approved GoS First Funding Amounts by the GoS, and subject to compliance with any Legal Requirements, the GoS shall be entitled to nominate two (2) board observers on the board of directors of the Company.

7.3 Transfer of Shareholding by GoS

7.3.1 The GoS acknowledges and confirms that it shall not transfer its Class B Shares during the Concession Period except transfer to any affiliated department or body owned or controlled by the Government of Sindh, subject to the applicable Legal Requirements.

7.4 Transfer Restrictions

7.4.1 Subject to clauses 7.5 and 7.4.2:

7.4.1.1 up to (and including) the second (2nd) anniversary of the Project Commercial Operations Date, no Sponsor shall transfer its shareholding in the Company unless such transfer is required by operation of Laws and, subject to the Legal Requirements, the Transfer Criteria is complied with;

7.4.1.2 following the second (2nd) anniversary of the Project Commercial Operations Date and subject to compliance with the Transfer Criteria, any Sponsor may transfer its shareholding in the Company (the "**Transferring Sponsor**") without the consent of the GoS, but with prior notice to the GoS, provided that such transfer does not result in the Sponsors (in aggregate) holding less than fifty-one percent (51%) of shareholding in the Company; and

7.4.1.3 following the second (2nd) anniversary of the Project Commercial Operations Date, if any proposed transfer of shareholding by a Transferring Sponsor results in the Sponsors holding (in aggregate) less than fifty-one percent (51%) shareholding in the Company, then the Transferring Sponsors shall be required to:

(a) comply with the Transfer Criteria; and

(b) seek prior approval of GoS.

7.4.2 Where the Transferring Sponsor is the Lead Investor or the Lead Developer, in addition to complying with the Transfer Criteria, the following conditions shall also apply:

7.4.2.1 prior to any transfer (as applicable):

(a) by Lead Investor, the Lead Investor confirms to the GoS in writing, that the proposed transferee shall at minimum acquire twenty-six percent (26%) of the Class A Shares; and

(b) by the Lead Developer, the Lead Developer confirms to the GoS in writing, that the proposed transferee shall at minimum acquire ten percent (10%) of the Class A Shares; and

7.4.2.2 in the sole opinion of the GoS, the proposed transferee referred to in clause 7.4.2.1, at minimum meets the qualification criteria on the basis of which a

Lead Developer or the Lead Investor (as applicable) can be qualified for the Project at the prequalification stage.

7.4.3 For the purpose of clauses 7.4, 7.5 and 7.7, the term "transfer" shall mean any issuance, sale, transfer, conveyance, disposal or any event, transaction, arrangement, Encumbrance or agreement of any nature that results in or may result in: (a) the issuance of any Class A Share to any Person; (b) the transfer of direct and/or indirect, legal and/or beneficial ownership of any shares, or securities convertible into shares, that causes or may cause the sale, transfer, conveyance or disposal of the Sponsor's legal and/or beneficial ownership, direct or indirect, in the total (or any part thereof) paid up and outstanding Class A Shares of the Company; or (c) the Sponsor's losing the power to direct the management, policies and decisions, in each case, of the Company.

7.4.4 Prior to the Final Expiry Date:

7.4.4.1 the Lead Investor shall hold at least twenty-six percent (26%) of the issued and outstanding share capital of the Company; and

7.4.4.2 the Lead Developer shall hold at least ten percent (10%) of the issued and outstanding share capital of the Company;

failure to comply with this clause 7.4.4 shall constitute a Company Event of Default.

7.5 Other Transfer Restrictions

7.5.1 In addition to the restrictions set out in clause 7.4, any proposed transfer of Class A Shares, shall be subject to the following restrictions:

7.5.1.1 the proposed transfer of Class A Shares, as applicable, must comply with the Legal Requirements;

7.5.1.2 the proposed transfer of Class A Shares must be in accordance with the terms of this Agreement;

7.5.1.3 the GoS (through Independent Appointees) has confirmed that it has completed its "know your customer" review to its satisfaction (acting reasonably and without unreasonable delay) and that the proposed transferee is acceptable to it (in its sole discretion) on reputational or similar grounds, taking into account without limitation, such transferee's environmental and social track record, links to terrorism, political affiliations and conflicts of interest;

7.5.1.4 no default is continuing or will or would result from the transferee becoming a party to this Agreement; and

7.5.1.5 the Company and the Sponsor have delivered certificates to the Independent Appointees certifying, as applicable, that each of the relevant foregoing conditions has been satisfied.

7.5.2 Each Sponsor shall cause the Company to, and the Company shall, refuse to recognize any purported transfer of Class A Shares in violation of this clause 7.5, or record or register any such transfer of Class A Shares. Any transfer made in breach of this clause 7.5 shall be null and void.

7.5.3 Subject to clause 7.7, notwithstanding any transfer of Class A Shares pursuant to this clause 7.5 or otherwise, each remaining Sponsor shall remain fully liable for all its obligations under this Agreement.

7.6 Undertakings

7.6.1 No later than ninety (90) days after the execution of this Agreement, the restrictions imposed under clauses 7.4 and 7.5 shall be recorded in the Constitutional Documents (so as to effectively constitute restrictions thereunder) of the Company and noted on all share certificates (if any) in respect of Class A Shares issued by the Company to the Sponsors.

7.7 Procedure for Transfer

7.7.1 On the date of any transfer of any Class A Shares, the Transferring Sponsor shall procure that the New Sponsor shall become a party to this Agreement, and be bound as if it were a Sponsor, by entering into a Deed of Accession which must be duly executed and delivered by the New Sponsor together with copies, certified by (in the case of a New Sponsor that is not an individual) a duly authorized officer of such New Sponsor or (in the case of a New Sponsor that is an individual) such New Sponsor, of:

7.7.1.1 (in the case of a New Sponsor that is not an individual) the New Sponsor's constitutional documents or (in the case of a New Sponsor that is an individual) his/her passport and other personal identification as required by the Company;

7.7.1.2 (in the case of a New Sponsor that is not an individual) a board resolution or other appropriate authorization authorizing the New Sponsor's execution of the Deed of Accession;

7.7.1.3 a legal opinion (in form and substance and from a counsel satisfactory to the Company) in respect of the laws of the jurisdiction of (in the case of a New Sponsor that is not an individual) incorporation or (in the case of a New Sponsor that is an individual) domicile of the New Sponsor as to (a) to (d) below (as applicable) confirming (as to the New Sponsor) that:

(a) the New Sponsor has the capacity to enter into the Deed of Accession (and any other documentation required to be signed by the New Sponsor in connection with such transfer);

(b) the New Sponsor's signatory (or signatories), if any, have been duly authorized;

(c) (in the case of a New Sponsor that is not an individual) such documentation required to be entered into by the New Sponsor has been duly executed in accordance with the New Sponsor's constitutional documents;

(d) such documentation required to be entered into by the New Sponsor has been duly executed in accordance with all applicable laws in its jurisdiction of (in the case of a New Sponsor that is not an individual) incorporation or (in the case of a New Sponsor that is an individual) domicile; and

(e) the obligations of the New Sponsor created pursuant to the documentation entered into by it are legally valid and binding on, and enforceable against, the New Sponsor (subject to any customary legal reservations or qualifications);

7.7.1.4 (in the case of a New Sponsor that is not an individual) the latest accounts of the New Sponsor, audited (if audited accounts have been prepared) or unaudited (if audited accounts have not been prepared) prepared in accordance with generally accepted accounting principles in the jurisdiction of its incorporation; and

7.7.1.5 (in the case of a New Sponsor that is an individual) a net worth statement for such New Sponsor for the most recent tax year in the jurisdiction of his/her domicile prepared in accordance with generally accepted accounting principles in the jurisdiction of his/her domicile audited by the Auditor (or such other firm of independent accountants of recognized international standing approved by the Company).

7.7.2 Subject to the satisfaction of the conditions in clause 7.4 and clause 7.7, the Company, the Sponsors and the New Sponsor shall enter into a Deed of Accession and deliver the documents referred to in clause 7.7.1.1.

7.7.3 Upon any transfer permitted by this clause 7.7, the Transferring Sponsor shall be released from its obligations under this Agreement to the extent such obligations are assumed by a New Sponsor.

7.8 Public Listing of the Company

7.8.1 The Company may make necessary plans and arrangements to publicly list itself on the stock market so that the shares of the Company are available to general public as an investment option, with the prior written approval of the GoS and the Independent Auditor.

7.9 Manner of Payments

7.9.1 On each date on which any sum is to be Funded by a Funding Party under this Agreement, such Funding Party shall pay that sum before 5:30 p.m. Pakistan Standard

Time on that date by payment in Pakistani Rupees or United States Dollars (as may be applicable) in immediately available funds by crediting the relevant Funding Account.

7.10 Taxes

7.10.1 All sums payable by each Funding Party under this Agreement shall be paid:

7.10.1.1 free of any restriction or condition;

7.10.1.2 free and clear of and (except to the extent required by Law) without any deduction or withholding on account of any Tax; and

7.10.1.3 without deduction or withholding (except to the extent required by Law) on account of any other amount, whether by way of set-off or otherwise.

7.10.2 If any Funding Party (or any other person) is required by Law to make any deduction or withholding on account of any Tax or other amount as is referred to in clause 7.10 from any sum paid or payable by any Funding Party under this Agreement:

7.10.2.1 such Funding Party shall notify the Company of any such requirement or any change in any such requirement as soon as it becomes aware of it;

7.10.2.2 such Funding Party shall pay any such Tax or other amount before the date on which penalties attach thereto;

7.10.2.3 the sum payable by the Funding Party in respect of which the relevant deduction, withholding or payment is required shall be increased to the extent necessary to ensure that, after the making of that deduction, withholding or payment, the Company receives on the due date and retains (free from any liability in respect of any such deduction, withholding or payment) a net sum equal to what it would have received and so retained had no such deduction withholding or payment been required or made; and

7.10.2.4 within three (3) Days after paying any sum from which it is required by law to make any deduction or withholding, and within three (3) Days after the due date of payment of any Tax or other amount which it is required by clause 7.10.2.2 above to pay, such Funding Party shall deliver to the Company evidence satisfactory to the Company of such deduction, withholding or payment and of the remittance thereof to the relevant taxing or other authority.

7.11 Non-Business Day

7.11.1 Any payment hereunder which would otherwise fall due on a day which is not a Business Day shall instead fall due on the immediately preceding Business Day.

8. REPRESENTATIONS AND WARRANTIES

8.1 Representations & Warranties by the GoS

8.1.1 The GoS hereby represents and warrants to the Sponsors and the Company that:

8.1.1.1 it has the power and the authority to execute, deliver and perform this Agreement and has complied in all material respects with all legal requirements in connection thereto;

8.1.1.2 it is legally authorized and all necessary actions have been taken to authorize it to execute and deliver this Agreement and perform the transactions contemplated to be performed by the GoS herein; and

8.1.1.3 all authorizations, approvals, consents, licences and permissions from any Competent Authority (including any regulatory authority) which are necessary to have been obtained at the time these warranties are given or repeated, as the case may be, to authorize it to execute and deliver, and perform in accordance with the respective terms its obligations under this Agreement are in existence (with all applicable conditions thereunder having been complied with) and have not expired on the date on which this warranty is given or repeated, as the case may be, have been duly obtained at such time and are in full force and effect.

8.2 Representations & Warranties by the Sponsors and the Company

8.2.1 Each Sponsor(s) and the Company hereby severally represent and warrant to the GoS that:

8.2.1.1 in case of the Company, it is a company duly incorporated and validly existing under the laws of Pakistan;

8.2.1.2 in case of the Sponsors, it is a company, firm or any corporate body, duly incorporated or registered in the country of origin and validly existing under the laws of its country of origin;

8.2.1.3 in case of the Company, its constitutive documents (such as certificate of incorporation, memorandum and articles of association or equivalent thereof) authorize, and all necessary corporate or other action has been taken to authorize, it to own its assets, carry on its businesses, and execute and deliver this Agreement and perform the transactions contemplated to be performed by it therein in accordance with its terms;

8.2.1.4 in case of the Sponsors, its constitutive documents (such as certificate of incorporation, memorandum and articles of association or equivalent thereof) authorize, and all necessary corporate or other action has been taken to authorize, it to own its assets, carry on its businesses, and execute and

deliver this Agreement and perform the transactions contemplated to be performed by it therein in accordance with its terms;

8.2.1.5 it has the power and the authority to carry on its business and to own its properties and assets and to execute, deliver and perform this Agreement and has complied in all material respects with all legal requirements relative to its business;

8.2.1.6 it has the capacity to sue or be sued in its own name;

8.2.1.7 all authorizations, approvals, consents, licences and permissions from any Competent Authority (including any regulatory authority) which are necessary to have been obtained at the time these warranties are given or repeated, as the case may be, to authorize it to execute and deliver, and perform in accordance with their respective terms its obligations under this Agreement are in existence (with all applicable conditions thereunder having been complied with) and have not expired on the date on which this warranty is given or repeated, as the case may be, have been duly obtained at such time and are in full force and effect;

8.2.1.8 neither the execution and delivery of this Agreement nor the performance of its obligations hereunder, nor the consummation of any of the transactions contemplated therein did or will:

(a) contravene or constitute a default under any provision contained in any agreement, instrument, law, ordinance, decree, judgment, order, rule, regulations, licence, permit or consent by which it or any of its assets is bound or affected; or

(b) cause any limitation on it or the powers of its directors, whether imposed by or contained in its constitutive documents or in any agreement, instrument, law ordinance, decree, judgment, order, rule, regulation, licence, permit, consent or otherwise, to be exceeded;

8.2.1.9 there has not occurred any contravention of, or default under, any agreement or instrument by which it or any of its assets is bound or affected;

8.2.1.10 no litigation, arbitration or administrative proceeding or claim before or of any court, tribunal, arbitrator or other relevant authority is presently in progress or pending or has been threatened in writing; and

8.2.1.11 it has taken no action and, to the best of its knowledge and belief after making reasonable enquiry, it is not aware of any action or legal process having been taken or commenced for (as applicable) its winding-up, dissolution, administration, liquidation, rehabilitation, insolvency, reorganisation or suspension of payments or for the appointment of a receiver, liquidator, trustee in bankruptcy or similar official in respect of it

or of any or all of its assets or revenues, or the commencement of any analogous process under any Laws.

8.3 Survival and Repetition of Warranties

8.3.1 The warranties contained in clause 8.1 and clause 8.2 are given and made on and as of the EFU Effective Date and shall survive the execution of this Agreement and shall be repeated as of and on:

8.3.1.1 in case of the Sponsors:

(a) on each day that each of the Funding Notice is issued by the Company;

(b) the date on which (as may be applicable) the Class A Equity Subscription Account (PKR) and Class A Equity Subscription Account (USD) is Funded by the Sponsor(s) and / or Lead Investor in accordance with this Agreement;

(c) on each day that the Cost Overruns Demand Notice is issued by the Independent Auditor; and

(d) the date on which the Cost Overrun is funded by the Sponsor(s) and/or Lead Investor in accordance with this Agreement.

8.3.1.2 in case of the GoS:

(a) the date of establishment of the GoS Equity Account and upon funding of the same in accordance with this Agreement;

(b) the date on which funds standing to the credit of the GoS Equity Account are debited in an amount equal to the Approved First Funding Amount pursuant to the First Funding Notice; and

(c) each date on which funds standing to the credit of the GoS Equity Account are debited in amount equal to the Approved GoS Funding Amount pursuant to Funding Notices issued from time to time.

9. COVENANTS

9.1 Positive Covenants

9.1.1 Each Party hereby severally undertakes and covenants with and for the benefit of the other Parties that until complete satisfaction of its obligations under this Agreement it shall:

9.1.1.1 obtain and / or maintain in full force and effect all authorizations, approvals, consents, licences and exemptions necessary and applicable to itself in

connection with this Agreement as and when such authorizations, approvals, consents, licences and exemptions as are required to be obtained in accordance with relevant Law;

9.1.1.2 perform all of its respective obligations under this Agreement;

9.1.1.3 in case of the Company, procure from the Independent Appointees any approval, consent, determination, certificate or other document or decision required or contemplated under this Agreement within the necessary timelines stated herein; and

9.1.1.4 in case of the Company and the Sponsors, take all actions necessary or desirable to preserve its existence and its corporate rights.

9.2 Miscellaneous

9.2.1 Each Party undertakes and covenants with the other Parties to duly perform its obligations under this Agreement and agrees that such obligations shall be specifically enforceable at the instance of the other Parties.

9.2.2 The Company and the Sponsors, each undertakes that the Company shall fulfill and comply with all corporate actions and requirements of the Laws prior to the Company's issuance of the First Funding Notice and the Subsequent Funding Notice to each Funding Party so as to enable each Funding Party to Fund its relevant Approved Funding Amount in accordance with the Company's constitutive documents and the Laws and within the timelines contemplated under this Agreement.

9.2.3 Each Party undertakes to take all actions necessary, including passing requisite shareholders' and board resolutions and making all filings, registrations, notifications and applications required by Laws, to ensure the payment of funds to the Company for purposes of Funding the relevant Approved Funding Amounts by the Funding Parties. Failure to obtain any required approvals or permissions shall not release the Company or any Funding Party from, or otherwise constitute a defence to, the performance by any of them of their respective obligations under this Agreement.

9.2.4 Each of the Sponsors, undertakes to take all actions necessary, including passing requisite shareholders' and board resolutions and making all filings, registrations, notifications and applications required by Laws, to ensure the payment of any Cost Overruns. Failure to obtain any required approvals or permissions shall not release the Sponsors from, or otherwise constitute a defence to, the performance by it of its obligations under this Agreement.

9.2.5 Each Party undertakes to take all actions necessary and perform, or cause to be done and performed, all such further acts and things, and shall execute and deliver all such other agreements, certificates, instruments and documents, as the other Party may reasonably request in order to carry out the intent and accomplish the purposes of this Agreement and the consummation of the transactions contemplated hereby.

10. OBLIGATIONS CONTINUING

10.1 Obligations Continuing

10.1.1 Unless expressly stated otherwise in this Agreement, the respective obligations of the Company and each Funding Party under this Agreement are and shall remain in full force and effect until its termination in accordance with clause 12.

11. TERMINATION

11.1 Termination

11.1.1 This Agreement shall stand terminated on the Final Expiry Date.

12. NOTICE

12.1 Communications

12.1.1 Any written communication or notice pursuant to the terms and conditions of this Agreement shall be in writing and either:

12.1.1.1 delivered personally;

12.1.1.2 sent by certified mail, return receipt requested;

12.1.1.3 sent by a recognized overnight mail or courier service with delivery receipt required; or

12.1.1.4 sent by facsimile transfer or email (emails shall be confirmed by a letter).

12.1.2 All notices to be sent to a Party shall be sent to the address and number set out for such Party in appendix 2 or where the recipient notifies the sender of another address or number, the last address or number so notified to it in writing, provided however that, a notification for change of address or number shall be effective fourteen (14) calendar days after the date of receipt of notification of change.

12.2 Effectiveness of Communications

12.2.1 A Notice or communication shall be deemed to have been made or delivered:

12.2.1.1 in the case of any communication made by letter, when delivered by hand, by recognised courier or by mail (registered return receipt requested) at the address set out in appendix 2;

12.2.1.2 in the case of any communication made by facsimile, when transmitted properly addressed to the facsimile number set out in appendix 2 and the sender has received a sent receipt; and

12.2.1.3 in the case of any communication made by email, when transmitted properly addressed to the email address set out in appendix 2, and the sender has received a sent receipt.

12.3 Language

12.3.1 All communications and documents shall be in English.

13. SUCCESSORS AND ASSIGNS

13.1 Successors, Assigns and Legal Heirs

13.1.1 This Agreement binds and benefits the respective successors and assigns (solely as permitted pursuant to clause 13.3) of the Parties.

13.2 Restriction on Assignment

13.2.1 Subject to clause 13.3, neither Party may assign, transfer, delegate or dispose of its rights or obligations under this Agreement without the prior written consent of the other Parties.

13.3 Permitted Assignment

13.3.1 The restriction set forth in clause 13.2 shall not apply to:

13.3.1.1 liens and Encumbrances arising by operation of law (or by an agreement evidencing the same) in the ordinary course of business of the Project;

13.3.1.2 a charge on the Project Accounts arising or created in the ordinary course of business of the Project and / or as security only for indebtedness to the Financing Party under the Financing Documents;

13.3.1.3 assignment of rights, interest and obligations of the Company and / or the Sponsors, in each case, in favour of the Financing Party (or any representative or security trustee of the same), in accordance with the Financing Documents; and

13.3.1.4 pledge of Class A Shares, as security only for indebtedness to the Financing Party in terms of the Financing Documents (provided, however, any enforcement of such share pledge shall be subject to the share transfer restrictions under clause 7 and shall require prior approval of the GoS for share transfer thereunder which shall not be unreasonably withheld or delayed by the GoS).

14. INDEMNITY

14.1 Indemnity

14.1.1 Each of the Sponsors shall, within four (4) Business Days of demand, on a joint and several basis, indemnify and pay to GoS, or reimburse GoS for any amount paid or payable by it on account of any costs, losses, liabilities and expenses (including legal fees and other advisors' and consultants' fees (including registration fees)) incurred by the GoS in connection with or arising out of any default attributable to that Sponsor including as a result of the failure by the Sponsors (or any of them) to pay any amount payable by the Sponsors hereunder on its due date.

15. PARTIAL INVALIDITY, SEVERABILITY AND AMENDMENT

15.1 Partial Invalidity

15.1.1 The illegality, invalidity or unenforceability of any provision of this Agreement under the law of any jurisdiction shall not affect its legality, validity or enforceability under the law of any other jurisdiction nor the legality, validity or enforceability of any other provision of this Agreement.

15.2 Amendment

15.2.1 This Agreement may only be amended in writing by written agreement of the Parties.

16. GOVERNING LAW AND DISPUTE RESOLUTION

16.1 Governing Law

16.1.1 This Agreement and any non-contractual obligations arising out of or in connection with it shall be governed by and construed in accordance with the Laws.

16.2 Negotiation

16.2.1 The Parties agree to attempt to resolve any Dispute promptly, amicably, and in good faith. Each Party shall designate a representative who shall be entitled to enter into discussions to resolve by amicable agreement any Dispute in connection with this Agreement.

16.2.2 In the event any Party disagrees with any decision of an Independent Appointee, it will be deemed as a Dispute under this Agreement and shall be resolved in accordance with clause 16.

16.3 Public Private Partnership Policy Board

16.3.1 If any Dispute is not finally resolved between the Parties pursuant to clause 16.2 within thirty (30) Days from the date on which a Party receives notice from any of the other Parties that a Dispute exists, then the Parties shall endeavour to settle the dispute in an

amicable manner by mediation administered by an independent and impartial person appointed by the Public Private Partnership Policy Board. If any Dispute is not resolved between the Parties pursuant to this clause 16.3 within sixty (60) Days from the date on which the matter has been referred to the Public Private Partnership Policy Board, then such Dispute shall be settled exclusively and finally in accordance with clause 16.4.

16.4 Arbitration

16.4.1 Each of the Parties unconditionally and irrevocably agrees in respect of a Dispute, which cannot be resolved by the Parties pursuant to clause 16.3:

16.4.1.1 to the submission of such Dispute to binding arbitration governed by the Arbitration Act, 1940 by appointment of a board of arbitrators, consisting of one (1) arbitrator appointed by each disputing Party, and one (1) arbitrator appointed jointly by the arbitrators so selected by the disputing Parties (the **"Arbitrators"**). Any arbitration proceedings commenced pursuant to this clause 16.4.1 shall be referred to as Arbitration (**"Arbitration"**);

16.4.1.2 not to claim any right it may have under the Laws to hinder, obstruct, or nullify the submission of the Dispute to Arbitration; and

16.4.1.3 to accept the Award rendered by the Arbitrators and any judgment entered thereon by a court of competent jurisdiction as final and binding and not to hinder, obstruct or nullify the enforcement or execution of any decision rendered by the Arbitrators or court of competent jurisdiction.

16.4.2 The place of arbitration shall be Karachi, Pakistan.

16.4.3 The language of Arbitration shall be English.

16.4.4 Any decision or award resulting from the Arbitration (**"Award"**) shall be final and binding upon the Parties.

16.4.5 The Parties hereby waive, to the extent permitted under the Laws, any rights to appeal or to review of such Award by any Competent Authority.

16.4.6 The fees and expenses of the Arbitrators and all other expenses relating to Arbitration shall be borne and paid by the respective disputing Parties, unless the Award states otherwise. The Arbitrators may provide in the Award, for reimbursement to a Party, of its costs and expenses in bringing or defending the Arbitration claim, including legal fees and expenses incurred by such Party.

16.4.7 This Agreement and the rights and obligations of the Parties shall remain in full force and effect pending the Award for any Arbitration, which Award, if appropriate, shall determine whether and when any termination shall become effective.

16.5 Exclusive Jurisdiction

16.5.1 No Party shall have the right to, nor shall they, commence or maintain any legal proceedings concerning a Dispute, until the Dispute has been resolved in accordance with clause 16.3 or clause 16.4 and then only to enforce or execute an Award.

16.6 Obligations Continuing

16.6.1 Unless otherwise agreed in writing, the existence of a Dispute shall not relieve any Party from the performance of its obligations under this Agreement not the subject of the Dispute.

16.7 Decision of Independent Appointees

16.7.1 In the event the GoS, the Sponsors or the Company disagree with any decision of the Independent Appointees, then it will be deemed as a Dispute under this Agreement and shall be resolved in accordance with this clause 16.

17. COUNTERPARTS

17.1 This Agreement shall be executed in three (3) counterparts, each of which when executed and delivered shall constitute an original of this Agreement.

APPENDIX 1: PART I – FORM OF FUNDING NOTICE FOR SPONSOR

[ON THE LETTERHEAD OF THE COMPANY]

DATE:……
FUNDING NOTICE NUMBER:……

To,
[*Sponsors*]
..……..
……

CC:
..……..

Re: <u>Funding Notice Issued To Sponsor</u>

Dear Sirs,

1. Please refer to the agreement titled "EQUITY FUNDING & UTILIZATION AGREEMENT" dated …… (the **"Agreement"**) entered into between the Governor of Sindh (through Secretary, Local Government & Housing Town Planning Department, Government of Sindh) (the **"GoS"**); *[insert details]* (the **"Sponsors"**) and *[insert details]* (the **"Company"**). Unless expressly stated otherwise, all capitalized terms used herein shall bear the meaning ascribed thereto in the Agreement.

2. Pursuant to the terms of the Agreement, the Company hereby issues this Funding Notice to the Sponsor in accordance with the Approved Budget. The aggregate amounts to be Funded by each Funding Party, as approved and certified by the Independent Appointees, are set out below in paragraph 3 below.

3. The amounts to be Funded by each Funding Party are set out below:

   (a) **<u>PART OF APPROVED FUNDING AMOUNT TO BE FUNDED BY THE SPONSOR</u>**

   (i) **[Approved Sponsor First Funding Amount**: USD/PKR [●]
   [*or*]

   Approved Sponsor Subsequent Funding Amount: USD/PKR [●]

   A. EPC Payments USD/PKR [●]

   B. Non-EPC Expenditure USD/PKR [●]

   (ii) **[Approved GoS First Funding Amount**: PKR [●] [*or*]

   Approved GoS Subsequent Funding Amount: PKR [●]

   (b) **<u>REQUIRED FUNDING DATE</u>**: [●]

4. We, the Company, hereby confirm:

(a) all conditions to issuance of a Funding Notice as set out in clause [3.1.1 / 3.2.1][16] of the Agreement stand satisfied;

(b) the issuance of this Funding Notice to the Sponsor shall not result in any breach by the Company of the relevant Laws or the constitutive documents;

(c) this Funding Notice has been issued to the Sponsor in compliance with the terms of the Agreement;

(d) that a certificate issued by each of the Independent Appointees has been obtained and appended hereto certifying that the [Approved Sponsor First Funding Amount] [*or*] [the Approved Sponsor Subsequent Funding Amount] (as set out in paragraph 3(a)(i) above) is in accordance with the Approved Budget;

(e) that a certificate issued by each of the Independent Appointees has been obtained and appended hereto certifying that the [Approved GoS First Funding Amount] [*or*] [the Approved GoS Subsequent Funding Amount] (as set out in paragraph 3(a)(ii) above) is in accordance with the Approved Budget; and

(f) any Cost Overruns have been funded in terms of the Cost Overrun Demand Notice.

5. We the Company, hereby further confirm, represent and warrant that a copy of this Funding Notice is simultaneously being issued to the GoS, the Account Bank and the Independent Appointees.

6. The provisions hereof shall *mutatis mutandis* form part of the Agreement, notwithstanding anything to the contrary.

Yours Sincerely,

Signed for and on behalf of

[●]

[16] Delete as applicable depending on First Funding Notice / Subsequent Funding Notice prior to Commencement Date / Subsequent Funding Notice after Commencement Date.

(As the Company)

……..
Name:
Designation:

WITNESSES:

1….....
Name:
Address:
CNIC Number:

2. .....
Name:
Address:
CNIC Number

APPENDIX 1: PART –II - FORM OF FUNDING NOTICE FOR GOS

[ON THE LETTERHEAD OF THE COMPANY]

DATE:……
FUNDING NOTICE NUMBER:……

To,
[*GoS*]
..……..
……

CC:
..……..

Funding Notice Issued to the GoS

Dear Sirs

1. Please refer to the agreement titled "EQUITY FUNDING & UTILIZATION AGREEMENT" dated …… (the **"Agreement"**) entered into between the Governor of Sindh (through Secretary, Local Government & Housing Town Planning Department, Government of Sindh) (the **"GoS"**); *[insert details]* (the **"Sponsor"**) and *[insert details]* (the **Company**). Unless expressly stated otherwise, all capitalized terms used herein shall bear the meaning ascribed thereto in the Agreement.

2. Pursuant to the terms of the Agreement, the Company hereby issues this Funding Notice to the GoS in accordance with the Approved Budget. The aggregate amounts to be Funded by each Funding Party as approved and certified by the Independent Appointees, are set out below in paragraph 3 below.

3. The amounts to be Funded by each Funding Party are set out below:

(a) **PART OF APPROVED FUNDING AMOUNT TO BE FUNDED BY THE GOS**

(i)	**[Approved GoS First Funding Amount**:	PKR [●] *[or]*
	Approved GoS Subsequent Funding Amount:	PKR [●]]
	A. EPC Payments	PKR [●]
	B. Non-EPC Expenditure	PKR [●]
(ii)	**[Approved Sponsor First Funding Amount**: *[or]*	USD/PKR [●]
	Approved Sponsor Subsequent Funding Amount:	USD/PKR [●]]

(b) **REQUIRED FUNDING DATE**:

[●]

4. We, the Company, hereby confirm:

(a) all conditions to issuance of a Funding Notice as set out in clause [3.1.1 / 3.2.1][17] of the Agreement stand satisfied;

(b) the issuance of this Funding Notice to the GoS shall not result in any breach by the Company of the relevant Laws or the constitutive documents;

(c) this Funding Notice has been issued to the GoS in compliance with the terms of the Agreement;

(d) that a certificate issued by each of the Independent Appointees has been obtained and appended hereto certifying that the [Approved GoS First Funding Amount] *[or]* [the Approved GoS Subsequent Funding Amount] (as set out in paragraph 3(a)(i) above) is in accordance with the Approved Budget;

(e) that a certificate of the Independent Auditor has been obtained and annexed hereto that certifies that the [Approved Sponsor First Funding Amount] [or] [Approved Sponsor Subsequent Funding Amount] (as set out in paragraph 3(a)(ii) above) stands Funded and that funds representing the same stand credited to (as may be applicable) the Class A Equity Subscription Account (PKR) and Class A Equity Subscription Account (USD);

(f) any Cost Overruns have been funded in terms of the Cost Overrun Demand Notice; and

(g) there is no subsisting Company Event of Default.

5. We the Company, hereby further confirm, represent and warrant that a copy of this Funding Notice is simultaneously being issued to the Sponsors, the Account Bank, the GoS Account Bank and the Independent Appointees.

6. The provisions hereof shall *mutatis mutandis* form part of the Agreement, notwithstanding anything to the contrary.

Yours Sincerely,

Signed for and on behalf of

[●]

[17] Delete as applicable depending on First Funding Notice / Subsequent Funding Notice.

(As the Company)

……..
Name:
Designation:

WITNESSES:

1.....
Name:
Address:
CNIC Number:

2. .....
Name:
Address:
CNIC Number

APPENDIX 2: NOTICES

GoS:

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

Sponsors:

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

Company:

Address:	[●]
Attention:	[●]
Fax:	[●]
Email	[●]

APPENDIX 3: FORM OF GOS EQUITY ACCOUNT STANDING INSTRUCTIONS

[ON THE LETTERHEAD OF THE GOS]

DATE: [●]
REFERENCE: [●]

TO,
[GoS Account Bank]
..……..
……

CC:
..……..

RE: STANDING INSTRUCTIONS IN RESPECT OF GOS EQUITY ACCOUNT (*as defined below*)

Dear Sir/Madam,

1. GOS EQUITY ACCOUNT & ISSUANCE OF STANDING INSTRUCTIONS NOTICE

1.1 We, [●] (through [●]) (the **"Account Holder"**) refer you, [INSERT BANK NAME] (a banking company established under the laws of Pakistan having its registered office located at [●]) (the **"Account Bank"**) to the following bank account established and maintained in the name of the Account Holder at the Account Bank's branch located at [●]:

(a) Account Number [●], Account Title [●] (the **"GoS Equity Account"**);

AND, We, the Account Holder, hereby issue this notice (the **"Standing Instructions Notice"**) containing the Standing Instructions (*as defined below*) for the maintenance and operation of the GoS Equity Account and for matters relating to the same.

2. DEFINITIONS

2.1 In this Standing Instructions Notice, the following capitalized words shall bear the meaning ascribed to the same as below:

(a) **Account Bank** shall bear the meaning ascribed thereto in Paragraph 1;

(b) **Account Holder** shall bear the meaning ascribed thereto in Paragraph 1;

(c) **Approved GoS Funding Amount** means (as may be applicable) the Approved GoS First Funding Amount and the Approved GoS Subsequent Funding Amount;

(d) **Approved GoS First Funding Amount** means the amount set out in Pakistani Rupees as "*Approved GoS First Funding Amount*" in clause 3(a)(i) of the Funding Notice (GoS), as certified by the Funding Notice (GoS) Certificates;

(e) **Approved GoS Subsequent Funding Amount** means the amount set out in Pakistani Rupees as "*Approved GoS Subsequent Funding Amount*" in clause 3(a)(i) of the Funding Notice (GoS), as certified by the Funding Notice (GoS) Certificates;

(f) **Class B Equity Subscription Account** means the [●] account of the Company denominated in Pakistani Rupees and established and maintained at the Account Bank and bearing account number [●] and titled [●];

(g) **Company** means [●], a company incorporated under the laws of Pakistan, having its registered office located at [●];

(h) **Concession Agreement** means the concession agreement dated [●] between *[insert parties]* in respect of the Project;

(i) **Financial Close Date** means the date on which the definitive agreements entered into between the Company and its Financing Parties in respect of financing of the Project become effective and the Company has immediate access to the financing provided thereunder, as notified by the Account Holder and the Company jointly to the Account Bank in writing;

(j) **Financing Party(ies)** means the financial institutions, banks, funds, trusts or trustees of the holders of debentures or other securities, their successors, and assigns, that extend finance facilities and / or financial accommodation to the Company in respect of its Project, as jointly notified in writing by the Account Holder and the Company to the Account Bank on the Financial Close Date;

(k) **Funding Notice (GoS) Certificates** means each of the following certificates:

(i) the written certificates issued by the Independent Appointees that certifies the matters set out in clause 4(d) of the Funding Notice (GoS); and

(ii) the written certificate issued by the Independent Auditor that certifies the matters set out in clause 4(e) of the Funding Notice (GoS);

(l) **Funding Notice (GoS)** means the written notice, in the form attached hereto as **Annexure A**[18], issued by the Company to the GoS from time to time (with a copy delivered to the Account Bank) that has appended thereto the Funding Notice (GoS) Certificates;

[18] The Form under Schedule A of this EFU Agreement will be attached.

(m) **GoS Equity Account** shall bear the meaning ascribed thereto in Paragraph 1;

(n) **Independent Auditor** means [*insert details*];

(o) **Independent Engineer** means [*insert details*];

(p) **Project** means the designing, building, constructing, testing, commissioning, operating, maintaining, financing, and transferring by the Company of the Karachi Water Canal to be undertaken in public-private partnership mode by the Company in terms of the Concession Agreement;

(q) **Revocation Notice** shall bear the meaning ascribed thereto in Paragraph 5.1;

(r) **Sponsor** means [*insert details*];

(s) **Standing Instructions** means the legally binding, enforceable and irrevocable (subject to Paragraph 5.1 and Paragraph 5.2 below) standing instructions contained in this Standing Instructions Notice for the operation and maintenance of the GoS Equity Account;

(t) **Standing Instructions Notice** shall bear the meaning ascribed thereto in Paragraph 1;

(u) **Termination Payment** means the termination payment payable by GoS to the Company under the Concession Agreement from debiting funds from the GoS Equity Account; and

(v) **Termination Payment Certificate** means the written certificate issued by the Independent Auditor certifying the Termination Payment.

3. INTERPRETATION

3.1 In this Standing Instructions Notice:

(a) Words in this Standing Instructions Notice importing the singular shall include the plural or vice versa.

(b) Save where the contrary is indicated, any reference in this Standing Instructions Notice to:

(i) a Paragraph or an Annexure shall be construed as a reference to a paragraph or an annexure of this Standing Instructions Notice;

(ii) any instrument, memorandum, agreement, contract or document shall be construed as a reference to that instrument, memorandum, agreement, contract or document (together with any recitals or sections thereto) all as amended, varied, restated, novated or supplemented from time to time;

(iii) any person shall be construed so as to include their respective administrators, successors in interest and permitted assigns from time to time;

(iv) a statute, enactment or order shall be construed as a reference to such statute, enactment or order as the same may have been, or may from time to time be, amended or re-enacted and all subsidiary legislation and other instrument made under or deriving validity therefrom;

(v) the singular shall include the plural and vice versa, where appropriate;

(vi) the words '*including*' and '*includes*' and any grammatical variants of those words, will be read as if followed by the words '*without limitation*;'

(vii) a reference to a person shall be construed to include a juridical person;

(viii) a time of day shall be construed as a reference to Pakistan Standard Time; and

(ix) headings in this Standing Instructions Notice are for ease of reference only and shall be ignored in construing this Standing Instructions Notice.

(c) The Annexures appended to this Standing Instructions Notice shall form an integral part of this Standing Instructions Notice.

4. THE INSTRUCTIONS IN RESPECT OF MATTERS RELATING TO THE FUNDING NOTICE (GOS)

4.1 The Account Holder issues the following instructions to the Account Bank and hereby instructs the Account Bank to act as follows:

(a) **THAT,** upon receipt of the Funding Notice (GoS) by the Account Bank from time to time (together with the Funding Notice (GoS) Certificates), the Account Bank shall, within one (1) Business Day of receipt of the Funding Notice (GoS) from time to time (together with the Funding Notice (GoS) Certificates), debit the GoS Equity Account in an amount equal to the Approved GoS Funding Amount and credit the same to the Class B Equity Subscription Account; and

(b) **THAT,** upon receipt of the Termination Payment Certificate by the Account Bank, the Account Bank shall, within one (1) Business Day of receipt of the Termination Payment Certificate, debit the GoS Equity Account in an amount equal to the Termination Payment and credit the same to the Company account designated in the Termination Payment Certificate.

5. REVOCATION AND AMENDMENT OF STANDING INSTRUCTIONS

5.1 The Standing Instructions shall remain effective, in each case, until such date which is the earlier of:

(a) the date on which a written certificate, duly issued by the Independent Auditor, is received by the Account Bank from the Independent Auditor certifying that the Account Holder has fully complied with and has satisfied its funding obligations in respect of its commitments for the Project;

(b) the date on which the Standing Instructions are revoked pursuant a written revocation notice (the **"Revocation Notice"**) duly executed and confirmed by the authorized representatives of each of the Account Holder, the Sponsors and the Company and subsequently duly issued by the Account Holder to the Account Bank instructing revocation of the Standing Instructions;

(c) the date on which the Independent Auditor issues a notice to the Account Bank confirming the Termination Payment Date has occurred under the Concession Agreement.

5.2 The Standing Instructions Notice may be amended pursuant a written notice duly executed and confirmed by the authorized representatives of the Account Holder, the Sponsors and the Company and subsequently duly issued by the Account Holder to the Account Bank instructing amendment to this Standing Instructions Notice.

6. SEVERABILITY

6.1 If for any reason whatsoever any provision of this Standing Instruction Notice is or becomes invalid, illegal or unenforceable or is declared by any court of competent jurisdiction or any other instrumentality to be invalid, illegal or unenforceable, the validity, legality or enforceability of the remaining provisions shall not be affected in any manner, and the Account Bank and the Account Holder will negotiate in good faith with a view to agreeing upon one or more provisions which may be substituted for such invalid, unenforceable or illegal provisions, as nearly as is practicable.

7. GOVERNING LAW & DISPUTE RESOLUTION

7.1 These Standing Instructions Notice shall be governed by and construed in accordance with the laws of Pakistan and the courts of law at Karachi, Pakistan with competent jurisdiction shall entertain all disputes arising hereunder.

APPENDIX 4: FORM OF COST OVERRUNS DEMAND NOTICE

TO,
[THE SPONSORS]

CC: [*INSERT THE NAME OF THE COMPANY*]

COST OVERRUNS DEMAND NOTICE UNDER THE EQUITY FUNDING AND UTILIZATION AGREEMENT DATED [●]

Dear Sir,

1. We, [the Independent Auditor], refer to the Equity Funding and Utilization Agreement dated [●] (the **"Agreement"**). This is the Cost Overruns Demand Notice referred to in the Agreement. Capitalized terms used in this Cost Overruns Demand Notice which are not otherwise defined shall bear the meaning ascribed thereto in the Agreement.

2. Pursuant to the Agreement, we demand, in terms of clause 2.2 (*Commitment to fund Cost Overrun*) of the Agreement, that you immediately, and in any case within seven (07) days from the date of this Cost Overruns Demand Notice, pay to the Company the Cost Overruns in the manner and amount specified in paragraph 3 below.

3. We confirm that:

   (a) the total Cost Overruns amount incurred or likely to be incurred within the next ninety (90) days is:

   USD/PKR [*insert in figures*]/- (United States Dollars/Pakistani Rupees [*insert in words*] only).

   (b) payment of the amount specified in paragraph (a) above must be made to the [Class A Equity Subscription Account (USD)/ Class A Equity Subscription Account (PKR)] .

   (c) payment of the amount specified in paragraph (a) is to be made within seven (07) days from the date of this Cost Overruns Demand Notice.

Yours faithfully,

INDEPENDENT AUDITOR

APPENDIX 5: FORM OF DEED OF ACCESSION

This Deed dated [●] is supplemental to the Equity Funding and Utilization Agreement (the "**EFU Agreement**") between the Sponsors, the Company, and the GoS.

1 Definitions

Words and expressions defined in the EFU Agreement have the same meaning when used in this Deed.

2 Accession of New Sponsor

[●] (the **"New Sponsor"**) agrees for the benefit of each person named in the Schedule to this Deed that with effect on and from the date hereof it will be bound as a Sponsor as if it had originally been a party to the EFU Agreement in that capacity.

3 Representations and Warranties

The New Sponsor makes the representations and warranties set out in clause 7.7 of the EFU Agreement to the Parties on the date of this Deed.

4 Address Details

The address, fax number (and department or officer, if any, for whose attention the communication is to be made) for notices of the New Sponsors for the purposes of clause 13 of the EFU Agreement is:

Address: [●]

Fax Number: [●]

Attention: [●]

5 Governing Law and Service of Process

This Deed and any non-contractual obligations arising out of or in connection with it shall be governed by laws of Pakistan.

[*To be executed as a deed by the New Sponsor, the Sponsor and the Company*].

SCHEDULE

[List of parties to the EFU Agreement, including those who have executed earlier Deeds of Accession.]

SIGNATURE PAGES

IN WITNESS WHEREOF, the Parties, intending to be legally bound, have caused this Agreement to be executed by their duly authorised representatives as of the date first written above.

GOVERNOR OF SINDH, THROUGH THE SECRETARY, LOCAL GOVERNMENT & HOUSING TOWN PLANNING DEPARTMENT, GOVERNMENT OF SINDH

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

.....

Witness signature .....

Witness name (block capitals) .....

THE SPONSOR

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

Witness signature .....

Witness name (block capitals) .....

THE COMPANY

Signature .....

Name (block capitals) .....

Title .....

In the presence of:

Witness signature .....

Witness name (block capitals) .....

Witness signature .....

Witness name (block capitals) .....