Environmental Impact Assessment

November 2012

PAK: Sindh Cities Improvement Investment Program

Prepared by North Sindh Urban Services Corporation Limited for the Asian Development Bank.

North Sindh Urban Services Corporation Limited

ENVIRONMENTAL IMPACT ASSESMENT

OF

INDUS RIVER INTAKE FOR SUKKUR

NOVEMBER 2012

PREPARED BY
RCC CONSULTANTS

ABBREVIATIONS

ADB	Asian Development Bank
CA	Command Area
CITES	Convention on the International Trade in Endangered Species
CMS	Convention on Migratory Species
DNI	Distribution Network Improvement
EARF	Environmental Assessment and Review Framework
EIA	Environmental Impact Assessment
EMP	Environment Management Plan
EO	Environmental Officer
EPA	Environmental Protection Agency
ES	Executive Summary
GoS	Government of Sindh
HSEO	Health Safety Environment Officer
IDR	Indus Dolphin Reserve
IEE	Initial Environmental Examination
IPS	Intake Pumping Station
IR	Involuntary Resettlement
IMC	Independent Monitoring Consultants
IUCN	International Union for Conservation of Nature and Natural Resources
NCS	National Conservation Strategy
NEQS	National Environment Quality Standards
NGO	Non-Government Organisation
NSDWQ	National Standards for Drinking Water Quality
NSUSC	North Sindh Urban Services Corporation
O&M	Operation and Maintenance
PC	Public Consultation
PDSC	Project Design and Supervision Consultants
PDSC	Project Design and Supervision Consultant
PEO	Project Environment Officer
PEPA	Pakistan Environmental Protection Agency
PMD	Pakistan Meteorological Department
RCC	Reinforced Cement Concrete
REA	Rapid Environmental Assessment
ROW	Right of Way
SCIP	Sindh Cities Investment Programme
SEIA	Summary Environmental Impact Assessment
SEPCO	Sukkur Electric Power Company
SPO	Sindh Participatory Organization
SWD	Sindh Wildlife Department
SWM	Solid waste Management
SWPO:	Sindh Wildlife Protection Ordinance
SYWO	Sindh Young Welfare Organization
TA	Technical Assistance
WTP	Water Treatment Plant
WWF	World Wide Fund for Nature

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EXECUTIVE SUMMARY

1. The EIA Study for this proposed raw water intake project at Bukkur Island, Sukkur from river Indus. has been conducted to fulfil the Safeguard Requirements of Asian Development Bank ADB) & Sindh Environmental Protection Agency (SEPA) in perspective of ADB's Environmental Assessment Guidelines and rules and regulations of the Pakistan Environmental Protection Act (1997), Pakistan IEE and EIA Review Regulations (2000) and Pakistan Environmental Assessment Procedures (1997),as per ADB Safeguard Policy and Environmental Assessment Guidelines, EARF and Pakistan IEE and EIA Review Regulations (2000, This Project is categorized as Category-A and therefore requires an EIA. The Project will be implemented under a sector loan agreement between the Government of Sindh (GoS) and the Asian Development Bank (ADB) Tranche –II . North Sindh Urban Services Corporation (NSUSC) Limited is the project proponent and implementation agency. A detail feasibility study was commissioned by NSUSC in 2012 for 8 months under Tranche -1 to design the project based on detail hydraulic and hydrology and detail alternative analysis and environmental assessment and engineering design.

2. River Indus water is the main source of drinking water for the entire Sukkur city, Scarcity of drinking water due to unreliability of water supply at the present intake due to Barrage Operations, Low Indus Flow in the Sukkur Channel feeding existing intake and quality of water at intake due to pollutants loads has adversely impacted the water supply to the entire population specially in the low season flow. The existing arrangement has adversely impacted the community with adverse social and environmental health concerns . The rolong unavailability of water from river Indus for 15 to 20 days during dry season invariably lead to very serious quality of life and human rights aspects of access to drinking water leading to protests by the residents. To meet the desired demand of water Supply for Sukkur residents, This Project has been proposed after detail technical analysis and feasibility keeping in view the sensitivity of the areas being the Indus Dolphin Reserve (IDR)– A Ramsar Site..

3. This Project lies within the pond area created by Sukkur Barrage. The pond area stretches from Sukkur Barrage gate to about 5 km up stream to Lansdowne Bridge. In this pond high water level ,sustainable water flow is available so as to feed several irrigation canals on both banks of the river Indus including drinking water requirement of third largest city of Sindh , Sukkur at right Bank of Indus. The general area of interest for fetching raw water supply for Sukkur city is about 3.5 km long by about I km wide starting around Lansdowne bridge up to end of Sadhu Belo.

4. This water intake Projects is planned within declared Protected Area, namely the Indus Dolphin Reserve (IDR) and is also a Ramsar site.The main components of the proposed project include:

   i. Construction of RCC structure sump chamber (20x10x20 ft) to receive water from near end of right bank. A set of 3x36 inches pipes each about 200 ft length will be hydraulically jacked into river bed horizontally to emerge into free flowing zone at the designated intake point with noise level less then the ambient noise in the surrounding areas in medium flow and non ratting period of Dolphin . The water will flow to pump house through gravity

   ii. Construction of pump house (27x38 ft) at Bukkur Island above the sump chamber. Turbine suctions will be lowered into the sump chamber. The pump house will be constructed on 6 piles.

iii. Construction of Sub-station which will include electric panel room for turbines, transformers and generators on Bukkur Island.

iv. Laying of 3x36 inch diameter pipes below the ground surface of Bukkur Island and river basin. The total length of the pipes will be 1000 ft and the pipelines will be laid 5 ft below the ground surface below scour depth .

v. The project includes sump chamber, pump house, electric panel room and lying of pipelines. The entire length of the pipeline is below the ground surface.

5. Project alternatives have been discussed in this Report with maps and data collected during the feasibility study and also for the EIA like Dolphin counts and Noise Survey. Based on the Existing baseline study of the area and full consultation with primary , secondary and institutional stakeholders , adverse Environmental Impacts have been identified and Mitigation measures have been given in this Report collectively designed and further consented by the WWF and SWD, GoSindh in Public Hearing meeting on 18 Oct 2012 by SEPA .. Details are also provided in (Table ES-1). Environmental Management Plan and Environmental Monitoring Plan with estimated cost has also been provided in this Report. Findings of the Report: Most of the environmental impacts are due to construction work to be carried out in insignificant area (noncore) parts of Indus Dolphin Reserves. The important impacts identified are: potential & low possibility temporary disturbance to Indus Dolphin for two weeks during Jacking time only ; generation of dust and noise from construction activities. All the impacts are insignificancy reversible, temporary and of short term duration towards key receptors i.e Indus Dolphin only during construction period of 2 weeks. In all the duration during the construction and operation the noise level is within the existing ambient noise level due to existing activities in and around the areas of interest.

6. Recommendations: (1) It is recommended in this EIA Study that as these impacts are mostly insignificant, temporary in nature and can be properly avoided or mitigated by following the proposed mitigation measures given in the EMP of this Report. However, precautionary principle is also integrated through strong compliance and effect monitoring of the project through SWD and Independent Environmental Consultant. The mitigation measures includes start of low intensity activity (Pipe Jacking) for Dolphin adjustment/relocation in short duration, no work in breeding time of Dolphin and in medium flood , continuous monitoring during the activity and adjusting the work and schedule to minimise impacts, laying of pipe line during closure or no flow Indus at right Bank no direct pumping from Indus River, restricting construction work, providing sump to collect, and laying of underground pipeline careful alignment of pipelines instead of bridge supported over head pipeline, avoiding cutting of trees and minimizing the construction area. (2) For the Proper Implementation of EMP of this EIA Study, The cost estimated for EMP is included in the cost of bid engineer estimate for Contractor. The cost estimated for the Environmental Monitoring for Indus Dolphin should be placed with the Independent Monitoring Consultant's (IMC).

7. Conclusion: The proposed project will bring about a net-positive long term benefit to 1.8 million population by 2050 in terms of improved water supply to Sukkur and access to Basic Human Right of drinking water. Environmental impacts of the project will be associated mostly with the construction phase. The impacts mainly will be temporary or reversible, phased over a period of time, localised, and manageable.

8. The project will not have any significant impacts on Indus Dolphin, their numbers, location, breeding ground & core habitat. The Impacts on fish, protected ecological and archaeological sites are minimum and temporary of short duration. However, continuous affects and compliance monitoring measures have been recommended to ensure that any unforeseen impacts can be immediately identified and mitigated during the project implementation stage.

9. On the basis of the above, the EIA concludes and recommended that, mitigation measures for all impacts identified in the EIA are properly implemented, no significant, unacceptable changes in the baseline environmental conditions of the project area will occur. The operation of this Project will bring about sustainable water supply for the present and future generations ensuring inter- Intra Generational Equity for Sustainable Development for Sukkur Region without compromising the ecological integrity of the protected area keeping in view Precautionary Principle and EIA tool as a decision making instrument. In the long term positive impact on the socio-economic conditions and well being of the communities will be evident as per Program objectives of Sindh Cities Improvement Investment Program.(SCIP) .

Table ES-1: Summary of Impacts and Mitigation Measures

Issue	Phase	Proposed Mitigation Measure
Air quality deterioration	Construction	▪ Fugitive dust emissions will be minimized by appropriate methods, such as spraying water on soil, where required. ▪ Vehicle speed will be reduced to 15 km/h in dirt patches to avoid excessive dust emissions. ▪ In order to minimize exhaust emissions, generators, construction machinery and vehicles will be kept in good working condition and properly tuned. ▪ Construction camp will be located at Sukkur. No any camp will be established in protected area.
Air quality deterioration	Operation	▪ There will be less Air Quality Detorioration during the operational phase. However generators and turbine will be kept in good condition to avoid any detorioration.
Noise and Vibration	Construction	▪ Pump House will be confined with bufferwall so that noise level could be reduced to below 60dBA at out side pump house ▪ Construction camp will be located at Sukkur outside protected area. ▪ Machinery and equipment (potential noise producers) will be kept in good condition and fitted with mufflers where necessary. ▪ Within the river, the civil works will be done during the period (25th December to 10th January) when the gates of the barrage are opened having low level of water at the work sites with no Blind Dolpin Population in the pipe Right of Way. ▪ The exposure to construction workers to noise will be minimized by use of air plugs and maintaining safe distance from high noise generating sources. ▪ Construction work will be restricted by allowing 6 hrs continuous work at site and the work will start again after 2 hrs interval during the same day. ▪ The pump house will be supported on piles to avoid vibration. ▪ No direct pumping will be carried out from the Indus River. ▪ Sump chamber will be constructed to receive water through gravity from Indus River ▪ Best available techniques will be used to minimize vibration at source.
Noise and Vibration	Operation	▪ noise levels will also be monitored at selected locations to determine effect of noise on aquatic fauna specially on Indus Dolpin in the core area of Pipe Jacking inside river ▪ Buffer wall will reduce the noise outside pump house
Water Use, Quality and Availabity	Construction	▪ Minimize water use by adopting water conservation techniques. ▪ Domestic waste will be disposed off through municipal system at Sukkur. ▪ Precautions will be taken for transportation, storage and handling of fuel and oil, such as storing fuel within

Issue	Phase	Proposed Mitigation Measure
		bunded areas, safe-driving practices during transportation.
Water Use, Quality and Availabity	Operation	▪ Water Quality Will not be effected during the operational stage
Flooding and Water Flow Regime	Construction	▪ Water supply sources will be selected carefully to ensure that the project water requirement does not affect the local community use. ▪ Design will ensure that pumping machinery , system and equipment is above the highest flood level.
Flooding and Water Flow Regime	operation	▪ Design will ensure that pumping machinery , system and equipment is above the highest flood level.
Soil Erosion	Construction	▪ The area covered by the project activities will be kept to a minimum. Movement of construction equipment and vehicles will be restricted to the work areas. ▪ The construction corridor along the pipeline RoW will be properly marked. ▪ Surplus soil will be disposed of in a manner that does not disturb the natural drainage. ▪ The natural drainage pattern will not be disturbed, and will be repaired where damaged. ▪ Top soil along the trench will be stockpiles separately, and will be used as the upper most soil layer during the backfilling of the trench. ▪ Safe driving practices will be observed to minimize soil erosion. Reduced speed limit of will be observed and monitored in the project area, and off-track driving will be strictly disallowed. ▪ Plantation of 2000 native species along the banks of the River Indus and Bukkur Island to avoid soil erosion in affected area.
Soil Erosion	Operation	▪ The area covered by the project activities will be kept to a minimum. Movement of construction equipment and vehicles will be restricted to the work areas. ▪ Plantation of 2000 native species along the banks of the River Indus and Bukkur Island to avoid soil erosion in affected area. ▪ There shall be no soil erosion.
Damage to Vegetation Loss of Habitat Disturbance to Wildlife	Construction	▪ Clearing of vegetation will be kept to a minimum with regeneration and growth on the Bhakar Island on the cleared area with native species . ▪ The cutting of trees will be prohibited. Under unavoidable circumstances any clearing required shall be done with prior approval and be compensated as per rules and regulations of Forest department.Minimum of 2000 new plants will be provided as native species for compensatation and regeneration with one year protection by contractor. ▪ Use of local vegetation/wood as fuel by crew personnel will be prohibited. ▪ Unnecessary land uptake will be minimized. ▪ Noise from construction activities and unnecessary

Issue	Phase	Proposed Mitigation Measure
		movement of vehicles will be minimized by continuous monitoring . ▪ Night work will not be allowed to provide relief to especially nocturnal species. ▪ Effective construction planning and management to ensure that works are completed within time. ▪ Noise from generators and machinery will be minimized using appropriate means (silencers, barriers, etc.) as required. ▪ No refuse or waste will be left lying around work site. Waste disposal will be carried out to ensure no contamination of soil. ▪ No Jacking work will be carried out in the project area during this breeding period (April-May) of Indus Dolphin. ▪ Work within Indus River will be gradually started to give enough time to the aquatic fauna and Indus Dolpin leave the area. ▪ The project implementation unit/Safeguard cell will closely liaise with the sindh wildlife department prior to any construction activity. ▪ IMC &SWD will continouly monitor the actvity of Indus Dolpin during project actvity to adjust the work schedule and intensity .
Damage to Vegetation Loss of Habitat Disturbance to Wildlife	Operation	▪ IMC/NSUSC will continously monitor the actvity of Indus Dolpin during project actvity to adjust the work schedule and intensity for one year ▪ The project implementation unit will closely liaise with the sindh wildlife department prior to any construction activity. ▪ No refuse or waste will be left lying around work site. Waste disposal will be carried out to ensure no contamination of soil. ▪
Potential Disturbance to Indus Dolpin	Construction	▪ Within the river for pipe Laying , the civil works will be done during the period (25th December to 10th January) when the gates of the barrage are opened having low level of water/ no water at the work sites of pipe line avoiding Indus Dolpin disturbences . ▪ Avoiding contamination of the project area due to oil spills or domestic effluents etc in the Project Area. ▪ Project related activities within Indus water at Jacking Point of Intake will start gradually to give time to the Indus Dolpin to leave the area with continuous monitoring and escorting the area. ▪ Ensure Divers and Resuce Team is present all the time in the impact aea of Jacking (during Construction) to avoid any potential catch or disturbence to Indus Dolpin around Jacked Piped arae of 100 meter circle zone ▪ The jacked pipe water intake system will be provided with mesh size (5mm) to avoid aquatic fauna to enter into the sump chamber to avoid catch of Indus Dolpin ▪ Ensure presense of Indegenious divers in 100 meters zone of jack actvity to reflect back any incoming Indus Dolpin with continous monitoring to main river course

Issue	Phase	Proposed Mitigation Measure
		▪ Stop all actvities in case a dolpin enters into 150 meters protective zone of Jacking ▪ Only allow jacking of pipe when the river flow at Sukkur Barrage is recorded above 30,000 cusesc and preferrbaly above 50,000 cusecs ▪ No actvity below 30,000 cusces flow is allowed at Jacking Place at Bhakkar island. ▪ Only Jacking through Hydraulics Jacking is allowed as descriped in EIA
Potential Disturbance to Indus Dolpin	Operation	▪ The work area is non-core area of dolphins, so there will be less impacts on Indus Dolphin Reserve. ▪ During operations the noise will be within the ambient noise as recorded in Baslline to avoid any potential impact to Dolphin
Socioeconomic Impact and Disturbance to Archaeological or Cultural Sites	Construction	▪ No or insignificenty Impact . However, to avoid occurrence of any unforeseen impacts at the implementation stage, construction works will be planned in due consultation with the fishermen communities for Boat Travellers. ▪ The project implementation unit will closely liaise with the archeological department prior to any construction activity near the boundary of Bukkur Island.
Socioeconomic Impact and Disturbance to Archaeological or Cultural Sites	Operation	▪ There shall be no impact as the proposed location of intake works is not even 100ft close to any religious, archealogy or cultural site.

1 INTRODUCTION

1.1 Project Background and Justification

10. Sukkur City is known as historical and economical hub of Sindh province in Pakistan. It is situated along right bank of River Indus at upstream of Sukkur barrage. Indus River water is the main source of drinking for the entire city, Prolong unavailability of water from river Indus during dry season and scarcity of drinking water has badly affected the local communities and invariably lead to very serious protests by the residents.

11. The water supply problem of Sukkur and New Sukkur was identified a long time ago as being unsustainable. The problem exacerbates during periods when the gates of the Sukkur barrage are opened for maintenance for 15 to 20 days in January. During this period the river level drops and there is no water available at water intake point that is currently being used. At this time, the water available close to the right bank becomes highly contaminated due to less dilution and is difficult to treat to meet safe drinking water quality standards. In recent years, to overcome this problem a temporary solution has been found. Water is pumped across from Bukkur Island from the main Indus channel. Refer figure 1-1a which schematic plan of Sukkur and New Sukkur.

12. Water quantities to be exploited for the water supply system with the proposed water intake will not exceed more than 0.01% of the total capacity of the River Indus water source in 50 years minimum flow. These capacities are insignificant when compared to the overall regime of Indus River as a whole.

1.2 Project Objectives

13. The proposed project aims to improve the raw water availability upto year 2050 for treatment and supply of potable water to the Sukkur and New Sukkur Regions

1.3 Project Components

14. The project can be divided into four main components. and are listed below:

i. Construction of RCC structure sump chamber (20x10x20 ft) to receive water from Rohri side of Bukkur Island. A set of 3x36 inches pipes each about 200 ft length will be jacked into river bed horizontally to emerge into free flowing zone at the designated intake point.

ii. Construction of pump house (27x38 ft) at Rohri side of the Bukkur Island above the sump chamber. Turbine suctions will be lowered into the sump chamber. The pump house will be constructed on 6 piles.

iii. Construction Sub-station which will include electric panel room for turbines, transformers and generators.

iv. Laying of 3 nos 36 inch diameter M.S pipes 400 ft length below the ground surface of Bukkur Island and 600 ft length below river bed at a depth of 5 ft.

1.4 Project Proponent

15. The Project will be implemented under a loan agreement between the Government of Sindh (GoS) and the Asian Development Bank (ADB) under proposed tranche -2 . The North Sindh Urban Services Corporation (NSUSC) Limited will be the project proponent and implementing agency.

1.5 Project Location and Area of Influence

16. The Project Area lies within the pond area created by Sukkur Barrage. The pond area stretches from Sukkur Barrage gate to about 5 km up stream to Lansdowne Bridge. In this pond high water level is available

so as to feed several irrigation canals on both banks of the river Indus. The general area of interest for fetching raw water supply for Sukkur city is about 3.5 km long by about I km wide starting around Lansdowne bridge up to end of Sadhu Belo. The key map is shown in Figure 1-1. As per discussions with SWD and WWF the area of influence where the impact is anticipated due to proposed activities is 100 m radius of the proposed pumping station at Bukkur Island and 50 m along the proposed underground pipeline route passing through the right bank of Indus River. The location of the aforementioned wildlife protected area along with the project area and the EIA area of influence is shown in Figure 1-2.

1.6 Indus Dolphin Reserve (IDR) a Declared Protected Area

17. The proposed water intake Projects is planned within the non-core area of a declared Protected Area: the Indus Dolphin Reserve (IDR), which is also a Ramsar site. The IDR was declared as a reserve for protection of Indus Dolphin in 1974 under the Sindh Wildlife Ordinance 1972(notification provided in Annexure-A-2). and was later notified as a Ramsar site. The Indus Dolphin Reserve is one of the prime habitats of Blind Indus Dolphin (Platanista minor) with maximum population left between the Guddu and Sukkur Barrages. The Indus Dolphin Reserve boundaries cover an approximate area of 44,200 ha and are about 175km stretch between the Guddu (upstream from Sukkur) and the Sukkur Barrage. This area covers Jacobabad, Ghotki, Shikarpur and Sukkur Districts. This long stretch is maintained as the Indus Dolphin Reserve by the Sindh Wildlife Department (SWD). See Figure 1-3 for location of Guddu Barrage.

18. The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Government of Pakistan is party to the Ramsar Convention. Under this Convention Pakistan is required to take steps for the conservation of migratory species of wildlife animals and their habitats.

1.7 The Environmental Impact Assessment Study

1.7.1 Need for the Environmental Impact Assessment Study

19. Since the proposed water intake project is located within the IDR boundaries according to ADB's safeguards Policy Statement 2009 (SPS 2009) and the Pakistan Environmental Protection Act (1997), Pak EIA/IEE Regulations 2000 and environmental assessment and review framework (EARF), this project is categorized as Category-A, hence requiring a an Environmental Impact Assessment (EIA). The area where the proposed Intake is located is at about 3km upstream from the sukkur barrage which is the southern most extremity of the 210km long IDR- a non-core area of the reserve. Please see Map 1-3 for the extent of the IDR.

1.7.2 EIA Study Objectives

20. The objectives of the EIA study are:

i. To assess the existing environmental and socioeconomic baseline of the project area

ii. To identify, predict, evaluate and determine the significance of the likely impacts of the proposed project on the natural, biological and human environment of the area.

iii. To propose appropriate mitigation measures to minimize the adverse impacts and same be incorporated in the design of the project.

iv. To Prepare an Environmental Management Plan (EMP) and Environmental Monitoring Plan to provide an implementation mechanism for the mitigation measures identified in this Study.

1.7.3 EIA Study Methodology

21. This EIA Study has been carried out as per the rules and regulations of the Pakistan Environmental Protection Act (1997), Pakistan IEE and EIA Review Regulations (2000), Pakistan Environmental Assessment Procedures (1997), and ADB's SPS 2009. The afore-mentioned were followed as a minimum and various other guidelines were consulted and followed during the course of the study.

22. The EIA study covers the scoping, screening, stakeholder consultation, primary and secondary data collection and analysis, review of alternatives, identification and assessment of impacts, recommendations for mitigation measures, and development of an EMP.

23. Public consultation (PC) was carried out in February 2012, in line with ADB guidelines, Consultations were conducted with local fisher folk, government departments and key environmental NGO's and staff of the NSUSC. The Comments and grievances of all stakeholders have been incorporated in Appendix E and summarized in Section-VII of this EIA Report.

Figure 1-1a: Schematic Plan of Sukkur and New Sukkur

Figure 1-1: Key Map

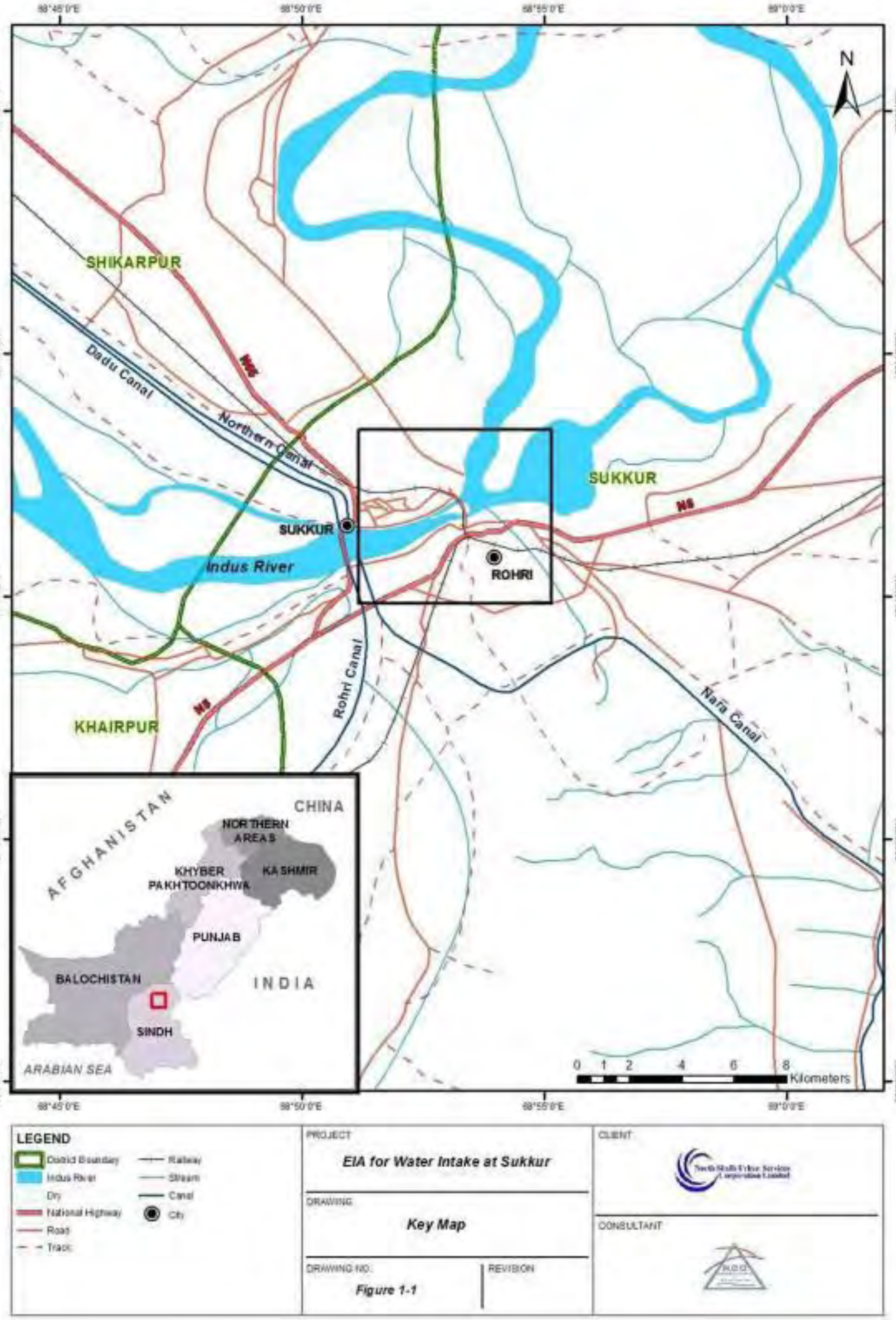


Figure 1-2: Project Area Map

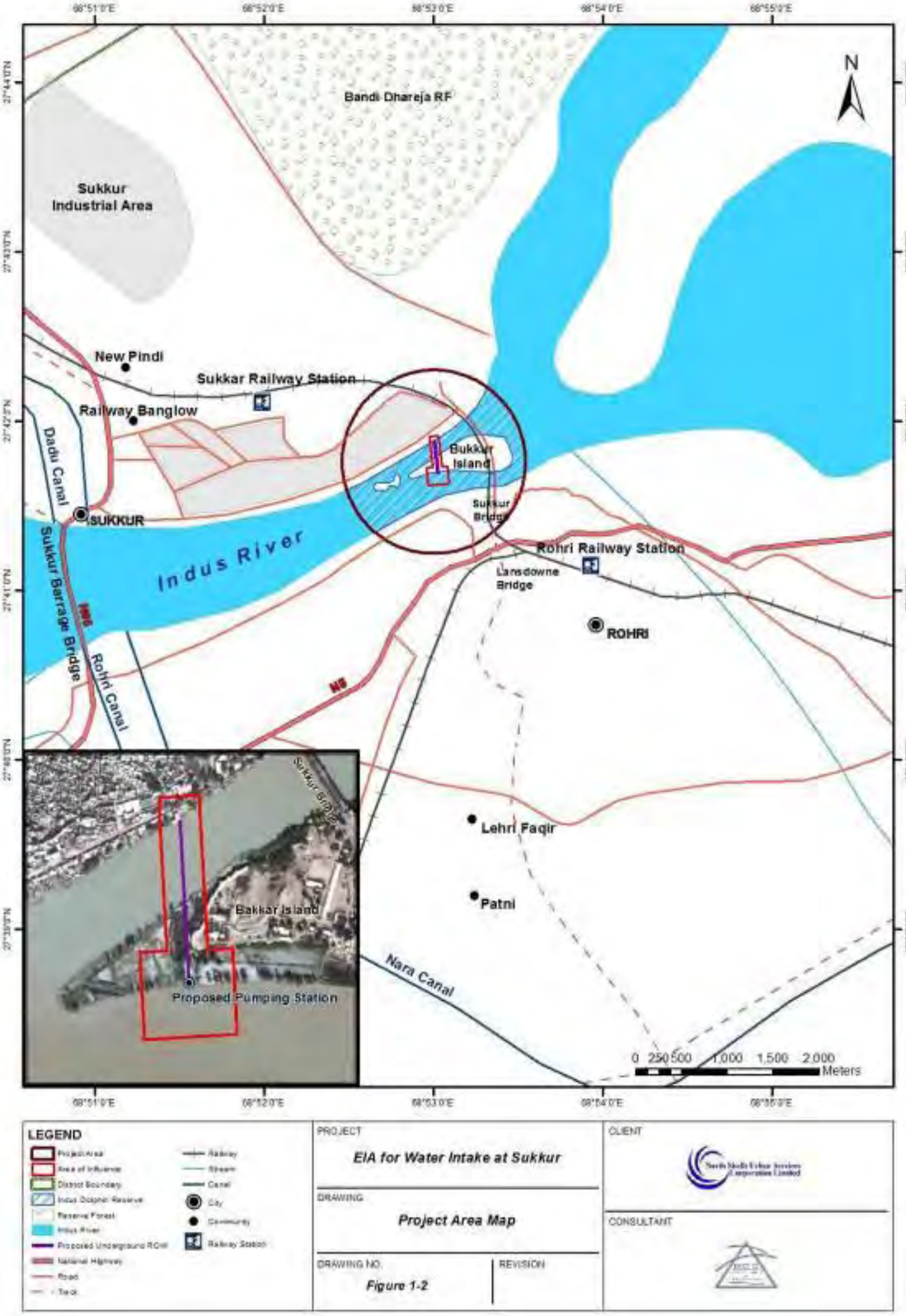


Figure 1-3: Location of Guddu Barrage

2 POLICY, LEGISLATION, AND GUIDELINES

2.1 Legal Framework for EIA

24. This Chapter discusses the policy, legal and administrative framework and institutional set-up relevant to the environmental assessment of the proposed project. These include national environmental Policy, legislation, guidelines, and ADB Environmental Impact Assessment Guidelines 2003 and other guidelines of international donor agencies.

2.1.1 National Environmental policy

25. The National Environmental Policy is the primary policy of Government of Pakistan that addresses the environmental issues of the country. The broad Goal of NEP is, "To protect, conserve and restore Pakistan's environment in order to improve the quality of life of the citizens through sustainable development". The NEP identifies the following set of sectoral and cross-sectoral guidelines to achieve its Goal of sustainable development.

2.1.2 National Conservation Strategy

26. Identifies core areas including conservation of biodiversity; pollution prevention and abatement; soil and water conservation; and preservation of cultural heritage, and recommends immediate attention to these core areas in order to preserve the country's environment.

2.1.3 The Biodiversity Action Plan (BAP)

27. This (BAP) Plan identifies the causes of biodiversity loss in Pakistan and suggests a series of proposals for action to conserve biodiversity in the country.

28. The BAP recognises that an EIA is used as a tool at a project level to identify environmental effects of a proposed project and to plan for reducing adverse effects. The BAP further stipulates that an EIA needs to be initiated at an early stage of project development and that public participation in the review of potential effects is important.

2.1.4 National Environmental Legislation

i. Pakistan Environmental Protection Act 1997

29. The Pakistan Environmental Protection Act, 1997 (PEPA) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. PEPA is broadly applicable to air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. Penalties have been prescribed for those contravening the provisions of the Act. The powers of the federal and provincial Environmental Protection Agencies (EPAs) were also considerably enhanced under this legislation and they have been given the power to conduct inquiries into possible breaches of environmental law either of their own accord, or upon the registration of a complaint.

30. Under section 12 of PEPA, no project involving construction activities or any change in the physical environment can be taken unless an IEE or EIA as required is conducted and a report submitted to the federal or provincial EPAs.

ii. Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000

31. The Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 (the „Regulations'), prepared by the Pak-EPA under the powers conferred upon it by the PEPA, provide the necessary details on the preparation, submission, and review of the initial environmental examination (IEE) and the environmental impact assessment (EIA).

32. The Regulation classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. Schedule I lists projects that may not have significant environmental impacts and therefore require an IEE. Water supply schemes and treatment plants with total cost of Rs. 25 million and above are included in Schedule II. Schedule II lists projects of potentially significant environmental impacts requiring preparation of an EIA. The Regulations also require that all projects located in environmentally sensitive areas require preparation of an EIA.

iii. National Environmental Quality Standards

33. The NEQS were first promulgated in 1993 and were last revised in 2000. The NEQS specify standards for industrial and municipal effluents, gaseous emissions, vehicular emissions and noise levels provided in Appendix B. The PEPA specifies the imposition of a pollution charge in case of non-compliance with the NEQS. Standards for disposal of solid waste have not been promulgated as yet.

34. Pak-EPA has recently published revised permissible limits of various pollutants in ambient air. Revised noise levels in various environments have also been published by Pak-EPA. Furthermore, limits on various parameters for drinking water quality are also introduced by the same.

iv. Sindh Wildlife Protection Ordinance, 1972 and Amendments 2001

35. This ordinance provides for the preservation, protection, and conservation of wildlife by the formation and management of protected areas and prohibition of hunting of wildlife species declared protected under the ordinance.

36. The ordinance also specifies three broad classifications of the protected areas: national parks, wildlife sanctuaries and game reserves. Activities such as hunting and breaking of land for mining are prohibited in national parks, as are removing vegetation or polluting water flowing through the park. Wildlife sanctuaries are areas that have been set aside as undisturbed breeding grounds and cultivation and grazing is prohibited in the demarcated areas. Nobody is allowed to reside in a wildlife sanctuary and entrance for the general public is by special dispensation. However, these restrictions may be

relaxed for scientific purpose or betterment of the respective area on the discretion of the governing authority in exceptional circumstances. Game reserves are designated as areas where hunting or shooting is not allowed except under special permits.

2.1.5 Indus Dolphin Reserve and Irrigation Act

37. IDR is also a Ramsar site. Under Amendment II to the SWPO, NSUSC can undertake the proposed activities within the protected areas, provided approval of the EIA is granted by the regulatory agencies.

v. The Sindh Irrigation Act (1879) and the Canal and Drainage Act (1873)

38. This Sindh Irrigation Act covers the construction, maintenance and regulation of canals for the supply of water and for the levy of rates of water supplied in the Province of Sindh.

vi. The canals and associated irrigation network exists in the project area and provisions of these acts applies to certain activities like water abstraction by project contractors etc. The Forest Act 1927

vii. This act is applicable to all regions of Pakistan. It includes procedures for constituting and managing various types of forests, such as reserved forests and protected forests. The act empowers the provincial forest departments to declare any forest area as reserved or protected and also prohibit the breaking up or clearing of forest for cultivation, grazing, hunting, removing forest produce; quarrying and felling, lopping and topping of trees, branches in reserved and protected forests. Antiquities Act 1975

39. The protection of cultural resources in Pakistan is ensured by the Antiquities Act of 1975. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area which may contain articles of archaeological significance.

40. Three sites of archaeological and historical significance lie within or in close vicinity of the EIA project area. Therefore any damage to sites located in the EIA project area should be avoided during proposed project related activities to protect these archaeological resources.

viii. Pakistan Penal Code (1860)

41. The Pakistan Penal Code (1860) authorises fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use.

2.1.6 ADB Safeguards Policy

42. ADB requires the consideration of environmental issues in all aspects of ADB's operations, and the requirements for Environmental Assessment are described in ADB Safeguard Policy Statement (SPS), 2009. Screening and Categorization. The nature of the environmental

assessment required for a project depends on the significance of its environmental impacts, which are related to the type and location of the project, the sensitivity, scale, nature and magnitude of its potential impacts, and the availability of cost-effective mitigation measures. Projects are screened for their expected environmental impact are assigned to one of the following four categories:

i. Category A. Projects could have significant adverse environmental impacts. An EIA is required to address significant impacts.

ii. Category B. Projects could have some adverse environmental impacts, but of lesser degree or significance than those in category A. An IEE is required to determine whether significant environmental impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report.

iii. Category C. Projects are unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are reviewed.

iv. Category FI. Projects involve a credit line through a financial intermediary or an equity investment in a financial intermediary. The financial intermediary must apply an environmental management system, unless all Projects will result in insignificant impacts.

43. Public Disclosure. ADB will post the EIA report on its website for 120 days prior to board approval so that affected people, other stakeholders, and the general public can provide meaningful inputs into the project design and implementation:

2.1.7 International Treaties and Conventions

44. Pakistan is a signatory to various international treaties and conventions on the conservation of the environment and wildlife protection. The country is thus obliged to adhere to the commitments specified in these treaties.

i. The Convention on Biological Diversity

45. The Convention on Biological Diversity was adopted during the Earth Summit of 1992 at Rio de Janeiro. The Convention requires parties to develop national plans for the conservation and sustainable use of biodiversity, and to integrate these plans into national development programmes and policies. Parties are also required to identify components of biodiversity that are important for conservation, and to develop systems to monitor the use of such components with a view to promoting their sustainable use.

i. The Convention on Conservation of Migratory Species of Wild Animals, 1979

46. The Convention requires countries to take action to avoid endangering migratory species. The term "migratory species" refers to the species of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries.

The parties are also required to promote or co-operate with other countries in matters of research on migratory species.

i. The Convention on Wetlands of International Importance, Ramsar 1971

47. Pakistan is a signatory to the said Convention. The principal obligations of contracting parties to the Convention are:

i. To designate wetlands for the List of Wetlands of International Importance;
ii. To formulate and implement planning so as to promote wise use of wetlands, to make EIA before transformations of wetlands, and to make national wetland inventories;
iii. To establish nature reserves on wetlands and provide adequately for their wardening and through management to increase waterfowl populations on appropriate wetlands;
iv. To train personnel competent in wetland research, management and wardening;
v. To promote conservation of wetlands by combining far-sighted national policies with coordinated international action, to consult with other contracting parties about implementing obligations arising from the Convention, especially about shared wetlands and water system;
vi. To promote wetland conservation concerns with development aid agencies; and
vii. To encourage research and exchange of data.

48. So far 19 sites in Pakistan have been declared as wetlands of International Importance or Ramsar Sites. Indus Dolphin Reserve is also a declared Ramsar site located within the project area.

i. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

49. This convention came into effect on 03 March 1973 in Washington. In all 130 countries are signatory to this convention with Pakistan signing the convention in 1976.

i. International Union for Conservation of Nature and Natural Resources (IUCN) Red List

50. The red list is published by IUCN and includes those species that are under potential threat of extinction. These species have been categorised as:

- Endangered: species that are sent to be facing a very high risk of extinction in the wild in the near future, reduction of 50% or more either in the last 10 years or over the last three generations, survive only in small numbers, or have very small populations.
- Vulnerable in Decline: species that are seen to be facing a risk of extinction in the wild, having apparent reductions of 20% or more in the last 10 years or three generations.
- Vulnerable: species that are seen to be facing a high risk of extinction in the wild, but not necessarily experiencing recent reductions in population size.

- Lower Risk: species that are seen to be facing a risk of extinction that is lesser in extent that for any of the above categories.
- Data Deficient: species that may be at risk of extinction in the wild but at the present time there is insufficient information available to make a firm decision about its status.

i. The Rio Declaration

51. The Rio Declaration comprises twenty seven principles which address such important issues as: sustainable development to integrate environmental protection into the development process; common but differentiated responsibilities to conserve, protect and restore the earth's ecosystems; public participation and information access at the national level; reduce and eliminate unsustainable patterns of production.

3 DESCRIPTION OF THE PROJECT

3.1 Existing System and Related Issues

52. The existing main municipal water supply of Sukkur city and part of New Sukkur is provided through two conventional water treatment plants (WTPs) at Bunder Road WTP and Numaish Gah WTP. The source of raw water supply for these two plants is an intake pumping station (IPS) located on the right bank of the River Indus just across the road from the Bunder road WTP and at a distance of about 3 km from Numaish WTP.

53. The existing intake is located on a right hand channel due to bifurcation of the Indus around an island and this channel has lower flow than the main left hand channel. At present Intake pumping station location contaminations levels fall and rise in prorate to flow of water in Sukkur channel. During High flows contamination levels reduces due to dilution and vice versa. During extremely Low flows (pond levels less than 195.0 ft) water may become unfit to lift for drinking purposes.

54. The Existing intake is not ideally located for several reasons, however, the detail analysis is provided in the Project Alternative Section of EIA based on Feasibility Study :

   i. It is located on the bank of the River Indus and may in extreme conditions be subject to flooding.

   ii. It is located downstream of untreated waste water outfalls which dispose of about one third of the total waste water flow of the city.

   iii. At certain times of the year the level of River Indus falls to a point that river bed dries up completely at the location of existing intake pipes.

   iv. There is a strong probability that in the near future the low water level of Indus will frequently fall below that of the intake pipes, which will result in failure of the municipal water supply.

3.2 Project Objectives and Cost

55. Sindh Cities Investment Program (SCIP) aims to provide the participating towns which reliable, cost-effective, financially sustainable and environmentally sound water supply, sanitation and SWM services. The program will introduce 24/7 water supply to coverage areas in phases, beginning with 6 pilot distribution net work improvement (DNI) zones in 4 towns under Tranche-1.

56. The overall objective of the proposed project is to provide an optimal solution for the raw water intake at Sukkur, since the current intake is inadequate during the dry season. The proposed project's main objective is to get uninterrupted water supply for treatment to supply potable water to Sukkur and New Sukkur towns.

57. The project has the interrelated objective to improve the raw water supply collection for water supply to the main water treatment works of

Sukkur (i.e. Bunder Road WTP and Numaish WTP) serving about 2/3rd of total projected (year 2050) population of 1.8 million particularly at times of low flow in the River Indus.

58. The proposed project will cost around Pak Rs. 290.0 million to provide raw water supply. The proposed pipelines will be able to supply 36 million gallons per day per pipe.

3.3 Environmental Category of the Project

59. Based on the Environmental Assessment and Review Framework (EARF), Rapid Environmental Assessment (REA) checklist was filled up, and concluded that the proposed project is categorized as A project requiring Environmental Impact Assessment report. The REA checklist filled up for the project is provided in Annexure C.

60. Based on Pakistan Environmental Protection Act (1997) and Pakistan IEE and EIA Review Regulations (2000), the project is listed in Schedule II requiring Environmental Impact Assessment report.

3.4 Description of Route

61. The total length of the proposed RoW is 1200 ft. The chainage wise pipeline route along with main observations is as under:

62. 00-200 ft: At the start 3x36 inches diameter pipes will be jacked horizontally from Rohri side bank of Bukkur island below the river bed to emerge at designated depths. The water will be collected in sump at Bukkur island pipes end.

63. 200-600 ft: The proposed route starts from sump chamber on Bukkur Island and travels along the existing RoW to reach near end of Bukkur Island. This section of the route is passing through the Island along Bukkur fort boundary on side and agricultural field on the other.

64. 600-1200 ft: The proposed route passes through the River bed of the Indus River to reach the right bank of the Indus River.

3.5 Project Implementation Schedule

65. The engineering design works of the project is nearing completion and the procurement and construction works is scheduled to commence in the second half of 2012. Commissioning of the project after its completion is expected by the end of 2012. The proposed project is listed in Tranche-2 projects for ADB financing.

3.6 Project Details

66. The proposed project includes:

67. Construction of RCC structure sump chamber (20x10x20 ft) to receive water from far end of the Bukkur Island. A set of 3x36 inches pipes each about 200 ft length will be jacked into river bed horizontally to emerge into free flowing zone at the designated intake point.

68. Construction of pump house (27x38 ft) at Bukkur Island above the sump chamber. The location of the pump house is shown in Photograph 2-4. Turbine suctions will be lowered into the sump chamber. The pump house will be constructed on 6 piles.

69. Construction of Sub-station which will include electric panel room for turbines, transformers and generators on Bukkur Island.

70. Laying of 3x36 inch diameter pipes below the ground surface of Bukkur Island and river basin. The total length of the pipes will be 1000 ft and the pipelines will be laid 5 ft below the ground surface.

71. The project includes sump chamber, pump house, electric panel room and lying of pipelines. The entire length of the pipeline is below the ground surface.

72. Mainly the project is contained within Bakhar Island, except the part as mentioned in para 59 above, which is passing through the River bed.

3.6.1 Design

73. The proposed pipelines have been sized for a capacity of 36 million gallons per day per pipe. The pipelines will be of 36 inch diameter.

3.6.2 Construction

74. NSUSC plans the total construction period 6 months which includes construction sump chamber, pump house, electric panel room and laying of underground pipelines. The pipeline will be constructed during the dry season in the right bank of the Indus River. The construction would be co-ordinated to minimise disruption to Indus Dolphin in the project area.

75. The pipeline will be buried to a depth of cover of 5 ft below the ground level. There will be at least 300-mm clearance in the trench either side of the pipe. The pipe will be strung along the construction RoW that is, welded into a continuous length for each section and then lowered into the trench.

76. Thrust boring shall be used in the initial 200 ft section of the pipeline.

77. The construction contractor will be required to conserve topsoil by removing a layer 100 to 150 mm thick and stockpiling it for reinstatement in a location to minimise any loss due to erosion or mixing with other materials.

3.6.3 Construction Methodology : Hydraulic Pipe Jacking Method (Hyderabad Highway As Reference Example)

78. The pipe jacking is most popular technology to insert pipes below ground without restoring to open cut trenches. Trench less technology is the advanced shape of the pipe jacking method. Pipe jacking is popular to cross the pipes under the highways. Crossing of pipes under river beds with water flowing above can only achieved with pipe jacking. Pipe jacking work consist of advancing series of pipe segments from jacking pit as shown in figure no. 1 below. The pit is generally built with braced sheet pile wall if the depth is more and soil condition is loose. The picture shows arrangement of jacking equipment assembled to insert 48 inches of mild steel pipe under Hyderabad Sindh Bypass highway.

Figure no. 1: Jacking Pit

79. In the jacking pit, a thick reaction wall has to be constructed to allow for thrust and load transfer. This reaction wall is constructed of reinforced cement concrete as shown in figure no. 2 below.

Figure no. 2: Reaction Wall

80. Jacking forces are exerted through hydraulic jack piston which works under Pressure Pump. The pressure pump is filled with oil and this oil is allowed in the hydraulic piston with pressure so that the piston exerts a forward thrust to the pipe. Such arrangement is shown in figure no. 3 below.

Figure no. 3: Work In Progress for Jacking Of Pipe Under Road Embankment At Hyderabad On 29th Nov 2012

81. The spoils are generally extracted and taken out manually by laborers by entering inside the pipe. The soil encountered is sand and boulders. Pipe segments as shown in figure no. 4 are extended one after other until completion of whole pipeline.

Figure no. 4: Jacking Pipe Segments and traffic within 100 feet

3.6.4 Noise Emission from Hydraulic Jacking

82. As given in the table below, at certain distance from jacking operation noise readings taken are between 55–75 dBA. With reference to this study and noise readings taken, it is obvious that readings are at acceptable level and this construction technique is safest available.

Table 3.1: below shows the results of these readings

Noise Source	Location of Point of Measurements	Condition	Result
Highway traffic	At jacking pit about 100 ft away from edge of highway	Jacking work stopped	65 dB
Jacking compressor	At Jacking Pit	Combined with Noise from highway and jacking in operation	75 dB
Jacking compressor	At 100 ft from pit opposite to highway	Combined with Noise from highway and jacking in operation	65 dB
Jacking compressor	At 200 ft from pit opposite to highway	Combined with Noise from highway and jacking in operation	60 dB
Jacking compressor	At 300 ft from pit opposite to highway	Combined with Noise from highway and jacking in operation	55 dB

3.6.5 Testing and commissioning

83. Hydro testing using clean fresh water to 1.1 times the operating pressure will be carried out. Pressure will be monitored over a period of 24 hours every half hour for any decay and if the system integrity is proved the pressure can be let down.

84. The contractor will be responsible for clean up and restoration on completion of the pipeline commissioning. The restoration will include repairing any natural drainage paths if damaged, removing any surplus soil and left over materials.

85. There will be continuous monitoring by wildlife specialist during the construction phase to monitor disturbance to the Indus Dolphin.

3.6.6 Operations and maintenance

86. For the new pipeline the main pump house will be based at far end of the Bukkur Island. The power required for the project during its

operation phase will be 600 KVA and will be provided by Sukkur Electric Power Company (SEPCO). During the occasional breaks in power supply from the utility company diesel generator will be used.

3.6.7 Staffing, Material and Equipment

87. Skilled and un-skilled labour will be procured from within the country. The total workforce is expected is 50 during construction and 15 during operation phase of the project (which can be procured from within the project area). Materials including concrete aggregate and sand will be obtained from quarries in Sukkur/Rohri and from sources along the river Indus, respectively. Steel and cement will be procured from in-country manufacturing units. Fill material will be obtained from excavated earth.

3.6.8 Transportation and Accommodation

88. The transportation of material and machinery will be through the existing network of metalled and un-metalled roads. The transportation using boats will be minimized as much as possible. There is existing road network to the Bukkur island will be used as much as possible. The contractors will establish their own camp at Sukkur during construction. The camp will not be located close to the work area, keeping in view environmental restrictions and requirements.

1. Timing

89. The proposed project operations have to follow strict timing schedules to lessen the impact on wildlife in the Indus River specially Indus Dolphin. Restrictions on the timing of the proposed operations may be necessary if the operations significantly affect the breeding of key wildlife species in the area. The key wildlife species within the project area for EIA include Indus Dolphin. The EIA has recommended measures to minimise the adverse impacts of proposed activities within IDR.

Table 3-1: Projected Water Demand and Supply

Year	Population (Growth Rate 3.38%)	DEMAND	SUPPLY	SOURCES		
		mgd	Total capacity in MGD	River Indus (mgd)	Canals (mgd)	Total (mgd)
2012	534,404	21.38	9	7	2	9
2014	571,139	22.85	12	10	3	13
2020	697,201	27.89	24	18	6	24
2030	972,122	38.88	42	30	12	42
2040	1,355,452	54.22	54	42	12	54
2050	1,889,940	75.60	75	56	18	74

90. Figure 3-3 below shows location of WTPs.

Figure 3-31: Location of WTPs at Sukkur

Figure 3-2 :Project Area Map depicting sites around Proposed Intake

4 DESCRIPTION OF THE ENVIRONMENT

91. This section of the EIA Study covers the Baseline study of the Project area which consists on Physical Environment, Biological Environment including Indus Dolphin Reserve and Socio-Economic Environment.

4.1 Physical Environment

4.1.1 Geology and Soils

92. In the Project area, the rocks belong to Paleozoic, Mezozoic and Terriary geological timescale. A typical lithological representation of the area is shown in Annexure-B.

93. Soils of river plain are generally loamy, clayey and seasonally flooded soils. In some areas of Sukkur salt affected soils are also present. The Rohri hills area is designated as rough mountainous land. These soils found along river i.e loamy and some sandy stratified soils (Torrifluvents and Torripsamments) of recent river plains.

94. Seven soil samples were collected from the project area and tests were conducted for different parameters. The test results are attached at Annexure-C of this report.

4.1.2 Climate and Ambient Air Quality

95. Temperature: The Sukkur District experiences extreme temperatures in summer. The annual average maximum temperature is approximately 340C with mean daily maximum temperatures remaining above 400C in May, June and July. June is the hottest month with highest recorded temperatures reaching up to 500C. Annexure-B shows mean monthly maximum and minimum temperatures of Sukkur respectively. .Daytime minimum temperatures even in winter remain above 220C. Winters are mild and short with mean minimum temperatures not falling below 80C.

96. Annual Rainfall: The area is exceedingly dry with mean annual rainfall averaged over a thirty four year period less than 88mm. The available data indicates that there are two wet seasons: the first with low rainfall in February and March (with mean monthly rainfall of 5.9mm and 4.9mm respectively) and second with higher rainfall in the monsoon period of July, August, and September (with mean monthly rainfall of 44.6mm, 21.3mm and 10.5mm respectively). Approximately 78% of the mean annual rainfall occurs in the two wet seasons with 72% in monsoon. The heaviest recorded rainfall in a given day is 184.5mm in the month of July. The mean monthly rainfall data is graphical represented in Annexure-B.

97. Wind Direction: The wind direction is generally NE (November to April) in winter and SW in summer (May to September). Dust storms are not frequent in the area. Hot winds blow during the months of June and July.

98. Although a comparison of meteorological data between periods 1951-1970[1] and 1971-2004 shows no significant meteorological changes, the pattern of rainfall and the maximum daily temperatures in the area are observed to have changed with lower occurrence of monsoon rains (the drought cycle in

[1] Information on climate provided in the District Gazetteer of Sukkur District

Pakistan is reported to have increased from 3 per year to 4 per year) and exceeds maximum summer daytime temperatures.

99. In the Direct Influence area of the Project there is no industrial or commercial activity is taking place, therefore, the air Quality is relatively good. In general two stroke Rickshaws in the city and Vehicular traffic on the roads causes some dust emissions whose effect is fairly localized.

4.1.3 Noise Baseline

100. Noise emissions baseline has been established through primary data. The noise was monitored for 24 hours in the close vicinity of the project within 1 km Radius. The locations selected were Lansdown bridge, Inside existing Intake Jetty, outside existing intake jetty, near Sadhu Bella, at and away from Bukhur Island, at Sukkur Barrage and at Lansdowne bridge when train crossed. All the results are tabulated and graphically presented as under. Maximum average is 83dB(A) inside pump room and same is 58dB(A) at outside pump house. The table presents that there are many emitters in the same zone in the vicinity, so the proposed project will not have impact beyond baseline results. The proposed project will not worsen the baseline as the pump house outside reading is 58 which is acceptable internationally.

Table: 4.1 Noise Baseline at Various Locations

Location	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	Avg. Reading dB(A)
Time	3:01pm	4.01pm	5.03pm	6.04pm	7.05pm	8.04pm	9.03pm	10.05pm	11.04pm	12.03am	1.05am	2.04am	3.05am	4.02am	5.01am	6.06am	7.06am	8.08am	9.10am	10.11am	11.12am	12.09pm	1.09pm	2.12pm	
At lansdowne Bridge	73.9	74.3	79.8	77.6	71.3	76.4	75.8	75.9	73.2	71.5	69.8	69.2	67.2	61.2	61.4	61.2	63.4	64.4	71.4	71.4	73.2	75.4	75.1	75.8	71.24
Time	3.12pm	4.14pm	5.16pm	6.14pm	7.13pm	8.14pm	9.14pm	10.16pm	11.17pm	12.15am	1.15am	2.16am	3.18am	4.19am	5.17am	6.18am	7.19am	8.15am	9.13am	10.14am	11.15am	12.16am	1.17am	2.18pm	
Inside Jetty Intake	83.2	82.8	81.8	83.8	82.8	82.4	83.8	81.8	81.4	82.5	83.4	81.6	81.7	82.1	82.3	83.6	84.1	81.9	81.8	84.9	85.1	84.5	84.8	84.1	83.01
Time	3.17pm	4.16pm	5.18pm	6.19pm	7.16pm	8.17pm	9.18pm	10.19pm	11.17pm	12.18am	1.19am	2.18am	3.19am	4.18am	5.19am	6.17am	7.20am	8.15am	9.13am	10.16am	11.18am	12.17pm	1.18pm	2.21pm	
Outside Jetty Inake at Bunder Road WTP	59.2	58.7	58.1	58.4	57.9	57.6	58.2	57.8	57.6	57.9	59.1	58.5	58.1	59.1	56.4	59.1	58.4	56.1	59.5	59.7	60.1	60.2	60.9	61.4	58.67
Time	3.30pm	4.31pm	5.33pm	6.32pm	7.30pm	8.32pm	9.33pm	10.31pm	11.32pm	12.33am	1.30am	2.32am	3.33am	4.31am	5.32am	6.33am	7.35am	8.36am	9.39am	10.38am	11.37am	12.36pm	1.36pm	2.33pm	
Near Sadhu Belo	57.3	58.1	59.2	58.7	56.1	57.5	57.9	58.1	58.5	58.9	57.4	57.5	58.1	59.1	54.1	55.1	55.4	55.5	56.1	56.8	56.9	58.1	59.2	59.1	57.45
Time	3.33pm	4.35pm	5.34pm	6.33pm	7.35pm	8.36pm	9.32pm	10.31pm	11.33pm	12.32am	1.31am	2.30am	3.33am	4.35am	5.33am	6.32am	7.33am	8.33am	9.35am	10.38am	11.38am	12.39pm	1.38pm	2.39pm	
Approx. 300m away	58.1	58.2	57.3	57.9	58.4	58.2	58.1	57.6	57.1	58.1	57.5	57.1	56.9	56.1	56.2	57.1	57.5	57.2	57.2	58.9	60.1	60.2	61.2	60.2	58.02

from Jetty Near Bukkur Island																									
Time	3.36pm	4.39pm	5.38pm	6.39pm	7.40pm	8.38pm	9.36pm	10.37pm	11.39pm	12.38am	1.39am	2.40am	3.39am	4.37am	5.38am	6.39am	7.38am	8.98am	9.37am	10.36am	11.38am	12.38pm	1.39pm	2.41pm	
Bukkur Island	58.7	57.3	58.7	58.1	57.1	58.5	57.9	57.6	57.4	58.1	58.4	59.1	57.4	56.1	54.1	55.1	55.4	54.3	56.1	56.5	58.5	59.1	59.2	58.9	57.40
Time	3.40pm	4.44pm	5.45pm	6.48pm	7.45pm	8.48pm	9.47pm	10.48pm	11.47pm	12.45am	1.46am	2.48am	3.46am	4.48am	5.46am	6.48am	7.49am	8.49am	9.45am	10.46am	11.47am	12.44pm	1.43pm	2.46pm	
Approx. 100m	56.2	58.2	57.1	58.1	59.4	57.1	56.1	59.1	56.1	55.9	55.8	55.5	55.1	54.8	54.2	55.8	55.2	56.8	57.1	58.1	58.1	56.1	57.9	58.2	56.75
away from Bukkur Island																									
Time	3.45pm	4.49pm	5.50pm	6.52pm	7.50pm	8.51pm	9.52pm	10.51pm	11.52pm	12.53am	1.49am	2.50am	3.52am	4.51am	5.53am	6.52am	7.53am	8.54am	9.54am	10.55am	11.56am	12.54pm	1.56am	2.56pm	
NSUSC Pumping Station	58.6	53.7	55.7	65.1	62.1	61.8	61.8	60.5	60.1	60.1	60.2	60.2	61.4	61.1	60.5	61.5	61.3	61.5	62.2	62.2	62.1	64.1	64.1	64.2	61.09
Time	3.52pm	4.56pm	5.58pm	6.55pm	7.55pm	8.56pm	9.57pm	10.56pm	11.59pm	12.58am	1.53am	2.52am	3.57am	4.57am	5.58am	6.58am	7.58am	8.58am	9.58am	10.59am	11.59am	12.59pm	1.59pm	2.59pm	
Under Lansdowne Bridge in river	61.8	62.4	63.2	62.5	63.6	64.1	62.5	62.7	63.4	61.4	61.2	60.5	58.2	60.1	59.2	59.1	60.9	62.1	63.1	62.8	62.9	63.8	63.4	64.1	62.04
At Lansdowne Bridge while Passing Train						86.8 dBA, Time 9.54pm																			

Source: RCC Consultants.

24 Hours Noise Levels At Lansdowne Bridge

24 Hours Noise Levels At Inside Jetty Intake

24 Hours Noise Levels At Outside Jetty Intake At Bunder Road WTP

24 Hours Noise Levels At Near Sadhu Bela

24 Hours Noise Levels At Approx. 300m away from Jetty Near Bukkur Island

24 Hours Noise Levels At Bukkur Island

24 Hours Noise Levels At Approx. 100m Away from Bukkur Island

24 Hours Noise Levels At NSUSC Pumping Station

24 Hours Noise Levels At Under Lansdowne Bridge in River

24 Hours Noise Levels At Lansdowne Bridge while Passing Train

24 Hours Noise Levels At Lansdowne Bridge

RCC Consultants

24 Hours Noise Levels At Lansdowne Bridge while Passing Train

RCC Consultants

24 Hours Noise Levels At Inside Jetty Intake

RCC Consultants

24 Hours Noise Levels At Outside Jetty Intake At Bunder Road WTP

RCC Consultants

24 Hours Noise Levels At Near Sadhu Belo

RCC Consultants

24 Hours Noise Levels At Approx. 300m away from Jetty Near Bukkur Island

RCC Consultants

24 Hours Noise Levels At Bukkur Island

RCC Consultants

24 Hours Noise Levels At Approx.100m Away from Bukkur Island

RCC Consultants

24 Hours Noise Levels At NSUSC Pumping Station

RCC Consultants

24 Hours Noise Levels At Under Lansdowne Bridge in River

RCC Consultants

4.1.4 Hydrology

i. Surface Hydrology

101. The major surface water source in the area is the Indus River. The Indus drains an area of about 950,000 km2 generates a mean annual discharge of 6,682 m3/s (236,000 cusecs). The mean annual flood at the Sukkur Barrage is 18,100 m3/s (640,000 cusecs).

102. The hydrograph of the river is strongly seasonal with a long low water season between October and March and a high water season between April and September – driven primarily by snowmelt in the upper catchment and monsoon rainfall. The river usually peaks in mid August or early September. The river carries large sediment loads due to widespread and rapid erosion in its upper catchments. It is estimated that about 1 billion m3 of sediment is deposited in its floodplain each year. As a result of this continuing deposition, the river has developed natural levees along its length.

103. Three barrages Guddu, Sukkur, and Kotri regulate river flows in Sindh. The project area is within the pond area created by Sukkur Barrage. The pond area stretches from Sukkur Barrage gate to about 5 Kilometer up stream up to Lansdowne Bridge. In this pond high water level is maintained so as to feed several irrigation canals on both banks of the river Indus. The general area of interest for fetching water supply for Sukkur city is about 3.5 Kilometer long by about 1 Kilometer wide starting around Lansdowne bridge up to end of Sadhu Belo.

104. Six canals takes off from Sukkur barrage for irrigation purposes. These include Dadu Canal, Nara Canal, Rohri Canal, Rice Canal, N.W Canal and Khirthar Canal. The discharge volumes from 1961 to 2010 recorded at Sukkur barrage in Annexure-B.

105. As soon the barrage gates are fully opened and the canal gates are fully closed the pond level drops. Analysis of last 50 years data indicate that during closure period average pond level drops to 184.0ft. Table 4.2 below gives data analysis report during closure periods from 1961 up to 2011. It is concluded that the total closure days since 1961 to 2011 are 784 averaging 15.86 days closure per year.

ii. Groundwater

106. In Sukkur, Ground water at Numaish Gah and Bunder Road is saline. Drawing of large quantity of water makes ground water more saline. The water table in the area along canals and Indus ranges from 12ft to 20ft with a gradient generally oriented southwards. Groundwater for domestic consumption is abstracted through shallow hand pumps (with motors installed on some). These hand pumps are usually dug to a depth of 20 to 30ft. Water quality is generally sweet, but very few brackish groundwater can also be found randomly during the field survey. Tube wells installed for supplementing canal irrigation are dug to depths of 75ft to 100ft. The groundwater at these depths is mostly sweet. The discharge from these tube wells was judged to be around 0.5 cusecs. The locals reported that these tube wells could be operated for up to 8-10 hours continuously without any drop in discharge or water pressure. The water supply for Sukkur and Rohri cities is also abstracted directly from the Indus.

107. Sweet groundwater is found in the areas along the canal network and River Indus. However a relative decline from previous years was reported by the communities. This has mainly been due to over abstraction through deep tube wells installed for supplementing canal irrigation.

4.1.5 Biological Environment

1. General Ecological Attributes of the Water Intake

108. Habitats: Indus River habitat is an ecologically important area with respect to fauna and flora. The Indus River and its associated marshes on both banks which are usually inundated during the monsoon season are very important as staging and wintering habitat for migratory birds. The main river course is also important for migratory species as it plays an important role for their navigation. The abundance of different invertebrates, including insects and soil biodiversity coupled with different palatable floral species, their grubs are the main source of food for resident and migratory birds.

109. Different plant species were observed from this habitat, at the river banks and Bukkur Island which is land area surrounded with river water. Species that grow in the island include Alhagi maurorum, Desmostachya bipinata, Saccharum spontaneum, Saccharum bengalensis, Salvadora oleoides, Salvadora persica, Tamarix indica, Tamarix aphylla and etc. Some of the submerge species are Typha domingensis, Typha elephantine and Phragmites karka.

110. The migratory species of birds were observed along Indus and marshes on its both sides at the time of survey. However, their concentration was low. Mainly wader species were observed during the field visit.

111. Flora: During field work for the EIA, 34 plant species belonging to 18 families were identified in main habitat within the project area. Annexure-B provides a list of the floral species observed during recent EIA site visit in the major habitat of the project area. The quantitative analysis of floral composition was carried out in calculating, Relative cover, Relative density, Relative frequency and IVI important value index of species. Life forms of the identified species are as follows:

Life form	Number
Grass	5
Herb	9
Tree	14
Shrub	4
Sedge	2

112. List of flora species found in the project area for EIA along with the I.V.I values for the major critical habitat identified by botanist in the main habitat for quadrates measuring 20 x 20 m (Climax community: Trees/Tall shrubs etc) and 2 x 2 m (Underneath flora: tall herbs/sub-shrubs/herbs and grass) is provided in Annexure-B.

113. The species found in the project area which are of importance in terms of medicinal and economical use include Desmostachya bipinnat and Typha elephantina.

114. No endemic or rare floral species exist within the area of influence of the project.

115. Fauna: A variety of techniques were used to establish the presence and distribution of species in the project area. These techniques were incorporated into the sampling plan to account for all types of birds,

mammals, reptiles and fish species. At each sampling site a one-hour plot search was carried out by the survey team members to detect as many species of birds, reptiles and mammals as possible within a circular zone of approximately 250-meter radius. Ground surveys were conducted along banks and island for identification of water birds. This involved walking along the edge of the river bank to select a suitable site for making observations using binoculars and spotting scope. The survey teams ensured that the birds were observed without causing any disturbance. The Blind Indus Dolphin is the most sensitive faunal species found in the project area, the mammal is an endangered species and many efforts are being made for its protection. The Indus dolphin is discussed separately in this chapter. Figure 4-2 shows the sampling locations of wildlife survey conducted during the field visit of the EIA.

116. During field surveys 41 species of birds were recorded from the area (Annexure-B). Abundant species include: bank myna, little green bee-eater, white-cheeked bulbul, crested lark, pied bushchat, common babbler, house crow, common myna and house sparrow.

117. During the field survey, along with resident species a few winter visitors were also recorded viz. black redstart, lesser whitethroat, Common Chiffchaff, Common Sandpiper and yellow wagtail. Out of 41 recorded species, 19 are abundant, 21 are common, 1 less common while no species is rare in Pakistan. Depending upon the degree of threat, 8 (including Cattle Egret, Eurasian Kestrel, Grey Heron, Indian Pond Heron, Large Egret, Little Cormorant, Little Egret and Marsh Harrier) are declared protected under the Sindh Wildlife Ordinance, Long-tailed Grass Warbler is listed in IUCN Red List 2006, 3 (including Eurasian Kestrel, Little Stint and Redshank) are covered in CMS and 6 (including Eurasian Kestrel, Little Stint and Redshank, Eurasian Kestrel, Little Brown Dove, Marsh Harrier and Rose-ringed Parakeet) in CITES Appendices.

118. Mammals: 8 species of mammals were recorded during the field visit. Out of these 8, 4 are common, 3 are less common while 1 is rare. Out of these 8 mammals, one is the Indus dolphin.. Small mammals mainly gerbils, jirds, rats and mice are common as was noticed by their burrow system. These small mammals are a main source of food for raptors and carnivore species and have an important role in the food web. A complete list of the mammalian species observed in the project area is provided in Annexure-B.

119. Reptiles. A total of 9 reptile species including 2 species of fresh-water turtles were recorded from the project area during the field visit of which 5 are common, 4 are less common and none is rare. Comparatively uncommon species include indian cobra which is encountered in riverine and densely vegetative areas. Since the field visit for EIA was conducted during winter season, the number of recorded species of reptiles is quite low. It is expected that more species of reptiles may be recorded after the winter season as most of the reptiles hibernate during winters. A list of reptiles observed during the field visit is provided in Annexure-B. Out of 9 recorded species, Indian Monitor is protected under the Sindh Wildlife Protection Ordinance and 4 (including Indian Cobra, Indian Monitor, Indian Softsheel Turtle and Indian Pound Turtle) are listed on different

Appendices of CITES in view of their importance for international trade.

120. Fish Fauna: During field survey,9 important edible fish species were recorded in the project area. The species include Notopterus chitata (gandan), Labeo rohita (Dambra), Catla catla (Thaila), Cirrhimus mrigala (Morakhi), Osteobrama cotio (Dhambra), Aorichthys aoe (Singharee), Rita rita (Khagga), Wallago attu (Malli) and Bagarius bagarius (Khagga).

121. The family Cyprinidae is the most common family represented by 4 species while the other 28 species are divided among four families in various combinations.

4.1.6 Indus Dolphin Reserve

122. The project area is located within protected area Indus Dolphin Reserve and is habitat for a variety of wildlife. For collection of Relevant data regarding Indus Dolphin, two baseline Surveys are required in seasons of Winter and Summer. Data collected during winter (Feb-2012) and summer (Aug-2012) has been incorporated in this EIA study. in order to accurately assess the behaviour and extent of habitat of these mammals in the project area which can then be used to carry out the impact assessment.

123. According to a recent WWF study conducted in 2012 “Conservation of Indus River Dolphin (Platanista gangetica minor) in the Indus River system, Pakistan: an overview”. The Indus River Dolphin is one of the most threatened obligate freshwater species found only in the Indus River system of Pakistan. According to the population surveys of 2001 and 2006 the population trend was increasing but the recent 2011 population survey, revealed less dolphins numbers compared to 2001 and 2006. The Indus River Dolphin mortality has significantly increased after the devastating flood in 2010, which is the highest mortality rate in a year, this however, is a one time event and this decrease can not be attributed to habitat depletion or any human activity.

124. The extent of the river between the Sukkur and Guddu barrage is shown in Figure 1-2. Due to the sinuosity of the Indus the length of the IDR fluctuates between 175km in dry weather to a maximum of 210km recorded in floods and the rainy season. This tract of river between the Guddu to Sukkur Barrage is a very important reserve and habitat for Indus Dolphin and was declared a protected area in 1974 under the Sindh Wildlife Ordinance, later it was declared a Ramsar site to protect the wetlands formed by the impoundment created by the barrages at Guddu and Sukkur. The stretch of river between the Guddu and Sukkur barrage contains almost 60% of entire population of the river dolphin which is endemic to Pakistan. However, some scientists are of the opinion that Indus dolphin is a sub-species of Ganges dolphin of India. The IDR has an area of 44,200 hectares. The IDR is a protected area of high profile and is continuously monitored by the Sindh Wildlife Department (SWD). In addition, this area is part of a recently launched Pakistan Wetlands Programme which is being implemented jointly by the Federal Ministry of Environment and WWF Pakistan with financial assistance of UNDP/GEF and Royal Netherlands Embassy (RNE) in Islamabad. In

a recent survey (April, 2011) conducted in the IDR the population of Indus Dolphin was estimated to be 1171. According to the survey of SWD and Global Environmental Services, 918 Dolphins including young animals were recorded within limits of the Guddu to Sukkur Barrage. As per Sindh Wildlife Department the total population of Indus Dolphin within the project area is around 40-50.

125. The blind Indus Dolphin (Platanista minor) is probably the most specialized of the world's fresh-water dolphins. Head and body length is 1.75-2.75 meters. Its rostrum is very narrow proximally, 21-30 teeth on each side of jaw. Once it was common in Indus and all its tributaries but now it is confined to the Central Indus. It is a quite social animal and has schools of up to 10 animals. Since the Indus dolphins are blind, they continuously use echo-location technique to locate their prey and other objects. Due to the absence of predators in the river the dolphins move around freely and do not stay in tight groups. Generally river dolphins tend to stay in the deep regimes of the river where there are counter currents available or still water niches in river bed so as to avoid energy consuming upstream swimming, they also forage for their food closer to the river bed.

126. As per observations of different scientists, the Indus dolphins start their courtship in March and early April and most of the births take place during the same period. During the flood season, sometimes, the dolphins are pushed to the canal system from the barrage gates. These stranded dolphins are sometimes killed by the fishermen. Sindh Wildlife Department with the help of WWF Pakistan and Lahore Zoo has started a rescue programme under which these stranded dolphins are captured from canals and released back to Indus River. Because of its declining status, it is listed as "Endangered" in IUCN Red List 2004. Indus dolphin may be seen in Indus waters throughout the project area. However, upstream of Sukkur Barrage is its stronghold.

127. Echo location method in Indus Dolphin: The Indus River dolphin is functionally blind having evolved without a crystalline lens or well-developed light-sensitive organ. A deep fold just above the dolphin's mouth is the remnant of what might once have been eyes down the evolution line. However, this is not a disadvantage but an adaptation to living in the silt-laden turbid waters of the Indus where eyes are virtually useless, as very little light penetrates below the surface of the murky water. Giorgio Pilleri conducted research on two Indus dolphin kept in an aquarium in Switzerland during 1970. He has described the sonar system used by the Indus dolphins to locate any object or fish in turbid waters of Indus (The Secrets of The Blind Dolphins). Indus Dolphins has the ability to produce high-pitched clicks (Indus dolphin can produce ultrasonic frequencies of over 20,000 Hz.

128. While a normal human can hear the audio frequencies in the 20-20,000 Hz. range). These sound pulses are emitted into the water through the 'melon' at the front of the dolphin's head. When these clicks hit an object, some of the sound echoes back to it. By listening to the echo and interpreting the time it took the echo to come back, the dolphin senses the distance of the object. This gives the dolphin some information about the structure and size of the object. By moving its head, the dolphin can get more information on other aspects of the object.

Secondary Source Data (WWF Study 2012 cited above)

Population

129. In 2001, dolphin direct counts obtained from five Indus Dolphin subpopulations were: Jinnah – Chashma (2); Chashma – Taunsa (84); Taunsa – Guddu (259); Guddu – Sukkur (725) and Sukkur – Kotri (18) (Braulik, 2006). The metapopulation was estimated to number approximately 1200.

130. In 2006, a more complex survey method was adopted which generated both direct counts and those corrected for missed individuals. Direct counts recorded in each Indus Dolphin subpopulation were as follows: Jinnah – Chashma (1); Chashma Taunsa (82); Taunsa – Ghazi Ghat (44); Guddu – Sukkur (1,289) and Sehwan – Kotri (4). The corrected estimates for the three largest Indus River Dolphin subpopulations were estimated 101 (CV=44.1%) between Chashma and Taunsa barrages, 52 (CV=14.9%) between Taunsa barrage and Ghazi Ghat, and 1,289 (CV=33.4%) between Guddu and Sukkur barrages. The metapopulation was estimated as 1,550 – 1,750 individuals in 2006 (Braulik et al., 2012).

131. Further research by Researchers of Wild Life Research Institute Faisalabad have concluded that water depth, width of river and the water flow affected the distribution of Dolphin in the River. Based on actual survey it was concluded that river depth below 5 feet is not preferred by the Dolphin, whereas the river depth of 08-17 feet is preferred by Dolphin as per results 88.03% population of Dolphin preferred the depth of 08-17 feet and 80% of dolphin . The mitigation measures proposed for the Jacking is influenced by these research findings. (*Effect of Water Depth and River Width on Indus Dolphin Population Muhammad Akbar , Abdul Aleem Chaudhry and Muhammad Javed Arshed Punjab Wildlife Research Institute, Gatwala, Faisalabad, Pakistan*).

132. The Result of Survey conducted at site giving relationship of depth, width and discharge is given below for each Month based on average of the Study carried out by M/s RCC Consultants for NSUSC in 2012.

S.no	Description	Qty
50 Year Low Flow		
1	Location Opp: Existing Pumping Station	
	Width of Water Between	
	Bukkur Island @ left Bank	670 ft
	Depth of Water	12 ft
50 Year High Flow		
1	Location Opp: Existing Pumping Station	
	Width of Water Between	
	Bukkur Island @ left Bank	1800 ft
	Depth of Water	35 ft

Jack Area Distance 200 ft	Depth of Water in ft	Width of River at location (total) in feet of the River Current	River Discharge average in reference month (Cusec)
Jan	16	720 ft	150,000
Feb	18	800 ft	200000
March	22	910 ft	350000
April –upto Dec	22-31	1200 to 1700 ft	500000 to 950000

PRIMARY SURVEY FOR DOLPHIN OBSERVATIONS

133. Two Observational Surveys were carried out to assess the distribution and number of dolphins in the 200m radius around the point at which the pipe would emerge in the river. One survey was conducted in Feb 2012 over a period of three days and observations were made twice a day –morning and afternoon. Dolphin surfacing frequency was measured and was used to assess the abundance in the area where the project will take place. The detailed survey results are presented in Annexure H. In February very few dolphins were observed, the data showed only 6 daily sightings over the three day period. However, the exact coordinates were not noted but these dolphins were observed in the area closer to the sukkur barrage and downstream from the Lanedowne bridge in deeper waters.

134. The second Observational Survey was carried out from 30th July 2012 to 1st August 2012 for Surfacing of Dolphin by team of RCC Consultants along with the Sindh Wildlife Department members in one Boat for three days. The Observation is the only method for the Survey of Dolphin used in morning and afternoon and was focused on the same 200 meter zone around the point where the jacked pipe would emerge in the river. The detailed results of these observations are presented in Annexure H. Between 12 to 21 dolphin observations were made during this survey and their abundance was plotted on the map below.

135. The plot/map shows that in the area closer to the sukkur barrage a greater number of dolphin can be observed and this trend continues on all three days. Whereas in the area just upstream of Lansdowne bridge a fewer number of dolphin were observed and none were observed on day 1.

136. By looking at these two surveys (summer and winter) it can be seen that in the winter times due to shallower depths available the dolphin stay away from the area, whereas in the summer with greater quantities of water available dolphins are observed to move up and downstream more freely.

137. It can be concluded that the area closer to the bridge is where dolphin abundance is low, and they only travel upstream if they have to forage for food, and that too only is done when there are sufficiently deep waters available.

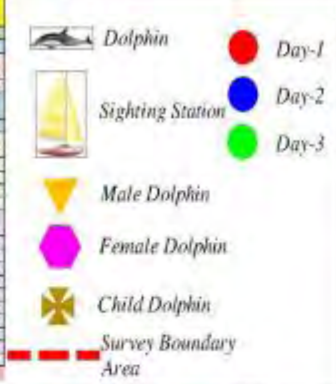
DAY-1			
Date: [illegible]			
S.no	GPS Coordinate	Sex	Timing (Evening)
1	[illegible]	M	[illegible]
2		M	[illegible]
3		M	[illegible]
4		M	[illegible]
5		M	[illegible]
6		M	[illegible]
7		M	[illegible]
8		M	[illegible]
9		M	[illegible]
10		M	[illegible]
11	[illegible]	M	[illegible]
12		M	[illegible]
Total No Dolphin Sighted		12	

DAY-2			
Date: [illegible]			
S.no	GPS Coordinate	Sex	Timing (Morning)
1	[illegible]	M	[illegible]
2		M	[illegible]
3		M	[illegible]
4		M	[illegible]
5		M	[illegible]
6		M	[illegible]
7	[illegible]	M	[illegible]
8		M	[illegible]
9	[illegible]	M	[illegible]
10		M	[illegible]
11	[illegible]	M	[illegible]
12		M	[illegible]
13		M	[illegible]
14		M	[illegible]
15		M	[illegible]
16		M	[illegible]
17		M	[illegible]
18		M	[illegible]
19		M	[illegible]
20		M	[illegible]
21		F	[illegible]
22		F	[illegible]
23		F	[illegible]
24		F	[illegible]
25		C	[illegible]
26		C	[illegible]
27		C	[illegible]
28		C	[illegible]
Total No Dolphin Sighted		28	

DAY-2			
Date: [illegible]			
S.no	GPS Coordinate	Sex	Timing (Evening)
1	[illegible]	M	[illegible]
2		M	[illegible]
3		M	[illegible]
4		M	[illegible]
5		M	[illegible]
6	[illegible]	M	[illegible]
7		M	[illegible]
8	[illegible]	M	[illegible]
9		M	[illegible]
10	[illegible]	M	[illegible]
11		M	[illegible]
12		M	[illegible]
13		M	[illegible]
14		M	[illegible]
15		M	[illegible]
16		M	[illegible]
17		M	[illegible]
18		F	[illegible]
19		F	[illegible]
20		F	[illegible]
21		C	[illegible]
Total No Dolphin Sighted		21	

DAY-3			
Date: [illegible]			
S.no	GPS Coordinate	Sex	Timing (Morning)
1	[illegible]	M	[illegible]
2		M	[illegible]
3	[illegible]	M	[illegible]
4		M	[illegible]
5	[illegible]	M	[illegible]
6		M	[illegible]
7		M	[illegible]
8		M	[illegible]
9		M	[illegible]
10	[illegible]	M	[illegible]
11		M	[illegible]
12		M	[illegible]
13		M	[illegible]
14		M	[illegible]
15		M	[illegible]
16		M	[illegible]
17		M	[illegible]
18		F	[illegible]
19		C	[illegible]
Total No Dolphin Sighted		19	

DAY-3			
Date: [illegible]			
S.no	GPS Coordinate	Sex	Timing (Evening)
1	[illegible]	M	[illegible]
2		M	[illegible]
3	[illegible]	M	[illegible]
4		M	[illegible]
5	[illegible]	M	[illegible]
6		M	[illegible]
7		M	[illegible]
8		M	[illegible]
9		M	[illegible]
10	[illegible]	M	[illegible]
11		M	[illegible]
12		M	[illegible]
13		M	[illegible]
14		M	[illegible]
15		M	[illegible]
16		M	[illegible]
17		M	[illegible]
18		M	[illegible]
19		F	[illegible]
20		C	[illegible]
Total No Dolphin Sighted		20	



Drawing Title:-

RIVER INDUS DOLPHIN SIGHTING SURVEY RESULTS

Funded By:- Asian Development Bank

Client:- North Sindh Urban Services Corporation Limited

Consultants:- RCC Consultants

DATE	REVISION	Designed: RCC CONSULTANTS	Scale:- N.T.S
		Drawn: TANVEER AHMED	Drawing No: 001
		Checked: S.M.L	JOB NO.

4.2 Socioeconomic Environment

138. The project area lies within Bukkur Island and right bank of the Indus River (figure 4-1 shows location of Bukkur Island). The pond area of River Indus get divided into two channels (Sukkur and Rohri channels) by an Island called Bukkur named as such by pious saint Syed Muhammad Makili in 7th Century of Hijra (13th Century AD). The Island is a limestone rock, oval in shape. At present it is occupied by Army Public School, Rangers Offices. Sadhu Bela is part of this Island but presently separated by short stretch of river. The distance of Bukkur island from the Sukkur Barrage is about 3900m. The population on the island is about 100 persons but day visitors could be as high as 400 persons. The access to the island is by boat & by land over bridge. Small scale agricultural activities are practiced within the Bukkur Island while the rest of the area is within Indus River. Fishing activity is also practiced in Indus River. Since the project is not likely to affect any community secondary data is used to compile this section. The fisherman community during the field survey consulted and their concerns recorded.

Figure 4-1: Location of Bukkur Island

139. Fishing within the project area is practiced between Sukkur and Guddu Barrage. Fishing rights at the Barrage are licensed by fisheries department for Rs. 100 every year. Fishing at the Sukkur Barrage has no national significance; fish catch from the area is minimal and is only enough for the local markets.

140. About 200 households are dependent on fishing activity between Sukkur and Guddu barrage. Most of these people belong to the Mirbahar/Mallah. The average earning is ranges between Rs. 700 to 800 per day.

4.2.1 Culture and Archaeology

141. Sukkur is rich with cultural monuments and archaeological sites. The land of Sukkur has seen many phases and the remains of all those people, who inhabited this land and contributed their spice to its culture, are spread all over the country. Figure 4-2 shows the locations of the archaeological sites within the vicinity of the project area. A photographic record of these sites is presented at the end of this chapter as Annexure

A-1. There are many prominent and known archaeological sites and monuments in within the vicinity of the project area include:

i. Bukkur Fort entire area, including walls and Tomb of Hazarat Sadruddin.

ii. Near Lansdowne Bridge "Sat Bahan Astan" is located. A small graveyard from 15th to 17th century has beautifully decorated tombs with blue Glazed tiles.

iii. "Sadhu Belo" a Hindu Pilgrimage area on the main island in river Indus along Sukkur City, this was the asthan (Places) of a Sadhu known as Bankhandi (Forest wonderer) in 1823.

5 PROJECT ALTERNATIVES ANALYSIS

142. The Purpose of this section is to provide an analysis of the various available options for a sustainable long term water intake system for the city of Sukkur. This analysis looks at all technically viable options from an environmentally sustainable perspective, the results of the technically feasible options have then been compared with the Ecologically Sustainable Development (ESD) Framework Analysis for Project (*Harding, R (ed) 1998, Environmental Decision Making : The role of scientist, engineer and the Public pp 27-29ESD framework*).

143. The technical feasibility of the options considered here has been examined in detail in a study that was conducted over a period of 10 months by Ms RCC Consultants under Tranche 1. The study was titled: "Optimal approaches review and feasibility study on water availability at Sukkur intake" (ADB loan 2499-Pak), Annexure I and Annexure J. The study was conducted over several volumes; two of the most relevant have been annexed with the EIA: Alternatives Technical Analysis and Alternatives Cost Analysis; and the Hydrological and Hydro geological Investigation report. These studies looked at the technical feasibility of the options and collected data for following key components:

- 50 years data at Indus for water level and discharges at Sukkur Barrage
- River bed bathymetric survey in project areas
- Projected data for high and low floods at various locations
- Water quality of surface water in Indus
- Ground Water Survey analysis
- Alternative analysis and technical evaluation of options
- Proposed best suitable technical and environmental option for Raw Water Intake

144. After studying the data on available options and the environmental aspects associated with each the project alternative analysis was carried out:

5.1 No New Project Option

145. The option of "No Water supply from the River Indus" for the city of Sukkur's growing needs is not a sustainable option as economic and social development cannot be sustained with the available source of water and will create serious social unrest and uncertainty in the society with irreversible social impacts. Furthermore, the current set up has serious water quality issues, and the quality of water supplied to the city deteriorates to a great extent during low flow months. Hence, if the current source of intake remains the same the city will drinking water quality and availability issues for the projected 1.8 Million population of Sukkur who depended on the present water intake. During months of low flow in the Indus, or when the barrage gates are open a temporary system is put into place where a pipe is laid in the dry river bed on the right bifurcation of the river known as the Sukkur Channel of the river, and a channel is dug across the Bukkur island and water is then pumped across from the left bifurcation channel (known as the Rohri Channel) of

the river through the dug channel to the pipe running across the Sukkur Channel.

146. In order to fulofill the city's water needs the existing intake on the right bank at Bunder Road Intake Phase-1 has been drawing water from the Sukkur Channel of the IDR since 1935. when the population was few thousand. The option to continue with this arrangement is not feasible due to following reasons:

- The water quality at the Sukkur channel as per survey conducted is highly contaminated with abundance of fecal coliform and e-coli due to upstream sewerage discharge from the 7 waste water disposal stations as well as entry of untreated effluent of upstream population along the right bank of Indus.
- The water availability is unreliable and not available during closure of the Sukkur Barrage in winter creating serious water shortages. Figure no. 1 shows dry part of river bed during barrage closure periods.

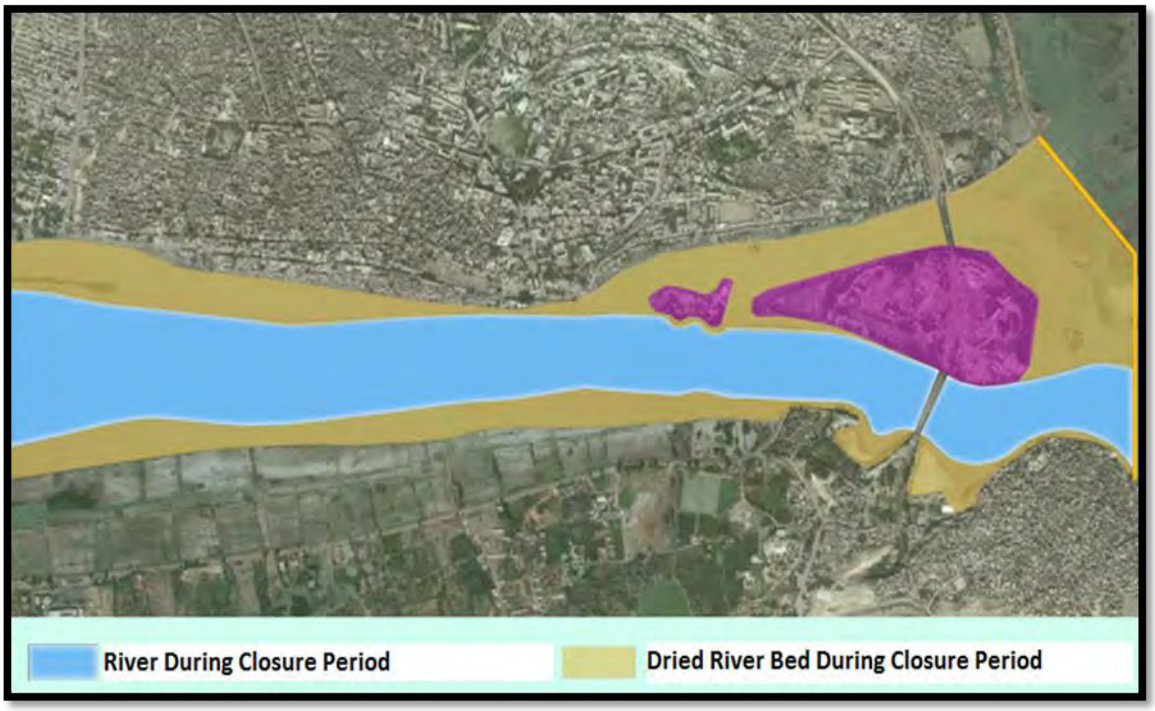
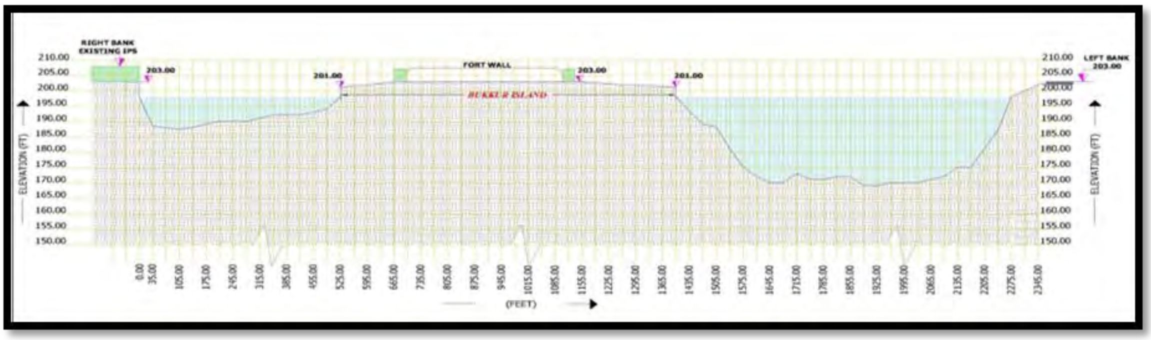


Figure no. 1: River Bed during closure period

- The existing capacity of the intake pipe cannot be extended or upgraded due to river bed profile in the Sukkur channel is about 20 feet higher than the Rohri channel side of river Indus. Figure no. 2 shows such river bed profile cross section at the point of existing intake works. The main flow of river Indus exits only along Rohri side river channel. The water along Sukkur channel side flows only when barrage doors are closed and the water level ponds to levels above 190 ft RL. Additionally, water from the present intake cannot be drawn from the Sukkur channel in the event of low flows as water, due to low flows becomes highly polluted (upstream waste water discharge) and limited opportunity of dilution. Therefore, as suggested by data the Sukkur channel is highly vulnerable to seasonal fluctuations with 5 year return period for the lowest flow of 7000 cusecs the water will not be available at existing intake as the Indus Bed will be dried up in Sukkur Channel. This is in addition to annual drying up of the bed during closure period averaging 20 to 25 days.

Figure no. 2: River Bed Profile cross-section at the point of existing Intake Works



147. It can be concluded that the existing intake is not suitable to address the needs of the city due to environmental concerns, high pollutant loads, and unavailability of water during low flows and annual closure periods. Thus, the option for using the existing intake by enhancing its capacity is not suitable or feasible.

5.2 Ground Water Use as Alternative Source

148. The use of ground water for drinking water purpose was investigated in the Tranche I through a feasibility study conducted by M/s Rockmore in Rohri , Sukkur the left Bank of the Indus. The study was reviewed by the Ms RCC consultant along with other ground water studies available for the area by various agencies. The ground water potential in terms of yield and quality for sustaining the requirement of city upto 30 MGD by 2020 was not established or confirmed. The Rockmore study also confirms that saturated zone is available at average depth of about 5 to 10 ft, however water quality deteriorates when moved away from the water bodies and yield is unreliable.

149. The conclusion from the ground water potential study is that the ground water resource is not adequate or with acceptable water quality to meet the drinking water requirement of the city hence is not an available option to explore and implement as an alternative.

5.3 Construction of Lagoons for Water Storage During Shortage

150. The Option of using the existing intake with construction of the Lagoon of approx 140 acres to serve the needs of the city during closure period by storing 270 Million Gallons (provision for 50% daily demand for 15 days) were also analyzed and evaluated . The option is not feasible due to following reasons:

- Existing intake needs major and intensive modification and the associated civil works carry a veryhigh cost;
- The water quality and availability issues will remain the same as stated earlier;

- The availability of the land in the vicinity of the city will be a major issue with very high social and land acquisition costs since the area is densely populated and also holds commercial value;
- The double pumping – first from the intake, then from the lagoon to water treatment plants will be high cost to the operations and estimated O&M costs are about Rs. 60/per 1000 gallons against the Rs.30/per 1000 gallons for proposed option;
- Storing the huge water body will create localized water logging in the area due to the close proximity of the river;
- The security of the water body for drinking purpose will be vulnerable to threats;

5.4 Moving the Intake Out of the Protected Area – IDR

151. The objective of not disturbing the biodiversity associated with the IDR will be fulfilled by moving the intake out of the IDR. There are three options to move the Water Intake out of the Indus Dolphin Reserve, these are discussed below:

A: Moving the Intake to a location upstream of Guddu Barrage

152. The option of moving the intake to a location upstream of the GudduBarrage about 175Kms upstream of Sukkur existing intake will allow to explore the option to take the intake out from the IDR as the IDR is between the Guddu and Sukkur Barrage. The options are not economically and technically feasible due to following reasons:

- Construction of intake pump house with very high power motors will be required with several intermediate pumping stations in between Guddu and Sukkur to transport the water with huge cost-very high ecological foot print.
- The losses of conveying water from 100 kms plus in pipes requires high pumping and electricity cost and land acquisition or possible resettlement.
- The operations and maintenance of the transmission line will be extremely difficult due to distances and long area.
- Huge number of stand by generators in the intake pumps house and intermediate pumping stations will be required with high O&M cost and local noise generations impact and air pollutions.

153. Therefore, this option, although located outside the IDR is no environmentally or technically feasible.

B: Intake of water from a location downstream of Sukkur Barrage

154. The last barrage on the Indus after the Sukkur barrage is the Kotri barrage and under the directives of the Indus River Regulatory Authority a certain discharge has to be maintained at Kotri barrage to couter sea water intrusion. The water downstream of the Sukkur barrage is dependent on the requirement of the Kotri Barrage water indent. It is mostly very less in quantity with high fluctuation in discharge and only flows in a small stream after discharge from the central gates of Sukkur Barrage out of 66 gates. The option of constructing intake at this location is not feasible due to following reasons:

- Construction of Intake in the River Bed downstream of Sukkur Barrage is not feasible as the river flow downstream of Sukkur barrage meanders widely within 1.5 km width river bed.
- Thus only option will be a floating type of Intake works which would pose serious technical problem as wide meandering of the river flow path would stress delivery pipe system. Again during high floods intake works will be vulnerable to serious damage during high floods of up to to 1.2 Million cusecs.

C: Intake at Right Bank Canals

155. The Right Bank Canal of Sukkur Barrage are non-perennial canals and no water is available during closure of Barrage as well as during non sowing season of the paddies etc. This option of constructing the intake will not provide reliable and sustainable supply thus can not be considered for the intake of raw water for Sukkur city.

5.5 Intake Works On Upstream Side of Lansdowne Bridge.

156. This option requires construction of Intake Pump Station (IPS) on upstream side of Lansdowne Bridge, upstream of the bifurcation barrier created by Bukkur island. The image below shows the upstream and downstream of Lansdowne Bridge. Construction of IPS on upstream side of Lansdowne Bridge is not a viable option for following reasons.

- River Indus upstream of the bifurcation is a free flowing river frequently meandering in a bed that is about 3 to 4 km wide. The main flow is at distance of about 1000 feet from the nearest bund. It too shifts location at times. The highly meandering nature of River Indus with sinuosity value of about 1.5 and above is essentially due to big variance in bed slopes at different section and typical flow patterns where river gets high flows during monsoon season otherwise remains dormant most of the time.
- The river Indus is known for its typical meandering nature , for instance direct distance of river Indus across Pakistan is only 1200 km but it transverses about 1800 km due it's snake like route. For these reasons Intake study area of interest from the day one excluded all parts of river Indus Upstream of the bifurcation area as well as downstream of Sukkur barrage.
- However an area within 20m on upstream side of the of the Lansdowne bridge was considered as an option but later was discarded on knowing that any foundation and piling works in such close vicinity of the historical bridge will not be allowed. And at distances larger than 20m from the bridge on upstream side the river flows shallow and wide.
- Any Intake work if made in that part of the Indus has to be constructed inside river bed at place of maximum depth. This means construction of a bridge on piles to carry delivery pipes and to carry out costly river training works to force river Indus to flow through the path of the Intake works. Such solution apart from disturbing the river ecology will also not be allowed by the Indus River Commission (IRC).
- Construction inside the River in shallow waters will be direct obstruction for Indus Dolphin, also the construction and operational works will be a big and critical issue, with high impacts on the dolphins.

- On the other hand Lansdowne Bridge is not a bifurcation barrier as indicated. In fact the bridge is spanned to a width of 1100 feet without any piles as it is a suspension bridge between the abutments. Thus entire space below the bridge to the full width of 1100 feet is unobstructed escape route for any Dolphin.

5.6 Construction of Intake at Left bank of River Indus on Far Side of the Bukkur island – Selected Option

157. This Option entails construction of intake works, a new pump house on far side of the Bukkur Island. The delivery pipe will be laid across the Sukkur Channel river part buried under the bed. The option of pipe on the Bridge was rejected due to environmental concerns.

158. This option is selected based on the various hydrological and hydrogeological investigation report and river bed and water quality study and computer modelling of the 100 years return period for minimum and maximum discharge by Ms RCC Consultant. In summary this option is selected due to the following reasons:

- It has the potential to address the demand of the 1.8 million people by year 2050 considering the inter-intra generational equity in a sustainable manner in low and high floods
- The water samples test shows that at Rohri side water is contamination free at the point of intake, reducing any health risk to population and ensuring to address the basic human right for present and future generation and meets WHO requirements except turbidity. Figure no. 3 shows contamination levels across selected location.

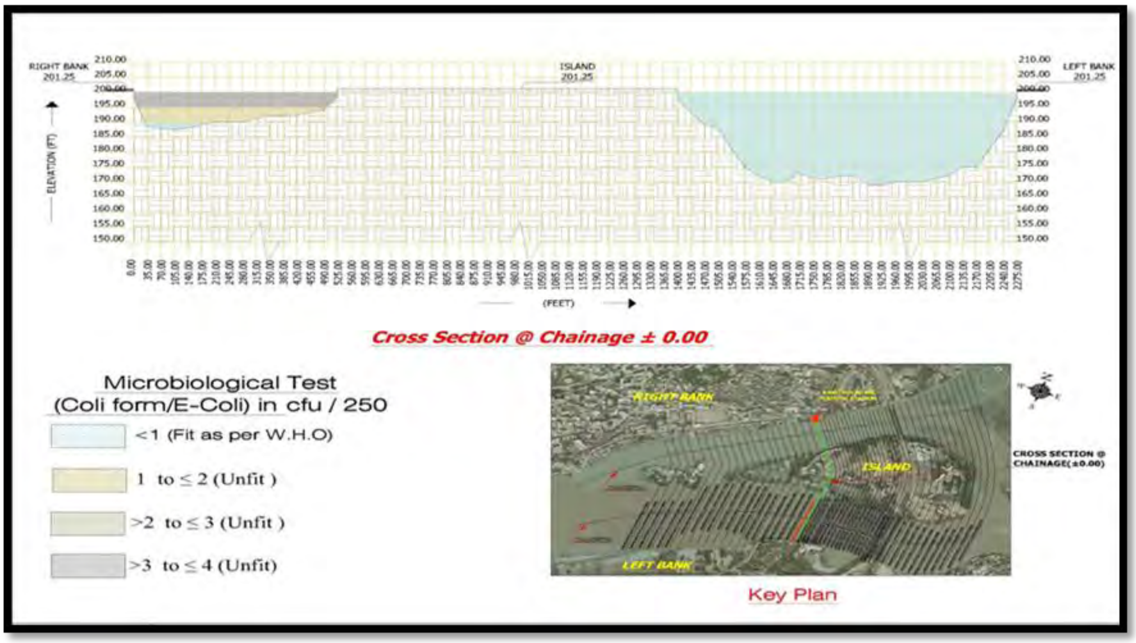


Figure no. 3: Contamination levels across selected location

- The river channel (Rohri Channel) as per survey at particular point is 20 ft deeper than the Sukkur Channel and all river beds thus making it suitable for the intake water sitting.
- The River Main flow stream occurs on Rohri Side and peak velocity occurs closer to Island thus making it suitable for the intake in a sustainable manner all year round. The Figure no. 4 shows velocity profile across proposed intake point.

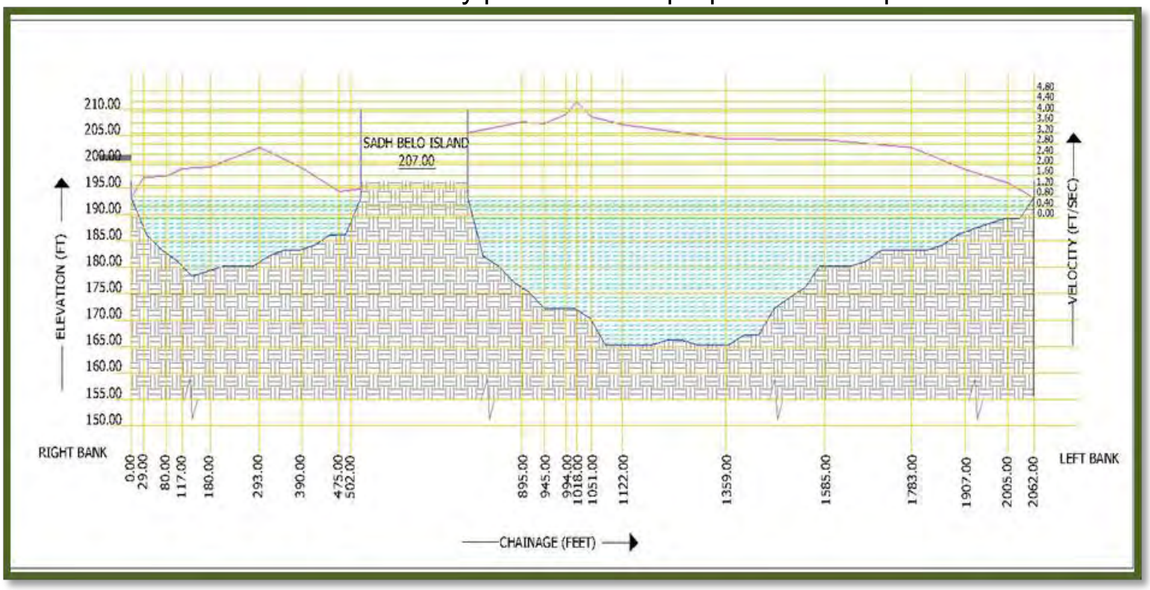


Figure no. 4: Velocity Profile across proposed Intake Point

- Based on flow data for the return period of 20 years sufficient water is available for 100 cusecs requirement of city in future at the point of intake. The water available is 3549.50, 2965.0 and 2965 cusecs for monthly and weekly and daily low flow conditions respectively

- The Indus Dolphin does not lives in or move in the vicinity of the intake as observed in the survey.
- The area is not classified as core area of the IDR by the SWD

159. Based on the detail studied carried as referred above and synthesized provided in the alternative analysis of the projects, The best option selected is option No 6. All the construction technology and mitigation measures are designed as described in the EIA to offset any impact in Indus Blind Dolphin in the IDR and address the needs of the city in a sustainable manner without impacting the environmental sensitivity of the area.

5.7 Selection of Best Option

160. All the possible alternatives have been discussed above in some detail and due justification. Further to compare and conclude with best possible and practical option, impacts with respect to site, quality, quantity, environment, health, social, economy and mainly on Indus dolphin has been summarized in following table 5.1 and 5.2.

Table: 5.1-Comparison of Alternatives

Project Alternatives	Description of Route	Quantity and Quality	Impacts			
			Environmental & Health	Indus Dolphin (ID)	Social	Economic
Alternative 1: No New Project, Using existing location of Intake Pump Station (IPS) (Existing Intake Jetty Rehabilitation)	▪ Same location	▪ Quantity not meeting city demand ▪ Heavy Shortage during winter ▪ Increased turbidity during shortage ▪ Increased microbial contamination during shortage	▪ RAMSAR SITE ▪ Eruption of diseases due to lack of water ▪ Highly turbid water during shortage ▪ Indirect Impacts on Indus Dolphin during construction	▪ Pump operation may have some impacts on Dolphins	▪ Frequent water shortage, especially during winter, vary from 15 days to 30 days ▪ Trouble-some situation, strikes in the city	Heavy operational and maintenance cost due to ▪ Supply water through tankers during shortage ▪ Increased chlorination ▪ Health cost with no improvement in water quantity
Alternative 2: Use of Ground Water Tube wells as water Source	▪ River bank, taking seepage water from ground	▪ Insufficient quantity to meet city demand ▪ Inadequate water source ▪ Availability of water for small	▪ Threat of Arsenic availability ▪ Good in other parameters	▪ No Impact	▪ Same water shortage problems as in option-1	High Cost of Pipeline laying

Project Alternatives	Description of Route	Quantity and Quality	Impacts			
			Environmental & Health	Indus Dolphin (ID)	Social	Economic
		duration ▪ Prolonged ground water recharge time ▪ No Turbidity				
<u>Alternative 3:</u> Construction of Lagoons for Water Storage During	▪ At upstream of existing Intake	▪ Cater 50% of shortage but shortage will be there	▪ Construction disturbance to wildlife and other biological habitat present at upstream along bank of River ▪ Water security problems ▪ Water logging in vicinity	▪ No Impact	▪ Same troubleso me situation	▪ Highest cost due to purchase of 140 acres of land ▪ Double pumping cost
<u>Alternative 4:</u> Moving Intake out of IDR	▪ Upstream of Guddu 145 KM away from Sukkur ▪ Down Stream of Sukkur Barrage in the mid of River (Where flow is available around the year) 3 Km pipe Line with crossing of 3 Major Canals	▪ Expected shortage due change in River course	▪ Disturbance to three canals and River ecology	▪ No Impact	▪ Same troubleso me situation	▪ Highest cost ▪ Technically most difficult option ▪ High energy consumption ▪ Not practicable

Project Alternatives	Description of Route	Quantity and Quality	Impacts			
			Environmental & Health	Indus Dolphin (ID)	Social	Economic
Alternative 5: Intake Pump Station on Island far Side	▪ On Island on Far side	▪ Abundant quantity of water ▪ Meeting demand of city up to 2030 and onwards	▪ RAMSAR SITE ▪ Improve health conditions	▪ Indirect impacts during construc-tion only	▪ Meet the water demand of city ▪ Practicabl e option	▪ Most economical option ▪ Most Durable Option
Alternative 6: Intake Works On Upstream Side of Lansdowne Bridge	▪ Upstream side Lans-down bridge	▪ Quality same as expected in option-5 ▪ Quantity variable due to change in River course	▪ High adverse on aqua life ▪ High on Dolphin	▪ High Adverse Impact	▪ Insecure due to high length of pipeline	▪ Extensive pumping ▪ Costly option

Table: 5.2: Ecologically Sustainable Development (ESD) Framework Analysis for Project
(Harding, R (ed) 1998, Environmental Decision Making: The role of scientist, engineer and the Public pp. 27-29)

SNo	ESD	Project Design of Intake	Option 1(NP)	Option 2(GW)	Option 3(lagoon)	Option 4 (Out of IDR)	Option 5 – Bhukhar Island	Option 6 (upstream LS Bridge)
1	Integration of economic and environmental goals in policies and activities	To address the economic and social needs of project areas	×	×	×	×	√	×
2	Intergenerational equity	Ensured that minimum water is taken by present generation keeping in view future requirement of water in a sustainable manner	×	×	√	√	√	√
3	Conservation of Biological Diversity and ecological Integrity	Through mitigation measures and effective monitoring of compliance and affects with WWF and SWD	×	×	×	×	√	×
4	Dealing nationality with risk and uncertainty	Through risk assessment and carry out activities in low risk times and at location where the population of Dolin population is minimum or no	×	×	×	×	√	×
5	Intergenerational equity –Social Equity	Provision of water for social and economic development an recognizing that sustainable development	×	×	√	√	√	√

		is basic human right						
6	Qualitative Development	Integrated approach through master planning as part of project planning	×	×	×	×	√	×
7	Efficiency	Efficient use of water resources through improved infrastructure and equitable distribution is ensured in Tranche 2 projects	×	×	×	×	√	×
8	Community Participation	Community was consulted in the project design	×	×	×	×	√	×
9	Constant Capital and sustainable income	The population of Blind Dolphin is increased due to Govt , SWD and WWF efforts and NSUSC project is acceptable to them	×	×	×	×	√	√

161. Based on the detail studied carried and comparison provided in above tables. The best option selected is option No 5-Intake Pump Station on Island far Side. All the construction technology and mitigation measures are designed as described in this report to offset any impact in Indus Blind Dolphin in the IDR and address the needs of the city in a sustainable manner without impacting the environmental sensitivity of the area. NSUSC has no other option practicable other than option-5. Excepting this all other options are not meeting the water requirement and hence are of no use, not technically, nor environmentally and economically feasible.

6 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

162. This section discusses the potential environmental impacts of the proposed project and identifies mitigation measures to minimize the impacts in the design, construction and operational phases of the proposed project.

6.1 Methodology

163. The scope of the project impacts (Direct and Indirect Impacts) is based on the Entire Project area and area of influence i.e 200 meters . The Methodology for impacts identification is based on the baseline Survey Conducted in winter season in Feb 2012. However Second survey is planned to be conducted in summer (August) 2012. Impact assessment of the project has been broadly categorized with respect to following two main Components

1. General Impacts associated with Construction and Operation activities
2. Potential Impacts associated with the Indus Dolphin during Construction and Operation Phase.

6.2 General Impacts associated with Construction and Operation activities

164. The General Impacts associated with Construction and Operation activities have been assessed in this EIA Report. Standard risk-based approach in is used. The method defines three levels of consequence (or severity) and likelihood (or probability of occurrence) - High, Medium or Low of an impact. Their Mitigation measures have been given in this Report.

165. All the project components are either on Bukkur island except intake pipes component that will be also buried deep in the River Indus with only tip emerging about 20ft below Bukkur Island. The pipe tips will be covered with mesh. The water will flow into these pipes under gravity. Thus there shall be absolutely not even mild impacts on the dolphin habitats as type construction is similar to residential building that will generate low level noises and all foundations on cast in situ piles.

6.2.1 Physical Environment

1. Air Quality

166. Construction Phase Impacts: Low impacts on air quality may occur during construction works due to dust emission from vehicular traffic on dirt track leading towards the Bukkur Island, earthworks at pump house and proposed RoW, exhaust emissions from construction machinery and generators.

167. These impacts will be localized and temporary. The existing communities are mostly located outside proposed location for pump house and hence the level of exposure to dust will be low.. Therefore impacts associated with this activity will be localized and temporary therefore assigned as Low Significance.

168. Operation Phase Impacts: There would be less emissions from the pipeline or pumping house other than the occasional use of standby generators at the pumping house during the interruption of the power supply from the utility Company . On the basis of this information, it is concluded that the consequence of the impact would be Negligible and its likelihood would be low. This impact is therefore assigned Low Significance.

169. Mitigation Measures: To mitigate the Impact which may occur during construction and Operation Phases i. e Dust Particles will be settle down through continuous water sprinkling on the main vehicle routes and for the emission control of machines and Generators, proper maintenance will be carried out Noise and Vibration

2. Water Use, Quality and Availability

170. Impacts during Construction: During construction phase, there can be potential small and localized impacts on water availability and quality due to water usage for domestic and construction purposes, disposal of domestic effluents from the construction camp, leaks and spillages of fuel or oil etc. These impacts and recommended mitigation measures have been discussed below.

171. Water Use during Construction: The construction works and workers will require water for domestic and construction needs during the project. The domestic water requirements will be for approximately 50 workers. Since the camp site will be located in Sukkur the piped water supply will be used to meet the requirement. The water requirement for construction works will be much less than the domestic water requirement and will therefore have a minimal effect as well. Therefore it is concluded that the consequence of the impact would be Low and its likelihood would be Low. This impact is therefore assigned Low Significance.

172. Disruption to Water Flows: The works at the pump house and within Indus River will be planned and executed during periods when the gates of Sukkur Barrage are opened having less or no water in the right bank of the Indus River. This will avoid the need for closing or disrupting the normal irrigation supplies to the farmers and other users. Therefore it is concluded that the consequence of the impact would be Low and its likelihood would be Low. This impact is therefore assigned Low Significance.

173. Oil Spills or Leakages: Oil spills or leakages may occur during handling and transportation of fuel and oil to the pump house and work areas. These may end up in the river water and impact downstream users, flora and fauna. Keeping in view the power requirement of the pump house a small size generator will be used having not more that 40 litres of tank. The impact from small leaks or spills (less than 40 liters) will not be significant as the spills will disperse, dilute, and remediate naturally. However, larger spills from machinery can adversely affect the water quality and associated flora, fauna, and downstream users. Therefore it is concluded that the consequence of the impact would be Medium and its likelihood would be Low. This impact is therefore assigned Low Significance.

174. Impacts during Operation: Since the same source of water is being used to supply raw water to the treatment plants. The proposed water intake will have use water for additional 15 days period when the water level in the right bank of the Indus River is low. Therefore it is concluded that the consequence of the impact would be Medium and its likelihood would be Low. This impact is therefore assigned Low Significance.

175. Mitigation, Management and Monitoring: Impacts from construction phase will be minimized by avoiding undue wastage of water and practicing standard water conservation techniques (especially at camp) and careful selection of water supply sources to ensure that the project water requirement does not affect the local use; disposing domestic effluents from camp through existing municipal drains; following standard operating conditions (and where necessary extra precautions) for the transport, storage, and handling of fuel and oil (such as storing fuel within bunded areas).

176. Monitoring measures will include compliance checks on the contractor's waste and fuel handling procedures.

3. Flooding and Water Flow Regime

177. Impacts during Construction: There will be no significant affects on the existing water flow regime or flood management mechanisms/structures during construction activities. Therefore it is concluded that the consequence of the impact would be Low and its likelihood would be Low. This impact is therefore assigned Low Significance.

178. Impacts during Operation: Since the existing water intake is using the same source of water from the right bank of Indus River. The water level and availability at existing source decreases when the gates of the barrage are opened for maintenance. On average the water availability at existing water intake decreases and remain low for 15 days in year. The estimated water demand 56.70 MGD upto year 2050. Water quantities to be exploited for the water supply system with the water intake at the source will not exceed more than 0.01% of the total average capacity of the River Indus. These capacities are insignificant when compared to the overall regime of Indus River as a whole. Therefore it is concluded that the consequence of the impact would be Low and its likelihood would be Low. This impact is therefore assigned Low Significance.

179. Mitigation, Management, and Monitoring: There will be no significant affect on the existing water regime and flood management mechanisms/structures during construction/operational activities.

4. Soil Erosion

180. Impacts during Construction: The construction activities, particularly trenching operation can potentially cause soil erosion where the RoW crosses Bukkur Island and right bank of the Indus River. With the help of appropriate features in the project design, these risks will be reduced to the acceptable limits. The loss of topsoil during the trenching operation can potentially affect the soil productivity. Similarly the pipeline and other project facilities can obstruct or change the natural drainage pattern. The mitigation measures included in the project design will ensure that these impacts remain within the acceptable range. On the basis of this

information, it is concluded that the consequence of the impact would be Low and its likelihood would also be Low. This impact is therefore assigned Low Significance.

181. Impacts during Operation: Waste production is insignificant in the operation phase, Therefore soil will not be polluted since the waste will be disposed at the city municipal system. Soil erosion might potentially occur at the pump house and along the canal banks, but this will be minimal as the areas cleared will be covered by compacted surfaces and re-vegetated. It is concluded that the consequence of the impact would be Low and its likelihood would also be Low. This impact is therefore assigned Low Significance. Additional specific mitigation measures are proposed for this impact.

182. Mitigation, Management, and Monitoring: The following mitigation and control measures will be implemented to minimize the intensity of the above impacts:

i. The area covered by the project activities will be kept to a minimum. Movement of construction equipment and vehicles will be restricted to the work areas.
ii. The construction corridor along the pipeline RoW will be properly marked
iii. Surplus soil will be disposed of in a manner that does not disturb the natural drainage.
iv. The natural drainage pattern will not be disturbed, and will be repaired where damaged.
v. Top soil along the trench will be stockpiles separately, and will be used as the upper most soil layer during the backfilling of the trench.
vi. Safe driving practices will be observed to minimize soil erosion. Reduced speed limit of will be observed and monitored in the project area, and off-track driving will be strictly disallowed.
vii. Plantation of native species along the banks of the River Indus and Bukkur Island to avoid soil erosion.
viii. Plantation of 2000 native species along the banks of the River Indus and Bukkur Island to avoid soil erosion in affected area.

6.2.2 Biological Environment

1. Impacts on Flora

183. Impacts during Construction: Loss of vegetation can occur during the construction activities due to clearing of land at Bukkur Island for proposed pumping station and Laying of Pipeline.

184. The project area also houses 34 species of floral species. Since the pump house and pipeline RoW occupy small areas, clearing of vegetation for these facilities will only have minimal impacts on vegetation. It is concluded that the consequence of the impact would be Low and its likelihood would also be Low. This impact is therefore assigned Low Significance.

185. Impacts during Operation: Since the pipeline will be buried and pump house will be a permanent structure no additional damage to natural vegetation is envisaged during operational phase of the project.

186. Mitigation, Management and Monitoring: These will include:

i. Clearing of vegetation will be kept to a minimum.
ii. The cutting of trees will be prohibited. Under unavoidable circumstances any clearing required shall be done with prior approval and be compensated as per rules and regulations of Forest department.
iii. Use of local vegetation/wood as fuel by crew personnel will be prohibited.

2. Impacts on Fisheries

187. Potential Impacts: Potential impacts of the proposed project are discussed below.

188. Reduction in Fish Stock. Fish stocks in Indus River have already declined over the years owing to the contamination of the water, low levels in winter season and increased industrial and domestic pollution. However, this impact has not been felt by local fishermen at Sukkur Barrage as sufficient water is received and the fishermen continue to find their share of the fish catch from the area.

189. Reduction in fish stock due to construction activities is unlikely. The only affect that might occur is the temporary displacement of fish from the immediate surroundings of the civil works within the project area. Within the river, the civil works will be done during the period when the gates of the barrage are opened having low levels at the construction site. It is concluded that the consequence of the impact would be High and its likelihood would also be Medium. This impact is therefore assigned Medium Significance. Additional specific mitigation measures are proposed for this impact.

190. Mitigation, Management and Monitoring: These will include:

i. Within the river, the civil works will be done for pipe line laying during the period (25th December to 10th January) when the gates of the barrage are opened having low level of water at the work sites.
ii. Avoiding contamination of the project area due to oil spills or domestic effluents etc.
iii. Project related activities within Indus water will start gradually to give time to the river fauna to leave the area
iv. The jacked pipe water intake system will be provided with mesh size (5mm) to avoid aquatic fauna to enter into the sump chamber during high water depth and discharge time (atleast 30,000 cusecs river discharge at Sukkur Barrage).

3. Impacts on Fauna

191. Potential impacts on wildlife at the proposed work site and along the banks of River Indus are mainly related to the construction phase. During construction disturbance to birds, mammals, and reptiles is anticipated within the immediate surroundings of the work sites.

192. Since the pumping house and RoW for pipeline laying will occupy small areas, the loss of habitat due to these facilities will not be significant. The project area also houses few species of birds, mammals and reptiles that

are protected against hunting or trade under national legislation and international conventions. The project staff will be given awareness trainings on the presence and importance of these species. Killing or hunting of these, and all other, wildlife species will be prohibited. However, during the migration season, autumn and spring, the operation in their habitat, may deprive them of resting places. This impact would be again minimum and migratory birds may settle to some other undisturbed habitat. Additional specific mitigation measures are proposed for this impact. It is concluded that the consequence of the impact would be High and its likelihood would be Medium. This impact is therefore assigned Medium Significance. Additional specific mitigation measures are proposed for this impact.

193. Impact during operations: Since the pipeline will be buried and the only impact will be the operation of the pump house within the existing ambient noise level threshold. The project staff will be given awareness trainings on the presence and importance of key species. Killing or hunting of these, and all other, wildlife species will be prohibited. Additional specific mitigation measures are proposed for this impact. It is concluded that the consequence of the impact would be High and its likelihood would also be Medium. This impact is therefore assigned Medium Significance. Additional specific mitigation measures are proposed for this impact.

194. Mitigation, Management and Monitoring: These will include:

i. Minimising unnecessary land clearing and land uptake in all construction activities
ii. Minimising noise from construction activities and unnecessary movement of vehicles and personnel outside of the work areas, following best practices
iii. Night work will not be allowed to provide relief to especially nocturnal species
iv. Effective construction planning and management to ensure that works are completed within time
v. Minimising clearing of trees
vi. Prohibition on hunting or intentional killing of wildlife by project people

6.2.3 Socio-economic Environment

195. The Proposed project will have positive impact on the residents of Sukkur city and will indirectly uplift the socio-economic conditions/Standards of the inhabitants of the area. water shortage problem will be solved and will bring immense pleasure for the inhabitants of the Sukkur City

196. There is local fishing done in this project area and its surrounding. The proposed operations may cause disturbance to fish species which may lead to changes in fish distribution and catch rates. As any impacts on fish catch rates will be short-term and localised, resulting in increased catch rates in other areas the impacts will be insignificant. On the basis of this information, it is concluded that the consequence of the impact would be Medium and its likelihood would also be Low. This impact is therefore assigned Low Significance.

197. Mitigation, Management and Monitoring: These will include:

i. To avoid occurrence of any unforeseen impacts at the implementation stage, construction works will be planned in due consultation with the fishermen communities.

198. Land and Resettlement issue

1. Impacts: No Impacts.
2. Damage to Cultural and Archaeological Sites

199. Potential Impacts: There are some archaeological sites protected under Antiquities Act 1975 observed / reported in the vicinity of the project area. However the Bukkur fort boundary is located within 100m of the area of influence therefore safe distances will be maintained from this site in order to avoid any damage to the sites or the archaeological artefacts. Cultural and religious sites in the form of Mandirs & places of pooja for Hindus exist in the vicinity of the project area. The proposed project interventions will maintain safe distance from such cultural sites to avoid damage to these sites. It is concluded that the consequence of the impact would be Medium and its likelihood would also be Medium. This impact is therefore assigned Medium Significance. Additional specific mitigation measures are proposed for this impact.

200. Mitigation, Management and Monitoring: Since the boundary of the Bukkur fort is less than 100 m from the existing RoW to be used for the project. Therefore the project proponent will closely liaise with the archaeological department prior to any construction activities near the boundary of the fort. Any need for monitoring will be identified and archaeology department will be involved in the process. Appropriate offsets will be provided from sites of religious, cultural or archaeological significance.

6.2.4 Impacts on the Blind Indus Dolphin During Construction and Operation Phases

Indus Dolphin: Noise Impacts during Construction:

201. In a river systems where construction activities are proposed noise can be generated by various types of machinery either in the water or by machinery used outside the water. In the present case nearly all the noise will be generated by machines used at the river bank on the Bukkur island. The equipment used on the surface will include typical construction equipment both mechanized and manual, including hydraulic jacking equipment to tunnel the pipe from the edge of the river under its bed into the river till a horizontal distance of 200ft.

202. Noise will be generated inside the water at the time when the pipe exits into the river and also during some finishing works that will be needed to secure the system and complete the works. This, it may be noted, will be for a very limited time in the entire 2 week construction operation.

203. Noise will be transferred into the water from the surface, and not through direct noise generation in water. Therefore, the noise will be somewhat attenuated before it hits the water surface. The hydraulic jacking device does not create any impact as opposed to manual drilling equipments, the system is discussed in the previous sections in detail. The maximum sound level will be at the source with an expected intensity of below 65

dB (A) maximum and lies within the range of ambient noise generated around the site: 58 to 71.24 dB(A) The sound intensity will attenuate with distance resulting in different levels of sounds at different locations.

204. High levels of noise directly generated in water, if at high frequencies can amplify and also reflect thereby creating confusing signals for cetaceans. However low frequency noise is easily absorbed, especially in turbid or dense media. However, dolphins have been seen to avoid areas where noise levels in water are suddenly increased, these observations have been made as part of studies conducted on marine dolphins.

205. To take the real picture of noise generated during jacking operation at the surface during construction of the project, a real case study of jacking in Hyderabad, Pakistan is taken into account.

<u>Measured Noise levels during pipe jacking(Hyderabad Highway as Case Example)</u>

206. A noise level survey was conducted for the above shown work. Source of noises at that location were as follows

- Traffic from nearby high way measured at the point of jacking pit.
- Noise of jacking compressor measured at the jacking pit and at distances of 100, 200 and 300 feet away from the jacking pit in opposite direction of the high way
- Noise of jacking piston. There was no noise from the jacking piston as it was pushing the pipe through slow movement like a car jack silently.

207. Table below shows the results of these readings

Noise Source	Location of Point of Measurements	Condition	Result
Highway traffic	At jacking pit about 100 ft away from edge of highway	Jacking work stopped	65 dB
Jacking compressor	At Jacking Pit	Combined with Noise from highway and jacking in operation	75 dB
Jacking compressor	At 100 ft from pit opposite to highway	Combined with Noise from highway and jacking in operation	65 dB
Jacking compressor	At 200 ft from pit opposite to highway	Combined with Noise from highway and jacking in operation	60 dB
Jacking compressor	At 300 ft from pit opposite to highway	Combined with Noise from highway and jacking in operation	55 dB

208. Pipe jacking at the Proposed Intake works.

209. The pipe diameter used at the proposed intake works is 36 inch in diameter. The soil through which jacking is to be done is pure silty sand, thus smaller size of the jacking equipment will be required compared with the above shown arrangement. Thus noise levels generated at the

surface on the island will be within range of 65 to 70 dBs and this range is comparable with the current noise levels at the proposed Intake location emanating from adjacent traffic on the Lansdowne Bridge.

210. As given in the above table, at certain distance from jacking operation noise reading taken are between 55–75 dBA. With reference to this study and noise readings taken, it is obvious that readings are at acceptable level. This proves that jacking operation and associated construction activities have no or minor adverse impact on IDR.

211. The data shows that major source of noises within IDR area between Lansdowne Bridge and Sukkur Barrage are, an existing Jetty Pump house on right bank of River Indus which emanates noise within range of 82 to 84 dBs throughout 24 hours. The second major source is traffic on Lansdowne Bridge which at peak averages to 75 dBs and reduces to 62 dBs at odd hours due to less traffic. However noise level rises to about 87 dBs when the passing train whistles. The Dolphin is already exposed to these noises.

212. For several other locations within study area as shown in table the average ambient noise levels are 55 dBs to 65 dBs. The noise generated from Jacking operation would be about 60 to 75 dBs within the ambient noise levels in the area. Thus no abnormal noise pollution is foreseen in IDR area during Intake work construction for 2 weeks construction period.

213. Therefore Noise Impact on the Movement of Indus Dolphin would be insignificant, minimum and is addressed here properly and does not exceed ambient noise level in any case. Therefore in perspective of general Impacts during Construction activities for two weeks of jacking is considered with low Significance.

214. It should also be noted that since fish species generally have good swimming abilities and can quickly avoid areas of high or disturbing sound levels thereby having reduced exposure. It is concluded that the consequence of the impact would be low and its likelihood would be Medium. This impact is therefore assigned Low Medium Significance. Additional specific mitigation measures are proposed for this impact.

215. Mitigation, Management and Monitoring during construction: The following mitigation and control measures will be implemented to minimize the intensity of the above impacts:

i. The exposure of construction workers to noise will be minimized by use of ear plugs and minimising exposure to potentially high noise generating activities and equipment (maintaining safe distance and minimising time spent near these sources). Other mitigation measures are given as below.
ii. Within the river for pipe Laying, the civil works will be done during the period (25th December to 10th January) when the gates of the barrage are opened having low level of water/ no water at the work sites of pipe line avoiding potential Indus Dolpin low probability disturbances.
iii. The raw water transmission pipes will be laid during period when the bed is completely dried.
iv. Avoiding contamination of the project area due to oil spills or domestic effluents etc in the Project Area.

v. Project related activities within Indus water at Jacking Point of Intake will start gradually to give time to the Indus Dolphin to leave the area with continuous monitoring and escorting the area if required. SWD have expertise in this area, which will be acquired.

vi. Ensure Divers and Rescue Team from SWD &WWF is present all the time in the impact area of Jacking (during Construction) to avoid any low possibility of potential catch or disturbance to Indus Dolphin around Jacked Piped area of 100 meter circle zone.

vii. The jacked pipe water intake system will be provided with mesh size (5mm) to avoid aquatic fauna to enter into the sump chamber to avoid catch of Indus Dolphin.

viii. Ensure presence of Indigenous divers in 100 meters zone of jack activity to reflect back any incoming Indus Dolphin with continuous monitoring to main river course.

ix. Stop all activities in case a dolphin enters into 150 meters protective zone of Jacking.

x. Only allow jacking of pipe when the river flow at Sukkur Barrage is recorded above 30,000 cusecs and preferably above 50,000 cusecs.

xi. No activity below 30,000 cusecs flow is allowed at Jacking Place at Bhakkar island.

xii. Minimizing noise from construction activities and unnecessary movement of vehicles and personnel outside of the work areas, following best practices.

xiii. Noise levels will also be monitored at selected locations to determine effect of noise on aquatic fauna.

xiv. Effective construction planning and management to ensure that works are completed within time.

xv. Construction crew's general awareness will be increased regarding the biological resources, particularly of the Indus Dolphin.

xvi. No work will be carried out in the project area of Jacking of Pipe during this breeding period (April-May) of Indus Dolphin.

xvii. Work within Indus River will be gradually started to give enough time to the aquatic fauna leave the area.

xviii. The project implementation unit will closely liaise with the Sindh Wildlife Department prior to any construction activity.

xix. The camp site will be located at Sukkur outside the protected area.

xx. Keeping potentially noise producing equipment and machinery in good condition and providing mufflers where necessary.

xxi. Providing noise barriers where necessary.

xxii. Providing ear plugs to construction workers etc.

xxiii. Construction work will be restricted by allowing 6 hrs continuous works at site and the work will start again after 2 hrs interval during the same day.

xxiv. The pump house will be placed on piling support to avoid vibration. Vibration reduction best available techniques will be used to minimize vibration at source.

216. Given the good swimming abilities of all aquatic mammals and their nomadic behaviour implies that they will actively avoid disturbed areas and so should never be exposed to levels which would cause pathological

damage, unless any intense noise generating activities are initiated suddenly when they are in close proximity. It may be added that no activities that generate intense noise in water are planned, however, to prevent any surprise impacts all construction work near the river water and any finishing works in the water will be started gradually and will be mitigated by local swimmers to discourage the Dolphin from entering the 200ft radius zone where the jacked pipe would emerge.

6.2.5 Impacts during Operation Phase

217. Impact of Noise and Vibration on Indus Dolphin: Impacts during Operation: No significant noise impacts are likely to occur during the operational phase of the project. It is concluded that the consequence of the impact would be Low to Medium and its likelihood would also be Medium. This impact is therefore assigned Medium Significance.

218. IDR is 175-210 Km long from Guddu Barrage to Sukkur Barrage. There are tens of noise sources and even some more severe sources like train movement and heavy traffic from Lansdown bridge and Sukkur barrage bridge with maximum noise of 71 dB (A) . This is to note that noise is generate in the same area round the clock (refer section of baseline environment) from the traffic including trains passing over Lansdowne Bridge which is only few hundred meters away from the proposed intake works, two water intake pump stations at Rohri 2 - 5Km upstream of proposed project, existing pump station of Sukkur.

219. Further to analyse the current noise levels due to traffic and noise emissions Lansdown bridge, Sukkur barrage bridge and from existing water intake pump house readings were taken on 29.11.2012 for 24 hours. The detailed results are presented in baseline section of this report. The 24 hours average of noise at various emitters is given as under.

Location	**Avg. Reading dB(A)**
At lansdowne Bridge	71.24
Inside Jetty Intake-Existing Intake	83.01
Just Outside Jetty Inake at Bunder Road WTP	58.67
Near Sadhu Belo	57.45
Approx. 300m away from Jetty Near Bukkur Island	58.02
Bukkur Island at Proposed Intake	57.40
Approx. 100m away from Bukkur Island	56.75
NSUSC Pumping Station	61.09
Under Lansdowne Bridge in river	62.04

220. It can be seen in the above table that maximum 24 hours average of noise is recorded at inside pump station i.e. 83dBA where just outside jetty is 58dBA, noise level is decreased due to buffer wall. This is to mention here that similar type of wall will be constructed and the proposed pump house will also emit noise ranging between 50 – 60 dBA out side and hence Dolphins have no significant impact due to noise generated. This is also to be noted that pump house will be constructed

on Island; therefore noise which is already within range will not disturb aqua life at all.

221. As far as the vibration is concerned, there will be no vibration in the water column as these high-tech Turbines will be supported on piles that will transfer vibration generated through piles to 60ft deep strata.

222. Mitigation, Management and Monitoring: These will include: Minimising noise from pump stations and restricted movement of vehicles and personnel, following best practices

i. Effective operation planning and management to ensure that work is done carefully

ii. Operation crew's general awareness will be increased regarding the biological resources, particularly of the Indus Dolphin.

iii. No excessive work during breeding period (April-May) of Indus Dolphin.

iv. The NSUSC will closely liaise with the Sindh Wildlife Department and WWF continuously.

7 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

223. This Chapter outlines the Environmental Management and Monitoring Plan (EMP) and defines the institutional arrangements required for the implementation of this Plan. The EMP consolidates the mitigation measures identified in this EIA Report. This section of the EIA Report also presents the Environmental Monitoring requirements for different phases of the project. Detailed Summary of Environmental Impacts Mitigation is given in Table 6-1.

7.1 Objectives of the EMP

224. This EMP provides a delivery mechanism to address adverse environmental and ecological impacts, enhance the project benefits, and introduces standards of good practice to be adopted for all Construction and operational activities of this proposed project,

225. The primary objectives of the EMP are to:

i. Facilitate the implementation of the mitigation measures identified in the EIA.
ii. Define responsibilities of the project proponents, contractors, and other members of the project team.
iii. Define a monitoring mechanism and identify monitoring parameters in order to ensure complete implementation of all mitigation measures and ensure effectiveness of the mitigation measures.
iv. Identify environmental training requirements at various levels and cost estimate required for the Implementation and monitoring of the Mitigation measures.

7.2 Components of the EMP

226. The EMP consists of the following:

i. Organizational structure and roles and responsibilities
ii. Mitigation programme
iii. Monitoring programme
iv. Environmental training programme

7.3 Responsibilities for Implementation of EMP

227. This section describes the organizational structure for environmental management during the execution of the proposed project and defines the roles and responsibilities for the implementation of the EMP. Institutional arrangements proposed for the project EMP implementation are as follows.

7.3.1 North Sindh Urban Services Corporation:

i. The overall responsibility for compliance with the Environmental Management Plan rests with the project proponent i.e. North Sindh Urban Services Corporation (NSUSC) Limited.

7.3.2 Contractors:

i. NSUSC will hire contractor(s) for the execution of works under the project. The contractor(s) will be responsible for the complete implementation of the EMP and the mitigation measures detailed in the EMP, EIA and terms and Conditions set forth in No objection Certificate (NOC) issued by Sindh EPA.
ii. Each contractor will be required to appoint a dedicated field Project Environmental Officer (PEO) at the project site. PEO will be responsible for the implementation of EMP and EIA.

7.3.3 Independent Monitoring Consultant (IMC)

228. NSUSC will appoint an Independent Monitoring Consultant (IMC) i;e Consulting firm or individual Consultant responsible for:

i. Supervision, monitoring and compliance with respect to the Environmental Management and Monitoring Plan given in EIA Report.
ii. Terms and Conditions set forth in No Objection Certificate (NOC) issued by the Sindh Environmental Protection Agency (SEPA).
iii. Compliance of ADB Safeguard Policy 2009 and Environmental Assessment Guidelines 2003.
iv. Other requirements laid down in the bid documents and with respect to the General and Specific Environmental Conditions given in the Contract.
v. Responsible to ensure the Implementation of Environment, Health and Safety Policies and Health and Safety Manual of NSUSC
vi. Fulfil the Reporting requirements to be submitted for SEPA, NSUSC and ADB.

229. Programme Manager of IMC will be responsible for the management of the IMC field monitors and effects monitoring team comprising of an Environmental Engineer, botanist and a wildlife specialist. Reporting to the Programme Manager, IMC’s field representatives will have functional responsibilities to ensure monitoring of the project activities as per the requirements of the EMP. The IMC will report directly to Dir O&S and Environmental Safeguard Cell of NSUSC who will then disseminate the Independent Environmental Monitoring reports and findings to SEPA and ADB.

230. The EMP and other environmental management requirements and specification will be made part of the contract between NSUSC and contractor(s).

7.4 Complaints and Grievances Redress Mechanism

231. For the purpose of addressing grievances and Complains handling of the community about the implementation of EMP, a Grievance Redress Committee (GRC) will be notified for this proposed project during the first week of the start of the Construction works.

232. The Grievance Redress Committee will normally comprise the Taluka Administrator, the Environment Safeguards Staff of the Safeguards Cell of NSUSC, IMC and a representative of the community.

233. Complaint will be lodged in the Safeguards Cell of NSUSC, whose officers will strive for an informal settlement within 10 days of lodging of the complaint. If the complaint cannot be settled, the grievance will be referred to the Grievance Committee. Within 30 days the committee will discuss the matter and refer grievances to NSUSC Safeguards Cell, and obtain a resolution. If the complaint still remains unresolved, it can be re-lodged by the aggrieved person within one month of the Safeguards Cell decision with the Grievance Committee, which refers it to the Management of NSUSC.

234. The Management of NSUSC will rule on the issue(s) within 21 days of its re-lodging with the Grievance Committee. The NSUSC decision must be in compliance with the provisions of the EIA/ and EMP. If the grievance redress mechanism fails to satisfy the aggrieved person, s/he can approach the Sindh Environmental Protection Agency.

7.5 Environmental Monitoring Plan

235. The objective of the environmental monitoring during the proposed project activities will be as follows:

i. To check compliance of the project activities with respect to the EIA , EMP and Requirements of SEPA and ADB on environmental Issues
ii. Effective Monitoring of the implementation of mitigation measures given in EMP and recording feedback for identifying corrective action for the project implementation. Further detail of Environmental Monitoring is given in Table 6.2

236. A “Management Plan for the Indus Dolphin Reserve” does exist which is prepared by WWF, but it is not yet endorsed or adopted by the Sindh Wildlife Department.

7.6 Training Programme

237. Environmental training will be part of the environmental management system. The training will be directed towards all personnel for general environmental awareness. This will include, but not limited to, trainings to the project staff on environmental sensitization, presence and significance of protected area and protected wildlife species etc.

238. The key objective of training programme is to ensure that the requirements of the EMP are clearly understood and followed throughout the project. The trainings to the staff will help in communicating environmental related restrictions specified in the EIA and EMP.

239. The contractor’s project environmental officer (PEO) will be responsible for the training of contractors and subcontractors staff engaged for the Project. Training will cover the requirements of the EIA and the EMP and will emphasize project staff to abide by the instructions given in the EMP

1. Detailed Cost Estimations: This section will provide detailed cost of implementation and Monitoring of EMP and Monitoring of the and Table 6-4 provides the detailed cost estimates for the implementation and Monitoring of EMP.

7.7 Indus Dolphin game reserve management plan (IDGRMP)

240. An Indus Dolphin Game Reserve management Plan (IDGRMP) is currently under preparation and a draft was studied for the purpose of this EIA report. The IDGRMP after finalization will be approved by the government of Pakistan after which it will be implemented across the Game Reserve. The activity is being undertaken by the WWF under its wetalnds programme, a GEF funded programme that looks at all the wetlands of Pakistan with the objective of improving wetlands management. The draft IDGRMP has species specific plans as well, and has a Plan for the Blind Indus Dolphin, there are no specific measures proposed against noise pollution in the plan at present. Once the IDGRMP is finalized and implemented by GoP NSUSC will ensure that it is followed and the project does not in any manner violate it.

Table 6-1: Summary of Mitigation Measures

Issue	Phase	Proposed Mitigation Measure	Responsibility	Cost Estimate
Air quality deterioration	Construction	▪ Fugitive dust emissions will be minimized by appropriate methods, such as spraying water on soil, where required. ▪ Vehicle speed will be reduced to 15 km/h in dirt patches to avoid excessive dust emissions. ▪ In order to minimize exhaust emissions, generators, construction machinery and vehicles will be kept in good working condition and properly tuned. ▪ Construction camp will be located at Sukkur. No any camp will be established in protected area.	PEO IMC	Good industrial practices. No additional costs
Noise and Vibration	Construction and operation	▪ Construction camp will be located at Sukkur outside protected area. ▪ Machinery and equipment (potential noise producers) will be kept in good condition and fitted with mufflers where necessary. ▪ Within the river, the civil works will be done during the period (25th December to 10th January) when the gates of the barrage are opened having low level of water at the work sites with no Blind Dolpin Population in the pipe Right of Way. ▪ Daily noise monitoring during the pipe jacking period will be conducted and monthly noise monitoring will be conducted during the operation period. ▪ Ensure Work method and durartion is adjusted as per Noise Meter reading below ambient threshold of baseline ▪ The exposure to construction workers to noise will be minimized by use of air plugs and maintaining safe distance from high noise generating sources. ▪ Construction work will be restricted by allowing 6 hrs continuous work at site and the work will start again after 2 hrs interval during the same day. ▪ The pump house will be supported on piles to avoid vibration. ▪ No direct pumping will be carried out from the Indus River only on gravity	PEO HSEO NSUSC IMC	Cost of noise monitoring included in the monitoring programme

Issue	Phase	Proposed Mitigation Measure	Responsibility	Cost Estimate
		. ▪ Sump chamber will be constructed to receive water through gravity from Indus River ▪ Best available techniques will be used to minimize vibration at source and contruction of Baffale Walls .		
Water Use, Quality and Availabity	Construction and operation	▪ Minimize water use by adopting water conservation techniques. ▪ Domestic waste will be disposed off through municipal system at Sukkur. ▪ Precautions will be taken for transportation, storage and handling of fuel and oil, such as storing fuel within bunded areas, safe-driving practices during transportation.	PEO IMC	Good industrial practices. No additional costs Cost of training drivers is included in the monitoring programme
Flooding and Water Flow Regime	Construction and operation	▪ Water supply sources will be selected carefully to ensure that the project water requirement does not affect the local use. ▪ Mitigation measures inherent in the project design include the provision of flood management mechanisms.	PEO IMC	Good industrial practices. No additional costs
Soil Erosion	Construction and operation	▪ The area covered by the project activities will be kept to a minimum. Movement of construction equipment and vehicles will be restricted to the work areas. ▪ The construction corridor along the pipeline RoW will be properly marked. ▪ Surplus soil will be disposed of in a manner that does not disturb the natural drainage ▪ The natural drainage pattern will not be disturbed, and will be repaired where damaged ▪ Top soil along the trench will be stockpiles separately, and will be used as the upper most soil layer during the backfilling of the trench ▪ Safe driving practices will be observed to minimize soil erosion.	NSUSC, PEO IMC	Cost covered under plantation under O&M budget

Issue	Phase	Proposed Mitigation Measure	Responsibility	Cost Estimate
		Reduced speed limit of will be observed and monitored in the project area, and off-track driving will be strictly disallowed ▪ Plantation of native species along the banks of the River Indus and Bukkur Island to avoid soil erosion ▪ Plantation of 2000 native species along the banks of the River Indus and Bukkur Island to avoid soil erosion in affected area		
Damage to Vegetation Loss of Habitat Disturbance to Wildlife	Construction and Operation	▪ Clearing of vegetation will be kept to a minimum with regeneration and growth on the Bhakar Island on the cleared area with native species ▪ The cutting of trees will be prohibited. Under unavoidable circumstances any clearing required shall be done with prior approval and be compensated as per rules and regulations of Forest department. Minimum of 2000 new plants will be provided as native species for compensation and regeneration with one year protection by contractor ▪ Use of local vegetation/wood as fuel by crew personnel will be prohibited ▪ Unnecessary land uptake will be minimized ▪ Noise from construction activities and unnecessary movement of vehicles will be minimized by continuous monitoring ▪ Night work will not be allowed to provide relief to especially nocturnal species ▪ Effective construction planning and management to ensure that works are completed within time ▪ Noise from generators and machinery will be minimized using appropriate means (silencers, barriers, etc.) as required ▪ No refuse or waste will be left lying around work site. Waste disposal will be carried out to ensure no contamination of soil ▪ No work will be carried out in the project area during this breeding period (April-May) of Indus Dolphin ▪ Work within Indus River will be gradually started to give enough time to the aquatic fauna and Indus Dolphin leave the area fror short durartion	PEO, HSEO, NSUSC, IMC	Training cost 50,000 Rs covered under O&M budget

Issue	Phase	Proposed Mitigation Measure	Responsibility	Cost Estimate
		▪ The project implementation unit will closely liaise with the sindh wildlife department prior to any construction activity ▪ IMC will continouly monitor the actvity of Indus Dolpin during project actvity to adjust the work schedule and intensity		
Potential Disturbance to Indus Dolphin	Construction and operation	▪ Within the river for pipe Laying , the civil works will be done during the period (25th December to 10th January) when the gates of the barrage are opened having low level of water/ no water at the work sites of pipe line avoiding Indus Dolphin disturbences ▪ Avoiding contamination of the project area due to oil spills or domestic effluents etc in the Project Area ▪ Project related activities within Indus water at Jacking Point of Intake will start gradually to give time to the Indus Dolphin to leave the area with continuous monitoring and escorting the area in medium discrage floods not less then 30,000 cusecs ▪ Ensure Divers and Resuce Team from SWD and WWF are present all the time in the impact aea of Hydraulic Jacking (during Construction) to avoid any potential catch or disturbence to Indus Dolphin around Jacked Piped arae of 100 meter circle impact zone ▪ The jacked pipe water intake system will be provided with mesh size (5mm) to avoid aquatic fauna to enter into the sump chamber to avoid catch of Indus Dolphin ▪ Ensure presense of Indegenious divers in 100 meters zone of jack actvity to reflect back any incoming Indus Dolphin with continous monitoring to main river course during construction ▪ Stop all actvities in case a dolpin enters into 150 meters protective zone of Jacking by Sighing Team (IMC) ▪ Only allow jacking of pipe by hydraulic Jacking when the river flow at Sukkur Barrage is recorded above 30,000 cusesc and preferrbaly above 50,000 cusecs ▪ No actvity below 30,000 cusces flow is allowed at Jacking Place at	PEO, HSEO, NSUSC, IMC	Good industrial practices. No additional costs

Issue	Phase	Proposed Mitigation Measure	Responsibility	Cost Estimate
		Bhakkar Island		
Socioeconomic Impact and Disturbance to Archaeological or Cultural Sites	Construction	▪ To avoid occurrence of any unforeseen impacts at the implementation stage, construction works will be planned in due consultation with the fishermen communities. If required at the implementation stage fishermen will be compensated for any temporary loss in livelihood. ▪ The project implementation unit will closely liaise with the archeological department prior to any construction activity near the boundary of Bukkur Island.	PEO, HSEO, NSUSC, IMC	Archaelogist cost along with compensation to fisherman included in the project

Table 6-2: Summary of Monitoring Requirements

Project Activity	Potential Issue	Parameter to be Monitored	Location	Methods	Frequency	Responsibilities	Monitoring Cost
Construction	The effect of dust, emissions and noise	Dust, smoke, noise levels	Construction sites, access roads, and surrounding receptors	Visual observations for dust and smoke Use of noise meter for noise levels Underwater noise monitoring	Monthly	PEO, HSEO, IMC	Rs 2,000,000/- Purchase of noise meters. 2 boats Cost covered under O&M budget
Construction and Operation	To monitor potential adverse effect on Indus Dolphin Adverse effect on birds and other wildlife	Monitor potential disturbance to Indus Dolphin Density/population or species diversity	Project area	Visual observation Standard wildlife survey techniques	Daily during construction and monthly during operation for one year.	Continous monitoring during construction phase by external consultants in coordination with SWD and WWF.	Rs:2,700,000/- Continous monitoring during constrction and periodic monitoring during operation. Cost covered under O&M budget

Table 6-3: Cost of Environmental Management and Compliance

S.No	Description	Cost (Pak Rs.)	Remarks
1	Project Environment Officer	460,000	80, 000per month for six months
2			
3	Environmental Trainings	500,000	Trainings to the Contractor Staff
4	Plantation plan	500,000/-	Estimated cost which will be refined during project implementation
5	Other Mitigation Measures in Construction Phase	600,000	Rs 1,000,000 per month
Total		2,060,000	

Note: Cost covered under O&M budget.

Table 6-4: Cost of Environmental Monitoring of Indus Dolphin

S.No	Description	Cost (Pak Rs.)	Remarks*
1	Noise Meters	500,000/-	Surface and underwater noise meters
2	Environmental Trainings	500,000	Trainings for the Contactor and NSUSC
3	Independent Monitoring Consultant (including wildlife and cetacean expert)	1,200,000	Independent compliance and effects monitoring
4	2 Boat	16,00,000	SWD and WWF
5	Miscellaneous Expenses for Monitoring	150,000/-	Rs 25,000 per month
Total			

* All equipment and assents used in monitoring will be handed over to NSUSC after construction.

8 PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

241. In this Section of the EIA Report for this Project, the Meaningful consultation process has been carried out to satisfy the ADB requirements as well as the requirements of the IEE and EIA Review Regulations, 2000.

8.1 Approach to Public Consultation

242. The public consultation (PC) process with various stakeholders has been carried out for the identification and mitigation of the Environmental Impacts at earliest stages. Public consultation for this EIA Study has been carried out during the planning and design stage of this project and views and recommendation suggested by the stakeholders have been incorporated in in this EIA Study

8.1.1 Public Consultation Process

243. The public consultation process has commenced in the initial/ feasibility stages (prior to construction) in order to disclose the project information to the stakeholders and record feedback regarding the proposed project and preferences.

244. The focus of attention has been given to the aquatic flora and fauna near the proposed water intake and pipeline route. In the detailed Consultation with Stakeholders few people registered views and recommendations but no any person/ officer was in opposition of this proposed project.

8.1.2 Consultation Methodology

245. Since there is no community residing within the project area therefore the project is not likely to have social impacts. However informal consultations conducted with the communities during the field survey to record their point of view with reference to the project. Fisherman communities were also consulted to record their concerns during the field survey for the EIA. The objective of these meetings was to solicit and record their views and concerns as may be incorporated in project design at the planning phase.

246. In the same vein, meetings were held with community and members of local and provincial government and NGOs. All the stakeholders were briefed regarding the proposed project. Their concerns and suggestions were recorded which are reproduced in this section of the report. Photographic record is presented in Annexure-D

8.1.3 Community Consultations

247. Community consultations were carried out through informal meetings, and focus group discussions especially covering issues related to Gender. The consultation exercise was conducted in Sindhi. The socioeconomic team, assisted by environmental specialists initiated the sessions by giving a brief, simple and non-technical description of the project providing an overview of all likely positive and negative impacts. This was followed by an open discussion in which all participants were encouraged to voice their concerns and opinions.

Feedback obtained from the stakeholders was documented, and all issues and suggestions raised were recorded.

248. All information was imparted to the communities and other stakeholders in such a manner that their expectations were not unnecessarily or unrealistically raised in order to avoid any future conflict involving tribal leaders or local administrators.

249. Community's Concerns: All the people with whom meetings were held were in favour of development of this Project as this will improve the water supply system of the city. They envisaged in the project activities a short-term and as well as long term benefit.

250. However, the communities raised some legitimate concerns. The main concerns common to most communities are listed below.

i. The local residents of Sukkur should be given priority during employment process for various project-related works and activities; especially local unemployed educated people should also be given preference for technical jobs
ii. The noise level should be kept to the minimal so that to minimize disturbance to the aquatic fauna
iii. Consultations with fisheries department and fishermen communities prior to construction works

8.1.4 Other Stakeholders

251. In addition to holding consultation meetings with communities, meetings with members of local and provincial government and NGOs were also deemed essential. All the stakeholders were given maximum project information verbally and project area map was shown to them. Their concerns and suggestions were noted which have been reproduced below. A list of these stakeholders consulted is provided in Annexure-D.

252. Proceedings of the meeting with Conservator SWD, Deputy Conservator SDW, Deputy Director EPA (Sukkur), Project Manager SPO, Imran Malik WWF, Executive Director SYWO and District Executive Manager Hands are presented below. The rest of the meetings were mostly of the sort of information collection and dissemination. The minutes of meeting with the stakeholders is provided in Annexure-D.

253. Deputy Director, Sindh Environmental Protection Agency, Sukkur: A consultation was held with Muneer Abbasi to discuss the environmental issues related to the proposed project. During the meeting, the HPK team briefed them regarding the proposed project, its location and the environmental issues pertaining to the proposed activities. He expressed interest in the briefing and provided very valuable suggestions given hereunder.

i. Waste should not be disposed of untreated.
ii. Water analysis should be carried out to depict water quality of the project area.
iii. He suggested to provide a concise report instead of voluminous reports.

254. M/s RCC consultants obtained formal approval from the Sindh Wildlife Department (SWD) for undertaking field survey of project area within the IDR. Representative of Sindh Wildlife Department (at Sukkur) also accompanied the field survey team as per instructions of Conservator, Sindh Wildlife Department.

255. Conservator, Sindh Wildlife Department: A consultation was held with Mr. Saeed Baloch to discuss the environmental issues related to the proposed project. He was informed with the help of the project area map about the proposed activities. His main concerns and suggestions were as follows:

i. The area for proposed activities is located in Indus Dolphin Reserve. The proposed activity will certainly disturb the wildlife in the reserve. Therefore proper mitigation measures should be suggested in the EIA report to lessen the impact on the wildlife of the area.
ii. No direct pumping of water from Indus River and suggested construction of sump chamber to pump water.
iii. Appropriate measures should be suggested to minimize impact of vibration on the Indus Dolphin.
iv. The crew members should be imparted with wildlife awareness trainings prior to start work in protected area.
v. Effects monitoring of the proposed activity should be conducted during the execution of the project to evaluate the impacts.
vi. Representative of the wildlife department should accompany the EIA team during the field survey to identify any protected species and or/habitat.
vii. Consultations with Sindh Wildlife department prior to construction works.

256. Deputy Conservator, Sindh Wildlife Department Sukkur: The survey team visited Sindh Wildlife Department at Sukkur to meet Mr. Ghulam Ali Gaddani, The Deputy Conservator. He was informed with the help of project's area map about the proposed activities in the protected areas and its surroundings. He shared data regarding Indus Dolphin Reserve and provided relevant information of the project area. He informed about the survey for Indus Dolphin has been recently in 2011 and shared the report with the EIA team. He understands the project activities very well and welcomed the project initiation. He advised that every effort should be made to protect the wildlife of the area and proper mitigation measures should be adopted in this regard. He informed that Indus dolphin can travel into the canals to a fair distance. The rescues are normally done from Dadu canal, Rice canal, Khirthar (North West) canal and Rohri canal. Several dolphins were often found dead at the time of rescue and some dolphins even die during rescue operation. He also informed that SWD should be fully involved by the proponent during the execution of the project.

257. Project Manager, SPO: EIA team contacted Mr. Nawaz Phulpoto at his head office in Sukkur. He was more concerned about the impacts of the project and suggestions in this regard are as under:

i. Project activities should be conducted in the manner to avoid disturbance to the Indus Dolphins.
ii. Waste associated with the proposed project should be disposed off properly.
iii. Appropriate mitigation measures should be recommended for different environmental aspects associated with the proposed project to lessen the impact.

258. Senior Programme Officer, WWF Sukkur: A meeting was held with Mr. Mohammad Imran Malik at his head office in Sukkur. He briefed the EIA team about the initiatives taken by WWF Pakistan for the conservation and protection of Indus Dolphin. He was more concerned about the impacts of the project and suggestions in this regard are as under:

i. Assessment of impacts should be carried out keeping the ecological sensitivity of the areas;
ii. Independent monitoring of the proposed protect activities during execution of the project;
iii. Ensure protection of key species, Indus dolphin, by suggesting proper mitigation measures to lessen the impact; and
iv. Community rights should be safeguarded.

259. Executive Director, SYWO Sukkur: A meeting was held with Mr. Shahzado Khaskheli at his head office in Sukkur. SYWO is the NGO working in the field of community mobilization, health and capacity development in the Khairpur and Sukkur districts. He was briefed about the planned project activities in the area. He welcomed the idea of proposed activities and recommended the local employment during the project construction and execution phase.

A. Consultation and Disclosure during Implementation

260. Public Hearing: The public hearing will provide a forum for the post submission consultation on the EIA. The Sindh EPA within 10 days of the submission of the EIA will publish a public notice in any English or Urdu or any national newspaper and in a local newspaper of general circulation in the area affected by the project. The EPA will fix a date (not be earlier than 30 days from the date of publication of the public notice) and venue for the public hearing. The circulation of the EIA reports, gathering of comments on EIA, and ensuring public participation during public hearings will be the responsibility of the concerned EPA. The public hearing will preferably be held at the town/city nearest to the project area with representatives from government agencies, academia, and prominent NGO's attending.

9 CONCLUSION

9.1 Findings

261. The Environmental Impact Assessment (EIA) assessed the environmental impacts of all components proposed for the Water intake at Sukkur. Potential adverse impacts were identified related to design, location, construction and operation of the project.

262. The potential adverse environmental impacts of the proposed water intake are mainly related to the construction period, which can be minimized by the mitigating measures and environmentally sound engineering and construction practices.

263. As stated above, most impacts are due to construction; this is because construction work is to be carried out in parts of IDR. The important impacts identified are: disturbance to Indus Dolphin; generation of dust and noise from construction activities.

9.2 Recommendations

264. The EIA makes the following recommendations:

(1) It is recommended in this EIA Study that, these impacts are mostly temporary in nature and can be properly avoided or mitigated by following the proposed mitigation measures given in the EMP of this Report. The mitigation measures includes no direct pumping from Indus River, restricting construction work, providing sump to collect, and laying of underground pipeline careful alignment of pipelines instead of bridge supported over head pipeline, avoiding cutting of trees and minimizing the construction area.

(2) For the Proper Implementation of EMP of this EIA Study, The cost estimated for EMP should be included in the cost of bid Document for Contractor and the cost estimated for the Environmental Monitoring for Indus Dolphin should be placed in Independent Monitoring Consultant's (IMC) bid Evaluation.

9.3 Conclusion

265. The proposed project will bring about a net-positive benefit in terms of improved water supply to Sukkur City. Environmental impacts of the project will be associated mostly with the construction phase. The impacts mainly will be temporary or reversible, phased over a period of time, localised, and manageable.

266. The project will not have any long term significant impacts on Indus Dolphin. The impacts on fish and protected ecological and archaeological sites are insignificant. However, monitoring measures have been recommended to ensure that any unforeseen impacts on Indus Dolphin can be identified and mitigated during the project implementation stage.

267. On the basis of the above, the EIA concludes that, all mitigation measures for potentially impacts identified in the EIA are implemented as per the prescriptions of the EIA, no significant unacceptable changes in the baseline environmental conditions of the project area

will occur. All the impacts after mitigation of impacts are insignificant, reversible and of short term duration. The operation will have a visible positive impact on the socio-economic conditions of the local residents of the area.

ANNEXURES:

ANNEXURE-A: Project Description Data

1: Photographs: Proposed route passing through existing RoW

2: Notification Indus Dolphin Reserve

ANNEXURE-B: Baseline Environmental Data

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B-15: Photographic Records: Biological Environment

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B-17: National Environmental Quality Standards

B-18: NEQS for municipal and industrial effluentsa

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B-20: NEQS for motor vehicle exhaust and noise

B-21: National Environmental Quality Standards for Noise

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C-2: Significance Ranking of Anticipated Impacts

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ANNEXURE-F Noise Level Reading at Bukhar Iseland and lansdown Bridge

ANNEXURE-F Hydrological Investigation Report

ANNEXURE-G: Indus dolphin Game Reserve Management Plan, WWF Pak

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ANNEXURE-I: Hydrological Investigation Report

ANNEXURE-A: Project Description Data

Photograph 2-1: Proposed route passing through existing RoW

Photograph 2-2: Agricultural fields along the existing RoW

Photograph 2-3: Proposed pipeline route passing through Indus River

Photograph 2-4: Proposed Location of pump house

EXTRAORDINARY Registered No. S-[illegible]

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The Sind Government Gazette

PUBLISHED BY AUTHORITY

KARACHI, FRIDAY, DECEMBER 27, 1974

PART I

GOVERNMENT OF SIND

WILDLIFE AND FOREST DEPARTMENT

NOTIFICATION

Karachi, the 23rd December 1974

No. WL&FT (DCF-GEN 762)/74.—In exercise of the powers conferred by section 40 of the Sind Wildlife Protection Ordinance, 1972 (Sind Ordinance V of 1972) the Government of Sind are pleased to direct that in the Second Schedule to the said Ordinance the following amendments shall be made namely:—

AMENDMENTS

1. In Second Schedule for the existing entry "Platanista gangetica—River Dolphin or [illegible] Susu, Suse, Sishuk, Bhulan, Sunsar" the following entry shall be substituted:

"Platanista [illegible] Indus Dolphin or [illegible], Susu, Susak, Sishuk, Bhulan, Sunsar"

Karachi, the 24th December 1974

No. WL&FT (DCF-GEN-767) 74.—In exercise of the powers conferred by section 16 of the Sind Wildlife Protection Ordinance, 1972 (Sind Ordinance V of 1972) the Government of Sind are pleased to declare the waters of river Indus between Guddu and Sukkur Barrages to be Game Reserve in relation to Indus Dolphin or Susu (Platanista [illegible]).

W. A. KERMANI,
Secretary to the Government of Sind
Wildlife and Forest Department.

L (iv) —Ext.-I.—647 (1934) Price: 65 Paisa

KARACHI: PRINTED AT THE SIND GOVERNMENT PRESS

(1650)-27-12-74—III

ANNEXURE-B: Baseline Environmental Data

Figure 4-1: A typical lithological Representation of the Area

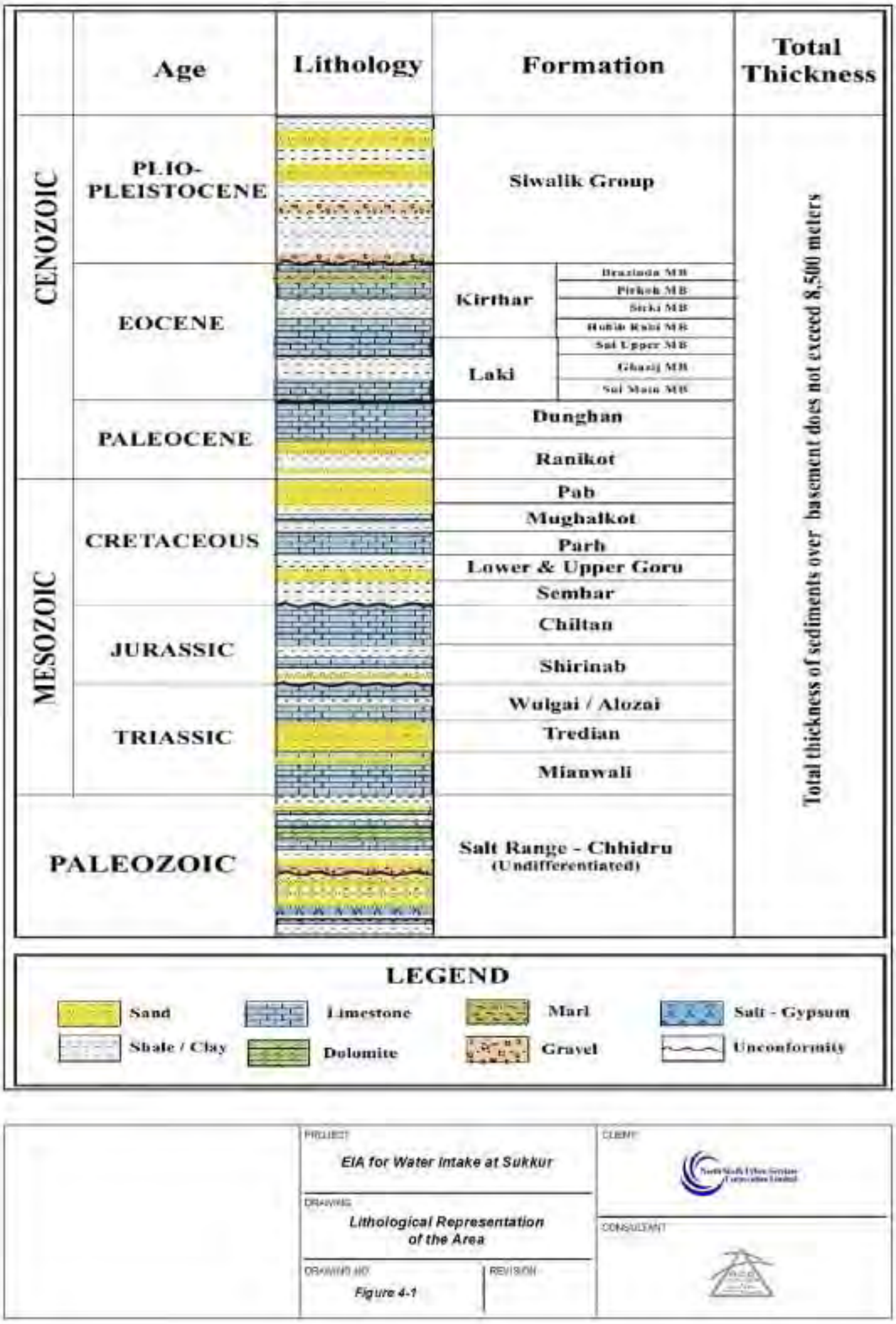

Figure 4-2: Topographical Features of the Project Area

Figure 4-3:Mean of Monthly Maximum Temperature for Sukkur Station

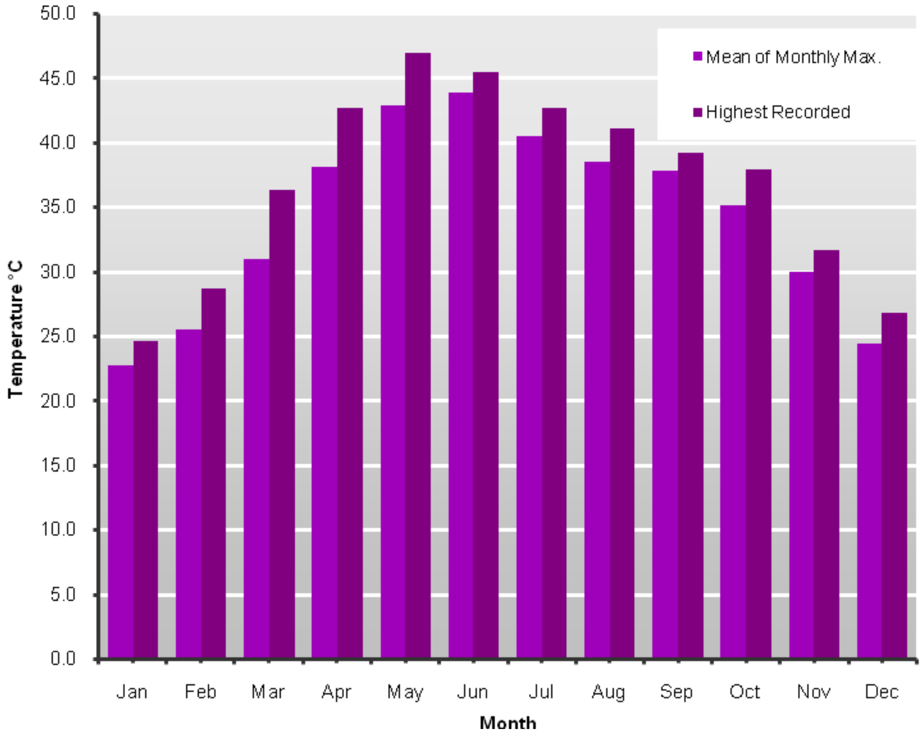

Figure 4-4: Mean of Monthly Minimum Temperature for Sukkur Station

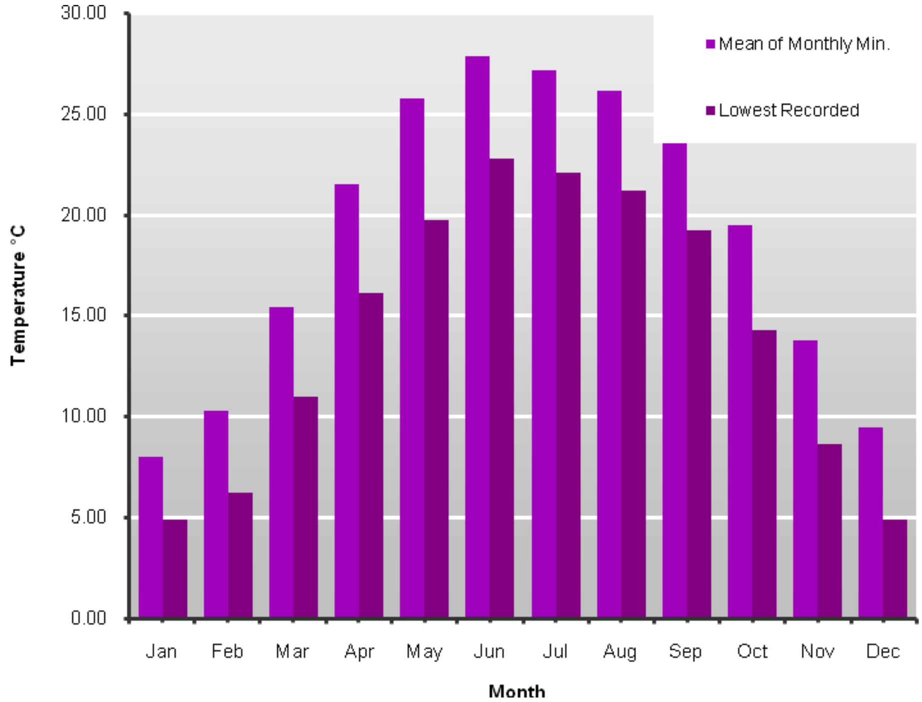

Figure 4-5: Rainfall Data for Sukkur Station

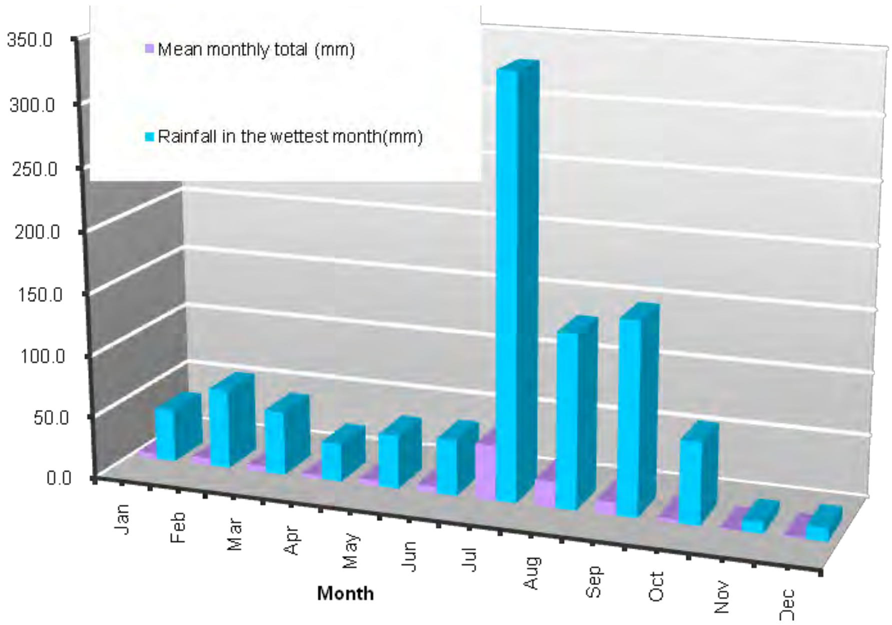

Table 4-1: Maximum Discharge Levels Recorded at Sukkur Barrage (Cusecs)

S.NO	Date	River Left Bank gauge (ft)	Sadhu Belo gauge R.L (ft)	Discharge in Cusecs
1	10/8/1961	200	200.48	828160
2	26-08-1962	197.85	198.33	439687
3	20-08-1963	198.1	198.58	522552
4	29-08-1964	200.7	201.18	710010
5	7/9/1965	198.4	198.88	989991
6	18-08-1966	200	200.48	665029
7	15-08-1967	198.6	199.08	656945
8	23-08-1968	198.4	198.88	585896
9	22-08-1969	199.9	200.38	652781
10	22-08-1970	198.6	199.08	329275
11	19-08-1971	198.7	199.18	581600
12	17-08-1972	200.4	200.88	374971
13	21-08-1973	202.9	203.38	1117246
14	11/6/1974	199.2	199.68	1177700
15	2/9/1975	202.5	202.98	1051316
16	17-08-1976	204.4	204.88	1200574
17	28-09-1977	199.55	200.03	1166336
18	20-08-1978	202.5	202.98	1116430
19	11/8/1979	199.1	199.58	501334
20	17-08-1980	198.1	198.58	615778
21	8/8/1981	199.15	199.63	631359
22	20-08-1982	198.5	198.98	465000
23	16-08-1983	201.3	201.78	763421
24	7/9/1984	199	199.48	607398
25	16-08-1985	198.8	199.28	390380
26	15-08-1986	199.3	199.78	1166574
27	4/9/1987	198.8	199.28	316245
28	31-07-1988	200.3	200.78	1118856
29	10/8/1989	198.8	199.28	910295
30	9/7/1990	199.3	199.78	551867
31	27-06-1991	199.3	199.78	567165
32	20-09-1992	199.3	199.78	1064200
33	25-07-1993	199.6	200.08	569160
34	2/8/1994	200.05	200.53	757350
35	7/8/1995	200.3	200.78	985929
36	24-08-1996	200.1	200.58	757190
37	8/9/1997	199.6	200.08	801170
38	24-07-1998	199.7	200.18	628755
39	1/10/1999	200	200.48	91818
40	9/8/2000	199.3	199.78	170775
41	1/8/2001	199.2	199.68	217848
42	23-08-2002	199	199.48	237549
43	7/8/2003	199.8	200.28	335933
44	24-07-2004	198.8	199.28	126130

S.NO	Date	River Left Bank gauge (ft)	Sadhu Belo gauge R.L (ft)	Discharge in Cusecs
45	26-07-2005	198.8	199.28	508837
46	16-08-2006	199.6	200.08	554088
47	24-08-2007	199.6	200.08	297840
48	15-08-2008	199.7	200.18	250085
49	26-08-2009	199.7	200.18	195717
50	10/8/2010	203.8	204.28	1130995

Table 4-2: Closure Periods from Years 1961 to 2011

Year	Total No of Closure Days	Gauge Level	Year	Total No of Closure Days	Gauge Level
1961-1962	16	185.56	1986-1987	16	183.58
1962-1963	15	184.22	1987-1988	16	184.48
1963-1964	17	185.57	1988-1989	15	184.28
1964-1965	20	184.88	1989-1990	16	186.53
1965-1966	17	183.94	1990-1991	16	184.08
1966-1967	15	183.33	1991-1992	15	184.28
1967-1968	11	187.2	1992-1993	15	185.98
1968-1969	13	184.96	1993-1994	16	187.08
1969-1970	14	184.72	1994-1995	18	182.28
1970-1971	13	193.43	1995-1996	15	187.28
1971-1972	7	185.11	1996-1997	13	183.78
1972-1973	15	185.86	1997-1998	16	184.68
1973-1974	15	185.23	1998-1999	16	185.98
1974-1975	15	185.23	1999-2000	14	184.38
1975-1976	15	184.61	2000-2001	13	182.48
1976-1977	15	185.23	2001-2002	16	180.62
1977-1978	15	184.18	2002-2003	19	181.48
1978-1979	15	185.22	2003-2004	17	180.98
1979-1980	14	185.9	2004-2005	24	182.88
1980-1981	25	185.8	2005-2006	21	182.08
1981-1982	14	185.39	2006-2007	15	184.78
1982-1983	18	185.2	2007-2008	16	184.28
1983-1984	15	187.46	2008-2009	15	183.48
1984-1985	16	185.28	2009-2010	16	185.68
1985-1986	16	186.58	2010-2011	14	184.48

Table 4-3: List of Floral Species in the Project Area

S. No	Plant species	Local Name	Family	Habit
1	Acacia nilotica (Linn.) Delile.	Sindhi Babur	Mimosaceae	Tree
2	Albizia lebbeck (Linn.) Bth.	Sarianh	Mimosaceae	Tree
3	Albizia procera (Roxb.) Benth	Sarianh	Mimosaceae	Tree
4	Alhagi maurorum Medic.	Kandero	Fabaceae	Herb
5	Azadirachta indica Adr. Juss.	Neem	Meliaceae	Tree
6	Bombax ceiba L.	Sumbul	Malvaceae	Tree
7	Calotropis procera (Willd.) R. Br.	Ak	Asclepiadaceae	Shrub
8	Cynodon dactylon (Linn.) Pers.	Chhabar	Poaceae	Grass
9	Dalbergia sisso Roxb.	Taari	Fabaceae	Tree
10	Desmostachya bipinnata (L.) Stapf.	Drabh	Poaceae	Grass
11	Eclipta prostrata(Linn.) Mant.	Daryahi Buti	Asteraceae	Herb
12	Eucalyptus spp.	sufedo	Myrtaceae	Tree
13	Euphorbia hirta Forsk.	Kherawal	Euphorbiaceae	Herb
14	Ficus benghalensis L.	Bar	Moraceae	Tree
15	Ficus religiosa Linn.	Pepul	Moraceae	Tree
16	Launaea procumbens(Roxb.) Rammayya & Rajagopal.	Bhattar	Asteraceae	Herb
17	Mukia maderaspatana (Linn.) M.J. Roem.	Nandh Wal	Cucurbitaceae	Herb
18	Phragmites karka (Retz.) Trin	Naro	Poaceae	Grass
19	Phoenix dactylifera L.	Khaji	Arecaceae	Tree
20	Phyla nodiflora (L.) Greene.	Bukkan	Verbenaceae	Herb
21	Phyllanthus reticulatus Poir.	Kamooh	Euphorbiaceae	Shrub
22	Prosopis juliflora (Sw.) DC.	Davi	Mimosaceae	Shrub
23	Saccharum bengalensis Retz.	Kanh, Booro	Poaceae	Grass
24	Saccharum griffithii Munro ex Boiss.	Kahan	Poaceae	Grass
25	Salvadora persica L.	Khabbar	Salvadoraceae	Tree
26	Solanum nigrum Linn.	Kanwal	Solanaceae	Herb
27	Solanum surattense Burm.f.	Kanderi	Solanaceae	Herb
28	Syzgium cumini (L.) Skeel	Jaman	Myrtaceae	Tree
29	Tamarix aphylla (Linn.) Karst.	Lao	Tamaricaceae	Tree
30	Tamarix indica Willd.	Lao	Tamaricaceae	Shrub
31	Typha domingensis Pers.	Pan	Typhaceae	Sedge
32	Typha elephantina Roxb.	Pan	Typhaceae	Sedge
33	Withania somnifera (L.) Dunal	………………	Solanaceae	Herb
34	Zizyphus nummularia mauritiana Lam.	Ber	Rhamnaceae	Tree

Table 4-4: List of Vegetation Species of Indus River and Bukkur Island (20x20m Quadrant)

S. No	Plant species name	Density	Relative density	Frequency	Relative frequency	Total cover	Relative cover	I.V.I
1	Acacia nilotica	3.0	7.96	100.0	16.67	181025.28	12.74	12.46
2	Calotropis procera	0.3	0.88	33.3	5.56	6364.17	0.45	2.30
3	Eucliptus	0.7	1.77	33.3	5.56	50913.36	3.58	3.64
4	Ficius religiosa	0.3	0.88	33.3	5.56	70713	4.97	3.81
5	Phyllanthus reticulates	2.0	5.31	33.3	5.56	67884.48	4.78	5.21
6	Prosopis juliflora	2.0	5.31	66.7	11.11	136240.38	9.58	8.67
7	Saccharum bengalense	5.0	13.27	66.7	11.11	230995.8	16.25	13.55
8	Saccharum griffithii	21.0	55.75	100.0	16.67	494991	34.82	35.75
9	Salvadora persica	0.3	0.88	33.3	5.56	80455.68	5.66	4.03
10	Tamarix indica	3.0	7.96	100.0	16.67	101826.72	7.16	10.60

Table 4-6: List of vegetation species of Indus River and Bukkur Island (2x2m Quadrant)

No	Plant species name	Density	Relative density	Frequency	Relative frequency	Total cover	Relative cover	I.V.I
1	Alhaji maurorum	1.0	6.25	33.3	6.67	2413.7	8.02	6.98
2	Cynodon dactylon	3.0	18.75	66.7	13.33	5543.9	18.42	16.83
3	Launaea procumbens	2.0	12.50	66.7	13.33	2715.4	9.02	11.62
4	Melilotus indica	1.3	8.33	33.3	6.67	804.6	2.67	5.89
5	Phyla nodiflora	2.3	14.58	66.7	13.33	6357.9	21.12	16.35
6	Rumex dentatus	0.3	2.08	33.3	6.67	254.6	0.85	3.20
7	Solanum nigrum	1.0	6.25	33.3	6.67	3771.4	12.53	8.48
8	Solanum surattense	0.7	4.17	33.3	6.67	1062.3	3.53	4.79
9	Typha domingenasis	2.3	14.58	66.7	13.33	2200.0	7.31	11.74
10	Typha elephantiyna	1.3	8.33	33.3	6.67	2464.0	8.19	7.73
11	Withania somnifera	0.7	4.17	33.3	6.67	2514.2	4.78	5.21

Table 4-5: List of Birds Observed in the Project Area

No.	Common Name	Scientific Name	Status		Occurrence				Listing			
			Migratory	Resident	Common	Abundant	Less Common	Rare	WPO/Act	IUCN Red List	CMS Appendix	CITES Appendix
1	Bank Myna	Acridotheres ginginianus		x		x						
2	Bay-backed Shrike	Lanius vittatus		x	x							
3	Black Redstart	Phoenicurus ochruros		x	x							
4	Black-winged Stilt	Himantopus himantopus		x	x							
5	Blue Rock Pigeon	Columba livia		x		x						III
6	Cattle Egret	Bubulcus ibis		x	x				x			III
7	Common Chiffchaff	Phylloscopos collybita	x		x							
8	Common Babbler	Turdoides caudatus		x		x						
16	Common Myna	Acridotheres tristis		x		x						
10	Common Sandpiper	Actitis hypoleucos	x		x							
11	Crested Lark	Galerida cristata		x		x						
12	Crow Pheasant	Centropus sinensis		x	x							
9	Eurasian Kestrel	Falco tinnunculus	x		x				x		II	II
13	Grey Heron	Ardea cinerea	x		x				x			
14	House Crow	Corvus splendens		x		x						
15	House Sparrow	Passer domesticus		x		x						

No.	Common Name	Scientific Name	Status		Occurrence				Listing			
			Migratory	Resident	Common	Abundant	Less Common	Rare	WPO/Act	IUCN Red List	CMS Appendix	CITES Appendix
17	Indian Pond Heron	Ardeola grayii		x		x			x			
18	Indian River Tern	Sterna aurantia		x	x							
19	Indian Robin	Saxicoloides fulicata		x	x							
20	Indian Roller	Coracias benghalensis		x	x							
21	Indian sand Martin	Riparia paludicola		x		x						
22	Indian Tree-Pie	Dendrocitta vagabunda		x	x							
23	Large Egret	Egretta alba	x		x				x			
24	Large Pied Wagtail	Motacilla maderaspatensis		x	x							
25	Lesser Whitethroat	Sylvia curruca	x			x						
26	Little Brown Dove	Streptopelia senegalensis		x		x						III
27	Little Cormorant	Phalacrocorax niger		x	x				x			
28	Little Egret	Egretta garzetta		x	x				x			
29	Little Green Bee-eater	Merops orientalis		x		x						
30	Little Stint	Calidris minuta	x			x					II	
31	Long-tailed Grass Warbler	Prinia burnesii		x			x			LR/nt		
32	Marsh Harrier	Circus aeruginosus	x		x				x			II
33	Pied Bushchat	Saxicola caprata		x		x						

No.	Common Name	Scientific Name	Status		Occurrence				Listing			
			Migratory	Resident	Common	Abundant	Less Common	Rare	WPO/Act	IUCN Red List	CMS Appendix	CITES Appendix
34	Redshank	Tringa totanus	x		x						II	
35	Red-vented Bulbul	Pycnonotus cafer		x		x						
36	Red-wattled Lapwing	Hoplopterus indicus		x		x						
37	Rose-ringed Parakeet	Psittacula krameri		x		x						III
38	White / Pied Wagtail	Motacilla alba	x			x						
39	White-browed Fantail Flycatcher	Rhipidura aureola		x	x							
40	White-cheeked Bulbul	Pycnonotus leucogenys		x		x						
41	Yellow Wagtail	Motacilla flava	x		x							

Note:

SWPO: Sindh Wildlife Protection Ordinance

CITES: Convention on the International Trade in Endangered Species

IUCN: International Union for Conservation of Nature

CMS: Convention on migratory species

Table 4-6: List of Mammals Observed in the Project Area

No	English Name	Scientific Name	Occurrence			Listing	
			Common	Less Common	Rare	SWPO	IUCN
1	Five Stripped Palm Squirrel	Funambulus pennanti	x				
2	House Mouse	Mus musculus	x				
3	Indian Gerbil	Tatera indica	x				
4	Indian Grey Mongoose	Herpestes edwardsi			x		
5	Indus Dolphin/Bhulan	Platanista minor		x		x	EN
6	Small Indian Mongoose	Herpestes javanicus	x				
7	Indian desert gerbil	Meriones hurrianae		x			
8	Little indian field mouse	Mus booduga		x			

Note: EN: Endangered.

Table 4-7: List of Reptile Species Observed in the Project Area

No	English Name	Scientific Name	Occurrence			Listing		
			Common	Less Common	Rare	SWPO	IUCN	CITES
1	Brilliant Agama	Trapelus agilus isolepis		x				
2	Indian Cobra	Naja naja naja		x				II
3	Indian Monitor	Varanus bengalensis	x			x		I
4	Saw scaled Viper	Echis carinatus	x					
5	Sindh Sand Gecko	Crossobamon orientalis	x					
6	Indian gardin lizard	Calotes versicolor	x					
7	Indian softsheel turtle	Aspideretes gangeticus		x		VU		I
8	Indian pound turtle	Lissemys punctata	x					II
9	Checkered Keelback	Xenochrophis Piscator		x				

Note: VU: Vulnerable

Photographic Records: Physical Environment

Photograph 4-1: A view of Bukkur Island

Photograph 4-2: Agricultural Land

Photograph 4-3: Indus River

Photograph 4-4: A view of Lansdowne bridge

Photograph 4-5: A view of right bank of Indus River

Photograph 4-6: A view of old open dug well

Photographic Records: Biological Environment

Photograph 4-7: Acacia nilotica

Photograph 4-8: Salvadora persica

Photograph 4-9: Solanum nigrum

Photograph 4-10: Alhaji maurorum

Photograph 4-11: Red vented bulbul

Photograph 4-12: Phylanodiflora

Photograph 4-13: Indus Dolphin

Photograph 4-14: A view of flock of birds

Photograph 4-15: Indian robin

Photograph 4-16: A flock of Black winged stilt

Photograph 4-17: Indian monitor lizard

Photograph 4-18: Survey team during field visit

Photographic Records: Socioeconomic, archaeological and cultural Environment

Photograph 4-19: A view of Sadhu Belo

Photograph 4-20: Sat Bahan Astan

Photograph 4-21: Kalka Devi

Photograph 4-22: Consultation with Fisherman

Photograph 4-23: A view of Bukkur Fort

Photograph 4-24: Indus Dolphin Centre

Table B-1: NEQS for municipal and industrial effluentsa

Parameters	Into Inland Water	Into Sewage Treatment[b]
Temperature or temperature increase[c]	≤3°C	≤3°C
PH	6-9	6-9
Biochemical Oxygen Demand (BOD_5) at 20°C[d]	80	250
Chemical Oxygen Demand (COD)[d]	150	400
Total Suspended Solids (TSS)	200	400
Total Dissolved Solids (TDS)	3,500	3,500
Grease and oil	10	10
Phenolic compounds (as phenol)	0.1	0.3
Chloride (as Cl^-)	1,000	1,000
Fluoride (as F)	10	10
Total cyanide (as CN-)	1.0	1.0
An-ionic detergents (as MBAS)[e]	20	20
Sulphate (SO_4)	600	1000
Sulphide (S-)	1.0	1.0
Ammonia (NH_3)	40	40
Pesticides[f]	0.15	0.15
Cadmium[g]	0.1	0.1
Chromium (trivalent & hexavalent)[g]	1.0	1.0
Copper[g]	1.0	1.0
Lead[g]	0.5	0.5
Mercury[g]	0.01	0.01
Selenium[g]	0.5	0.5
Nickel[g]	1.0	1.0
Silver[g]	1.0	1.0
Total Toxic metals	2.0	2.0
Zinc	5.0	5.0
Arsenic[g]	1.0	1.0
Barium[g]	1.5	1.5
Iron	8.0	8.0
Manganese	1.5	1.5

Parameters	Into Inland Water	Into Sewage Treatment[b]
Boron[g]	6.0	6.0
Chlorine	1.0	1.0

Source: Qadar (2003).

Notes:

[a] All values are in mg/l, unless otherwise defined

[b] Applicable only when and where sewage treatment is operational and BOD5=80 mg/L is achieved by the sewage treatment system

[c] The effluent should not result in temperature increase of more than 3°C at the edge of zone where initial mixing and dilution take place in the receiving body. In case zone is defined, use 100 meters from the point of discharge

[d] Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent

[e] Modified Benzene Alkyl Sulphate; assuming surfactant as biodegradable

[f] Pesticides include herbicide, fungicides and insecticides

[g] Subject to the total toxic metals discharge should not exceed level of total toxic metals

Table B-2: NEQS for municipal and industrial effluents[a]

Parameters	Into Inland Water	Into Sewage Treatment[b]
Temperature or temperature increase[c]	≤3°C	≤3°C
PH	6-9	6-9
Biochemical Oxygen Demand (BOD_5) at 20°C[d]	80	250
Chemical Oxygen Demand (COD)[d]	150	400
Total Suspended Solids (TSS)	200	400
Total Dissolved Solids (TDS)	3,500	3,500
Grease and oil	10	10
Phenolic compounds (as phenol)	0.1	0.3
Chloride (as Cl^-)	1,000	1,000
Fluoride (as F)	10	10
Total cyanide (as CN-)	1.0	1.0
An-ionic detergents (as MBAS)[e]	20	20
Sulphate (SO_4)	600	1000
Sulphide (S-)	1.0	1.0
Ammonia (NH_3)	40	40
Pesticides[f]	0.15	0.15
Cadmium[g]	0.1	0.1
Chromium (trivalent & hexavalent)[g]	1.0	1.0
Copper[g]	1.0	1.0
Lead[g]	0.5	0.5
Mercury[g]	0.01	0.01
Selenium[g]	0.5	0.5
Nickel[g]	1.0	1.0
Silver[g]	1.0	1.0
Total Toxic metals	2.0	2.0
Zinc	5.0	5.0
Arsenic[g]	1.0	1.0
Barium[g]	1.5	1.5
Iron	8.0	8.0
Manganese	1.5	1.5
Boron[g]	6.0	6.0
Chlorine	1.0	1.0

Source: Qadar (2003)

Notes:

[a] All values are in mg/l, unless otherwise defined

[b] Applicable only when and where sewage treatment is operational and BOD5=80 mg/L is achieved by the sewage treatment system

[c] The effluent should not result in temperature increase of more than 3°C at the edge of zone where initial mixing and dilution take place in the receiving body. In case zone is defined, use 100 meters from the point of discharge

[d] Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent

[e] Modified Benzene Alkyl Sulphate; assuming surfactant as biodegradable

[f] Pesticides include herbicide, fungicides and insecticides

[g] Subject to the total toxic metals discharge should not exceed level of total toxic metals

Table B-3: NEQS for selected gaseous pollutants from industrial sourcesa

Parameter	Source of emission	Standard
Smoke	Any	40% or 2 Ringlemann scale or equivalent smoke number
Particulate matter[b]	Boilers and furnaces:	
	Oil fired	300
	Coal fired	500
	Cement kilns	300
	Grinding, crushing, clinker coolers and related processes, metallurgical processes, converter blast furnaces and cupolas	500
Hydrogen chloride	Any	400
Chlorine	Any	150
Hydrogen fluoride	Any	150
Hydrogen sulfide	Any	10
Sulfur oxides[c]	Sulfuric acid/Sulfonic acid plants	5,000
	Other plants except power plants operating on oil and coal	1,700
Carbon monoxide	Any	800
Lead	Any	50
Mercury	Any	10
Cadmium	Any	20
Arsenic	Any	20
Copper	Any	50
Antimony	Any	20
Zinc	Any	200
Oxides of nitrogen[d]	Nitric acid manufacturing unit	3,000
	Other plants except power plants operating on oil or coal:	
	Oil Fired	400
	Coal fired	600
	Cement kilns	1,200

Source: Qadar (2003)

Notes:

a All values are in mg/Nm^3, unless otherwise defined

b Based on the assumption that the size of the particulates is 10 micron or more

c Based on 1% sulphur content in fuel oil. Higher content of sulphur will cause standards to be pro-rated

d In respect of the emissions of the sulfur dioxide and nitrogen oxides, the power plants operating on oil or coal as fuel shall, in addition to NEQS specified above, comply with the following standards

Table B-4: NEQS for motor vehicle exhaust and noise

Parameter	Standard	Measuring Method
Smoke	40% or 2 on the Ringlemann scale during engine acceleration mode	To be compared with Ringlemann Chart at a distance of 6 meters or more
Carbon Monoxide	New vehicles: 4.5% Used vehicles: 6%	Under idling conditions, non-dispersive infrared detection through gas analyzer
Noise	85 dB (A)	Sound-meter at 7.5 meters from the source

Source: Qadar (2003)

Notes:

[a] 10 years or older

Table B-5: National Environmental Quality Standards for Noise

No.	Category of Area/ Zone	Effective from 1st January, 2009		Effective from 1st January, 2010	
		Limit in dB(A) Leq			
		Day Time	Night Time	Day Time	Night time
1.	Residential area (A)	65	50	55	45
2.	Commercial area (B)	70	60	65	55
3.	Industrial area (C)	80	75	75	65
4.	Silence zone (D)	55	45	50	45

Source: Pakistan Environmental Protection Agency

Notes:

1. Day time hours: 6.00 am to 10.00 pm
2. Night time hours: 10.00 pm to 6.00 am
3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.
5. dB(A) Leq: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

Table B-6: National Standards for Drinking Water Quality

No.	Properties/ Parameters	Proposed standard values for Pakistan
Bacterial		
1.	All water intended for drinking (E.Coli or thermotolerant coliform bacteria)	Must not be detectable in any 100ml sample
2.	Treated water entering the distribution system (E.Coli or thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100ml sample
3.	Treated water in the distribution system (E.Coli or thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100ml sample. In case of large supplies, where sufficient samples are examined, must not be present in 95% of the sample taken throughout any 12-month period.
Physical		
4.	Colour	< 15 TCU
5.	Taste	Non objectionable/Acceptable
6.	Odour	Non objectionable/Acceptable
7.	Turbidity	< 5 NTU
8.	Total hardness as $CaCO_3$	< 500 mg/L
9.	TDS	< 1000
10.	pH	6.5-8.5
Radioactive		
11.	Alpha Emitters bq/L or pCi	0.1
12.	Beta emitters	1
Chemical		
Essential Inorganics		mg/L
13.	Aluminium (Al)	< 0.2
14.	Antimony (Sb)	< 0.005
15.	Arsenic (As)	< 0.05
16.	Barium (Ba)	0.7
17.	Boron (B)	0.3
18.	Cadmium (Cd)	0.01
19.	Chloride (Cl-1)	< 250
20.	Chromium (Cr)	< 0.05
21.	Copper (Cu)	2

No.	Properties/ Parameters	Proposed standard values for Pakistan
Toxic Inorganics		mg/L
22.	Cyanide (CN)	< 0.05
23.	Fluoride (F)*	< 1.5
24.	Lead (Pb)	< 0.05
25.	Manganese (Mn)	< 0.5
26.	Mercury (Hg)	< 0.001
27.	Nickel (Ni)	< 0.02
28.	Nitrate (NO_3)*	< 50
29.	Nitrite (NO_2)*	< 3
30.	Selenium (Se)	0.01
31.	Residual chlorine	0.2-0.5 at consumer end 0.5-1.5 at source
32.	Zinc (Zn)	5.0

Source: Pakistan Environmental Protection Agency,
* Indicates priority health related inorganic constituents which need regular monitoring.

Table B-7: National Environmental Quality Standards for Ambient Air

No.	Pollutants	Time-weighted average	Concentration in Ambient Air: Effective from 1st Jan, 2009	Concentration in Ambient Air: Effective from 1st Jan, 2012	Method of measurement
1.	Sulfur Dioxide (SO_2)	Annual Average*	80 µg/m^3	80 µg/m^3	Ultraviolet Fluorescence method
		24 hours**	120 µg/m^3	120 µg/m^3	
2.	Oxide of Nitrogen as (NO)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
		24 hours**	40 µg/m^3	40 µg/m^3	
3.	Oxides of Nitrogen as (NO_2)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
		24 hours**	80 µg/m^3	80 µg/m^3	
4.	O_3	1 hour	180 µg/m^3	130 µg/m^3	Non dispersive UV absorption method
5.	Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m^3	360 µg/m^3	High Volume Sampling, (Average flow rate not less than 1.1 m^3/minute)
		24 hours**	550 µg/m^3	500 µg/m^3	
6.	Respirable Particulate Matter. PM_{10}	Annual Average*	200 µg/m^3	120 µg/m^3	ß Ray absorption method
		24 hours**	250 µg/m^3	150 µg/m^3	
7.	Respirable Particulate Matter. $PM_{2.5}$	Annual Average*	25 µg/m^3	15 µg/m^3	ß Ray absorption method
		24 hours**	40 µg/m^3	35 µg/m^3	
		1 hour	25 µg/m^3	15 µg/m^3	
8.	Lead (Pb)	Annual Average*	1.5 µg/m^3	1 µg/m^3	ASS method after sampling using EPM 2000 or equivalent filter paper
		24 hours**	2 µg/m^3	1.5 µg/m^3	
9.	Carbon Monoxide (CO)	8 hours**	5 µg/m^3	5 µg/m^3	Non Dispersive Infra Red (NDIR) method
		1 hour	10 µg/m^3	10 µg/m^3	
* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.					
** 24 hourly/ 8 hourly values should be met 98% of the year. 2% of the time, it may exceed but not on two consecutive days.					

Source: Pakistan Environmental Protection Agency.

ANNEXURE-C: Impact Assessment Data

C-1: Underwater Noise Meter Location Map

ANNEXURE: C-2: Significance Ranking of Anticipated Impacts

Activities	Air Quality	Noise	Water Use, Quality and Availability	Water Availability	Flooding and Water Flow Regime	Soil Erosion	Loss of Vegetation	Terrestrial Wildlife	Water Ecology (fish fauna and Mammal)	Protected Area	Demography	Social Infrastructure	Livelihood (farmers)	Livelihood (fishermen)	Protected Archaeological Sites	Cultural Sites
Construction																
Camps, Transport, and Employment	L	L	L	L		L	L	L	M				L	L	L	L
Construction of Pump House	L	M	L	L	L	L	L		M	L					L	L
Pilling Work to Support Pump House	L	M	L	L	L	L	L	L	M	L				L	M	L
Laying of Pipelines	L	M		L	L	L	L	L	M	L					L	L
Operation Phase																
Pumping from Water Intake	L	M		L	L	L		L	M					L	L	L

Note:
L: Low
M: Medium
H: High

ANNEXURE: C-3:Rapid Environmental Assessment (REA) Checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES) for endorsement by the Director, RSES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the “without mitigation” case. The purpose is to identify potential impacts. Use the “remarks” section to discuss any anticipated mitigation measures.

Country/Project Title: Raw water Intake at Sukkur

Sector Division:

Screening Questions	Yes	No	Remarks

Screening Questions	Yes	No	Remarks
PROJECT SITING IS THE PROJECT AREA ADJACENT TO OR WITHIN ANY OF THE FOLLOWING ENVIRONMENTAL SENSITIVE AREAS AND ARCHAEOLOGICAL AND CULTURAL SITES	√		The project area is located with Indus Dolphin Reserve protected under Sindh Wildlife Protection Ordinance and is also a ramsar site. There are also archaeological sites within and in close vicinity of the project area. The archaeological sites are listed below: Bukkur Fort entire area, including walls and Tomb of Hazarat Sadruddin. Near Lansdowne Bridge "Sat Bahan Astan" is located. A small graveyard from 15th to 17th century has beautifully decorated tombs with blue Glazed tiles. "Sadhu Belo" a Hindu Pilgrimage area on the main island in river Indus along Sukkur City, this was the asthan (Places) of a Sadhu known as Bankhandi (Forest wonderer) in 1823.
▪ DENSELY POPULATED?		√	The project area is located in uninhabited area.
▪ HEAVY WITH DEVELOPMENT ACTIVITIES?		√	The project area is location is not developed or used for any intervention resulting in heavy development.
• CULTURAL HERITAGE SITE	√		Sadh Belo a Hindu Pilgrimage site and Tomb of Hazarat Sadruddin are located within the vicinity of the project area
• PROTECTED AREA	√		Project area is located in Indus Dolphin Reserve (ramsar site)
• WETLAND	√		Within Indus River

Screening Questions	Yes	No	Remarks
• MANGROVE		√	
• ESTUARINE		√	
• BUFFER ZONE OF PROTECTED AREA	√		
• SPECIAL AREA FOR PROTECTING BIODIVERSITY	√		The Indus Dolphin Reserve has Indus Dolphin an endangered species.
• BAY	√		
• ISLAND		√	Pumping house will be located in the far end of the Bukkur Island. Small built up area will be required to construct pump house.
B. POTENTIAL ENVIRONMENTAL IMPACTS Will the Project cause…			
▪ pollution of raw water supply from upstream wastewater discharge from communities, industries, agriculture, and soil erosion runoff?	√		The project is to supply raw water to the treatment plants
▪ impairment of historical/cultural monuments/areas and loss/damage to these sites?		√	Small built up area will be required in the Bukkur Island for pump house. The pipeline will be laid undergroung the Bukkur Island using existing RoW and River Indus. The total length of the pipeline is 1200 ft. Safe distance will be maintained from historical/cultural sites
▪ hazard of land subsidence caused by excessive ground water pumping?		√	Surface water will be used
▪ social conflicts arising from displacement of communities ?		√	Not applicable. Groundwater will not be used as source

Screening Questions	Yes	No	Remarks
▪ conflicts in abstraction of raw water for water supply with other beneficial water uses for surface and ground waters?		√	The main source of raw water is the Indus River water. The mean annual discharge of the water in Sukkur barrage is 649070.8 ft^3/sec from 1961 to 2010. The average level of water is over 200 feet above mean sea level (MSL) at Sadhu Belo guage. Water quantity is sufficient and additional abstraction from the river will not have significant impact.
▪ unsatisfactory raw water supply (e.g. excessive pathogens or mineral constituents)?		√	Raw water is will be treated in the treatment plants to ensured compliance with National Standards for Drinking Water
▪ delivery of unsafe water to distribution system?		√	Not applicable. This is not included in the scope of the EIA.
▪ inadequate protection of intake works or wells, leading to pollution of water supply?		√	The intake will be secured and to be accessible only to authorized persons.
▪ over pumping of ground water, leading to salinization and ground subsidence?		√	Not applicable. Water is being sourced from a river. Yield from the shallow tube wells is not significant within the Sukkur. Possibilities of extracting ground water in considerable quantity are remote in the area.
▪ excessive algal growth in storage reservoir?		√	Not Anticipated.
▪ increase in production of sewage beyond capabilities of community facilities?		√	Not Anticipated
▪ inadequate disposal of sludge from water treatment plants?		√	Not Applicable
▪ inadequate buffer zone around pumping and treatment plants to alleviate noise and other possible nuisances and protect facilities?	√		Risk is temporary and associated with construction activities. Noise will be generated from generators and construction machinery

Screening Questions	Yes	No	Remarks
▪ impairments associated with transmission lines and access roads?		√	Not applicable. The pipeline will be laid underground passing through small stretch of Bukkur Island and Indus River.
▪ health hazards arising from inadequate design of facilities for receiving, storing, and handling of chlorine and other hazardous chemicals.		√	Not Applicable
▪ health and safety hazards to workers from handling and management of chlorine used for disinfection, other contaminants, and biological and physical hazards during project construction and operation?	√		Not Applicable
▪ dislocation or involuntary resettlement of people?		√	Displacement of communities is not required in this project.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		√	Not applicable. The project will not affect indigenous peoples or other vulnerable group.
▪ noise and dust from construction activities?	√		Anticipated during construction activities. However, impacts are temporary and short in duration. The EMP will ensure measures are included to mitigate the impacts.
▪ increased road traffic due to interference of construction activities?		√	Anticipated during construction activities. However, impacts are temporary and short in duration.

Screening Questions	Yes	No	Remarks
▪ continuing soil erosion/silt runoff from construction operations?	√		As the pump house located in flat island, run-off during construction will be more but erosion will be less. However, impacts are temporary and short in duration. The EMP will ensure measures are included to mitigate the impacts.
▪ delivery of unsafe water due to poor O&M treatment processes (especially mud accumulations in filters) and inadequate chlorination due to lack of adequate monitoring of chlorine residuals in distribution systems?		√	Not Applicable,
▪ delivery of water to distribution system, which is corrosive due to inadequate attention to feeding of corrective chemicals?		√	Not Anticipated.
▪ accidental leakage of chlorine gas?		√	Not Applicable.
▪ excessive abstraction of water affecting downstream water users?	√		Not anticipated. Water quantity is sufficient and abstraction from the river will not have significant impact since the same source of water is being used by existing pumping station.
▪ competing uses of water?		√	Not anticipated.
▪ increased sewage flow due to increased water supply		√	Not Applicable
▪ increased volume of sullage (wastewater from cooking and washing) and sludge from wastewater treatment plant		√	Not Applicable
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		√	Priority in employment will be given to local residents. Construction contractors will be required to provide workers camp with water supply and sanitation.
▪ social conflicts if workers from other regions or countries are hired?		√	Priority in employment will be given to local residents

Screening Questions	Yes	No	Remarks
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during operation and construction?		√	Not applicable. Since no community reside within the project area.
▪ community safety risks due to both accidental and natural hazards, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		√	Not Applicable

ANNEXURE: C-4: Soil Sample Analysis Results

Pakistan Water and Power Development Authority
S & R Regional Office S.M (South) Lab: Building Hussainabad Hyderabad

SOIL ANALYSIS

Area: Sukkur Barrage
26-06-2011

Collected by: Mashooque Ali Baloch R.A

Serial No.	Lab No.	Location: Imaging Photo No	Location: Village / Site	Location: Bore Pit No	Depth ft	Texture Field Appraisal	Saturation percent age (S.P)	p^H of Saturation on Paste	Ecex 10⁶ at 25c	Soluble Cations Meq/Litre: Ca+Mg	Na	K	Soluble anions Meq/Litre: CO_3	HCO_3	CL	SO_4	Sodium Absorption Ratio S.A.R	Cation Exchange capacity meq/100gms C.E.C	Exchangeable sodium meq/100 gms E.S	Exchangeable sodium%age E.S.P gms C.S	Organic matter %age	$CaCO_3$%	Gypsum Content % age	Gypsum Requirement Ton/Acre	Boron P.P.M	Available Phosphorous P.P.M	Remarks
1	1	-	Sukkur	IRB H-01	0-6"	FSL	80	7.6	1.0	7.9	3.1	-	-	-	-	-	1.5	-	-	-	-	-		-	-	-	-

Pakistan Water and Power Development Authority
S & R Regional Office S.M (South) Lab: Building Hussainabad Hyderabad

SOIL ANALYSIS

Area Sukkur

Barrage

26-06-2011

Collected by Mashooque Ali Baloch R.A

Serial No	Lab No.	Location: Imaging Photo No	Location: Village / Site	Location: Bore Pit No	Depth	Texture Field Appraisal	Saturation percent age (S.P)	p^H of Saturation on Paste	Ecex 10^6 at 25c	SOLUBLE CATIONS Meq/Litre: Ca+Mg	Na	K	Soluble anions Meq/Litre: CO_3	HCO_3	Cl	SO_4	Sodium Absorption Ratio S.A.R	Cation Exchange capacity meq/100gms C.E.C	Exchangeable sodium meq/100 gms E.S	Exchangeable sodium %age E.S.P gms E.S	Organic matter %age	Ca CO_3%	Gypsum Content % age	Gypsum Requirement Ton/Acre	Boron P.P.M	Available Phosphorous P.P.M	Remarks
2	2	-	Sukkur	IRBH-01	6"-12"	FSL	900	7.1	0.5	3.6	1.9	-	-	-	-	-	1.5	-	-	-	-	-	-	-	-	-	-

Pakistan Water and Power Development Authority
S & R Regional Office S.M (South) Lab: Building Hussainabad Hyderabad

SOIL ANALYSIS

Area Sukkur

Barrage

26-06-2011

Collected by Mashooque Ali Baloch B.A

Serial No.	Lab No.	Location: Imaging Photo No	Location: Village / Site	Location: Bore Pit No	Depth	Texture Field Appraisal	Saturation percent age (S.P)	p^H of Saturation on Paste	Ecex 10⁶ at 25c	Soluble Cations Meq/Litre: Ca-Mg	Soluble Cations Meq/Litre: Na	Soluble Cations Meq/Litre: K	Soluble anions Meq/Litre: CO_3	Soluble anions Meq/Litre: HCO_3	Soluble anions Meq/Litre: CL	Soluble anions Meq/Litre: SO_4	Sodium Absorption Ratio S.A.R	Cation Exchange capacity meq/100gms C.E.C	Exchangeable sodium meq/100 gms E.S	Exchangeable sodium%age E.S.P gms E.S	Organic matter %age	Ca CO₃%	Gypsum Content % age	Gypsum Requirement Ton/Acre	Boron P.P.M	Available Phosphorous P.P.M	Remarks
3	3	-	Sukkur	IRBH-01	12"-48"	SIL	105	7.4	0.9	4.5	5.4	-	-	-	-	-	3.6	-	-	-	-	-	-	-	-	-	-

Pakistan Water and Power Development Authority
S & R Regional Office S.M (South) Lab: Building Hussainabad Hyderabad

SOIL ANALYSIS

Area: Sukkur

Barrage

26-06-2011

Collected by: Mashooque Ali Baloch R.A

Serial No.	Lab No.	Location			Depth	Texture Field Appraisal	Saturation percent age (S.P)	p^H of Saturation on Paste	Ecex 106 at 25c	SOLUBLE CATIONS Meq/Litre			Soluble anions Meq/Litre				Sodium Absorption Ratio S.A.R	Cation Exchange capacity meq/100gms C.E.C	Exchangeable sodium meq/100 gms E.S	Exchangeable sodium%age E.S.P gms E.S	Organic matter %age	Ca Co%	Gypsum Content % age	Gypsum Requirement Ton/Acre	Boron P.P.M	Available Phosphorous P.P.M	Remarks
		Imaging Photo No	Village / Site	Bore Pit No						Ca-Mg	Na	K	CO_3	HCO_3	CL	SO_4											
4	4	-	Sukkur	IRBH-02	0-6"	VFSL	80	7.1	0.9	6.2	3.7	-		-	-	-	2.1	-	-	-	-	-		-	-	-	-

Pakistan Water and Power Development Authority
S & R Regional Office S.M (South) Lab: Building Hussainabad Hyderabad

SOIL ANALYSIS

Area Sukkur

Barrage

26-06-2011

Collected by Mashooque Ali Baloch R.A

Serial No.	Lab No.	Location			Depth	Texture Field Appraisal	Saturation percent age (S.P)	p^H of Saturation on Paste	Ecex 106 at 25c	SOLUBLE CATIONS Meq/Litre			Soluble anions Meq/Litre				Sodium Absorption Ratio S.A.R	Cation Exchange capacity meq/100gms C.E.C	Exchangeable sodium meq/100 gms E.S	Exchangeable sodium%age E.S.P gms E.S	Organic matter %age	Ca Co%	Gypsum Content % age	Gypsum Requirement Ton/Acre	Boron P.P.M	Available Phosphorous P.P.M	Remarks
		Imaging Photo No	Village / Site	Bore Pit No						Ca+Mg	Na	K	CO_3	HCO_3	CL	SO_4											
5	5	-	Sukkur	IRBH-02	6"-60"	FSL	90	7.1	0.4	3.6	0.8	-	-	-	-	-	0.6	-	-	-	-	-		-	-	-	-

Pakistan Water and Power Development Authority
S & R Regional Office S.M (South) Lab: Building Hussainabad Hyderabad

SOIL ANALYSIS

Area Sukkur

Barrage

26-06-2011

Collected by Mashooque Ali Baloch B.A

Serial No.	Lab No	Location			Depth	Texture Field Appraisal	Saturation percent age (S.P)	p^H of Saturation on Paste	Ecex 106 at 25c	SOLUBLE CATIONS Meq/Litre			Soluble anions Meq/Litre				Sodium Absorption Ratio S.A.R	Cation Exchange capacity meq/100gms C.E.C	Exchangeable sodium meq/100 gms E.S	Exchangeable sodium%age E.S.P gms E.S	Organic matter %age	Ca Co%	Gypsum Content %age	Gypsum Requirement Ton/Acre	Boron P.P.M	Available Phosphorous P.P.M	Remarks
		Imaging Photo No	Village / Site	Bore Pit No						Ca-Mg	Na	K	CO_3	HCO_3	CL	SO_4											
6	6	-	Sukkur	IRBH-02	60"-72"	SiL	120	74	0.5	19	3.6	-	-	-	-	-	3.6	-	-	-	-	-		-	-	-	-

Pakistan Water and Power Development Authority
S & R Regional Office S.M (South) Lab: Building Hussainabad Hyderabad

SOIL ANALYSIS

Area Sukkur Barrage

26-06-2011

Collected by Mashooque Ali Baloch R.A

Serial No.	Lab No.	Location			Depth	Texture Field Appraisal	Saturation percent age (S.P)	p^H of Saturation on Paste	Ecex 106 at 25c	SOLUBLE CATIONS Meq/Litre			Soluble anions Meq/Litre				Sodium Absorption Ratio S.A.R	Cation Exchange capacity meq/100gms C.E.C	Exchangeable sodium meq/100 gms E.S	Exchangeable sodium%age E.S.P gms E.S	Organic matter %age	Ca Co%	Gypsum Content % age	Gypsum Requirement Ton/Acre	Boron P.P.M	Available Phosphorous P.P.M	Remarks
		Imaging Photo No	Village / Site	Bore Pit No						Ca-Mg	Na	K	CO_3	HCO_3	CL	SO_4											
1	1	-	Sukkur	IRBH-01	0-6"	FSL	80	7.6	1.0	7.9	3.1	-	-	-	-	-	1.5	-	-	-	-	-		-	-	-	-

ANNEXURE-D: EMP CHECKLIST

Checklist for Camp Establishment

No.	Description	Status	Additional Comments
1.	Has the camp been established in Sukkur outside protected area?	☐ Yes ☐ No	
3.	Has the camp site been selected at least 500 meters away from any proteted area IDR boundary?	☐ Yes ☐ No	
4.	Has the camp site been selected atleast 500 meters from any site of archelogical importance?	☐ Yes ☐ No	
5.	Will estabsishment of camp result in tree cutting?	☐ Yes ☐ No	
6.	Has the camp site been selected in consultation with Environmental eOfficer (E0).	☐ Yes ☐ No	
8.	Does the campsite waste disposed off through municipal systemt?	☐ Yes ☐ No	

Name ______________________________ Signature ______________

Date

Additional Comments

Checklist for Fuels, Oils and Chemicals

No.	Description	Status	Additional Comments
1.	Do the fuel storage facilities have adequate secondary containment up to 120% capacity in case of leakage or spillage?	☐ Yes ☐ No	
2.	Is there any other combustible or flammable material in the fuel storage area?	☐ Yes ☐ No	
3.	Is regular inspection carried out to check leaks and spills?	☐ Yes ☐ No	
4.	Have the entire oil and fuel storage areas provided with impervious floor underneath to prevent soil contamination from leaks or spills?	☐ Yes ☐ No	
5.	Are the fuel tanks properly marked with their contents?	☐ Yes ☐ No	
6.	Are the fuel transfer arrangements protected against spills?	☐ Yes ☐ No	
7.	Are the drip trays being used?	☐ Yes ☐ No	
8.	Is the fuel transfer operation being supervised?	☐ Yes ☐ No	
9.	Are the spills and leaks thoroughly cleaned?	☐ Yes ☐ No	
10.	Are the spilled oil or fuel and used clean-up material being disposed properly?	☐ Yes ☐ No	
11.	Are the spills and leaks reported and recorded?	☐ Yes ☐ No	
12.	Is the emergency response plane available on site?	☐ Yes ☐ No	

Name ______________________________ Signature ______________

Date

Additional Comments

ANNEXURE-E: Stakeholders Consultation Record

Table 7-1: Consolidated Stakeholders List

Name	Date	Organization	Designation
Saeed Baloch	6-2-2012	Sindh Wildlife Department	Conservator Sindh
Ghulam Ali Gaddani	14-2-2012	Sindh Wildlife Department	Deputy Conservator Sukkur
Mir Akhtar Talpur	14-2-2012	Sindh Wildlife Department	Deeputy Wildlife Officer Wetland Centre Sukkur
Rahim Gul	16-2-2012	SPO	Project Coordinator
Hakim Ali	16-2-2012	SPO	Social Organizer
Rubina Baidani	16-2-2012	SPO	Social Organizer
Riaz Ahmed	16-02-2012	SPO	Admn & Accounts
Abdul Ghaffar	16-02-2012	SPO	Social Organizer
Mohammad Yaseen Abbasi	16-2-2012	Hands	District Executive Manager
Arfeen	16-2-2012	Hands	Admn & Finance Manager
Muneer Abbasi	15-2-2012	Sindh EPA	Deputy Director
Gul Zamir	15-2-2012		Fisherman
Saifullah	15-2-2012		Fisherman
Imran Malik	16-2-2012	WWF	Senior Program Officer
Liaquat Ali Khokhar	16-2-2012	WWF	Assistant Project Officer Fisheries
Shahzado Khaskheli	16-2-2012	Sindh Young Welfare Organization	Executive Director
Aftab Soomro	16-2-2012	Local Resident	Engineer
Abu bakar	16-2-2012	Local Resident	

E 1: Minutes of Meeting

Project	Environmental Impact Assessment- Water Intake at Sukkur		
Subject	Meeting with Sindh Environmental Protection Agency (SEPA)	Ref	RCC/NSUSC/001
		Page	1
Venue	SEPA, Sukkur		
Date held	15 February, 2012		
Present	Sindh Environmental Protection Agency : Muneer Abbasi (Deputy Director SEPA Sukkur) RCC Consultants (Pvt) Ltd. : Dr. Syed Ali Ghalib, Tasneem Bhatti		
Objective	Consultation with Stakeholders		

Summary:
The meeting started with introduction of the project and purpose of meeting by EIA team. During the meeting the following views, comments, and information was gained from SEPA.
• Mr. Muneer informed that the project area is located within an environmentally sensitive area; therefore the impact of the project related activities will be on the species inhabiting the area spatially Indus dolphins. Therefore suggested to keep on board the Sindh Wildlife Department custodian of the Reserve. • Dr. Syed Ali Ghalib replied that the prior permission from SWD has been sought to conduct the survey in the Reserve area. Also the representative from SWD will accompany the team during the field survey.
• He also emphasized that the waste should not be disposed untreated. • Dr. Syed Ali Ghalib replied that the camp will be established in Sukkur and EIA proposes the camp site outside the protected area. However the waste will be disposed off properly.
• He also suggested providing a concise report instead of voluminous reports.

Project	Environmental Impact Assessment- Water Intake at Sukkur		
Subject	Meeting with Sindh Wildlife Department (SWD)	Ref	RCC/NSUSC/002
		Page	2
Venue	SWD, Karachi Office		
Date held	06 February, 2012		
Present	Sindh Wildlife Department : Saeed Baloch (Conservator SWD) RCC Consultants (Pvt) Ltd. : Dr. Syed Ali Ghalib, Tasneem Bhatti		
Objective	Consultation with Stakeholders		

Summary:

The meeting started with introduction of the project and purpose of meeting by EIA team. During the meeting the following views, comments, and information was gained from SWD Conservator Sindh.

- Mr. Baloch informed that the project area is located within Indus Dolphin reserve; the proposed activity will certainly disturb the Indus Dolphin, therefore proper mitigation measure should be suggested in the EIA report lessen the impact on the Indus Dolphin.

- Dr. Syed Ali Ghalib replied that the EIA report will suggest proper mitigation measures to avoid disturbance to the Indus Dolphin. He also informed that the pumping station will be constructed in Bukkur Island instead of locating it over the Indus River and the pipeline work will be carried out when their will be less or no water in the right bank of Indus River to avoid disturbance to the wildlife.

- He also suggested not to directly pump water from the Indus River.

- To this Dr. Syed Ali Ghalib replied that the direct pumping will not be required for the proposed intake and gravity conduit will be used to supply water to the sump through gravity.

- He also suggested to avoid vibration which could also effect Indus Dolphin.

- Dr. Syed Ali Ghalib replied that best available techniques will be used to mimimize vibrations at the pump house.

- He also suggested imparting wildlife awareness trainings to the crew member prior to start work in protected area.

Summary:
• Dr. Syed Ali Ghalib replied that EIA report will suggest training of the crew members about the wildlife of the area and their importance.
• He suggested effects monitoring of the proposed activity should be conducted during the execution of the project to evaluate the impacts • Dr. Syed Ali Ghalib replied that effects monitoring will be provided in the EIA report.
• He recommended representative of the wildlife department should accompany the EIA team during the field survey to identify any protected species and or/habitat • Dr' Syed Ali Ghalib agreed and suggested him to nominate the representative to accompany the EIA team during the field visit to which Mr. Baloch nominated two representatives.

<table>
<tr><td>Project</td><td colspan="3">Environmental Impact Assessment- Water Intake at Sukkur</td></tr>
<tr><td rowspan="2">Subject</td><td rowspan="2">Meeting with Sindh Wildlife Department (SWD)</td><td>Ref</td><td>RCC/NSUSC/003</td></tr>
<tr><td>Page</td><td>1</td></tr>
<tr><td>Venue</td><td colspan="3">SWD, Sukkur Office</td></tr>
<tr><td>Date held</td><td colspan="3">14 February, 2012</td></tr>
<tr><td>Present</td><td colspan="3">Sindh Wildlife Department : Ghulam Ali Gadani (Deputy Conservator SWD Sukkur)
RCC Consultants (Pvt) Ltd. : Dr. Syed Ali Ghalib, Tasneem Bhatti</td></tr>
<tr><td>Objective</td><td colspan="3">Consultation with Stakeholders</td></tr>
</table>

Summary:
The meeting started with introduction of the project and purpose of meeting by EIA team. During the meeting the following views, comments, and information was gained from SWD Deputy Conservator Sukkur.
• Mr. Gadani suggested that the project activities should be conducted in manner to avoid disturbance to the wildlife in the area specially Indus Dolphin. • Dr. Syed Ali Ghalib replied that the EIA report will suggest proper mitigation measures to avoid disturbance to the wildlife of the area and Indus Dolphin.
• He also suggested that the waste associated with the proposed project should be disposed off properly. • To this Dr. Syed Ali Ghalib replied that the camp will be established outside the project area and the waste will be disposed off properly.

Project	Environmental Impact Assessment- Water Intake at Sukkur		
Subject	Meeting with SPO	Ref	RCC/NSUSC/004
		Page	1
Venue	SPO, Sukkur Office		
Date held	16 February, 2012		
Present	Sindh Participatory Organization : Nawaz Phupoto (Project Manager SPO Sukkur) RCC Consultants (Pvt) Ltd. : Dr. Syed Ali Ghalib, Tasneem Bhatti		
Objective	Consultation with Stakeholders		

Summary:

The meeting started with introduction of the project and purpose of meeting by EIA team. During the meeting the following views, comments, and information was gained from SPO Project Manager.

- Mr. Phulpoto suggested that the project activities should be conducted in manner to avoid disturbance to Indus Dolphin.

- Dr. Syed Ali Ghalib replied that the EIA report will suggest proper mitigation measures to avoid disturbance to the wildlife of the area and Indus Dolphin.

- He also suggested that the waste associated with the proposed project should be disposed off properly.

- To this Dr. Syed Ali Ghalib replied that the camp will be established outside the project area and the waste will be disposed off properly.

Project	Environmental Impact Assessment- Water Intake at Sukkur		
Subject	Meeting with WWF	Ref	RCC/NSUSC/005
		Page	2
Venue	WWF, Sukkur Office		
Date held	16 February, 2012		
Present	WWF : Mr. Mohammad Imran Malik (Senior Programme Officer), Mr. Liaquat Ali Khokhar (Assistant Project Officer Fisheries) RCC Consultants (Pvt) Ltd. : Dr. Syed Ali Ghalib, Tasneem Bhatti		
Objective	Consultation with Stakeholders		

Summary:

The meeting started with introduction of the project and purpose of meeting by EIA team. During the meeting the following views, comments, and information was gained from WWF.

- Mr. Imran informed that WWF – Pakistan carries out conservation work according to the Global Programme Framework. The Framework includes year 2050 biodiversity and human footprint goals. The first biodiversity goal is that biodiversity should be protected and well managed in the world's most outstanding natural places, or Ecoregions. WWF - - Pakistan has about 30 active projects/programmes in this regard. The foremost example is The Indus Ecoregion Programme. The Indus delta is one of the most biologically rich areas in the world and The Indus Ecoregion Programme is an ambitious long-term (2006-2056) initiative of WWF – Pakistan and the Government of Sindh. The programme focuses on addressing poverty issues and natural resource degradation in the Indus Ecoregion, while finding opportunities for sustainable development.

  The second biodiversity goal is that populations of the most ecologically, economically and culturally important species should be restored and thrive in the wild. The goal is delivered through conservation of flagship species. From the elusive snow leopard of the high mountains to the green turtles of the Arabian Sea coast, Pakistan is home to an incredible variety of animal species. For Pakistan, this means conservation of Asian big cats, marine cetaceans, marine turtles and river dolphins.

  The human footprint goal states that by 2020, humanity's global footprint should fall below its 2000 level and continue its downward trend, specifically in the areas of:

    - Energy/carbon footprint
    - Commodities (crops, meat, fish and wood) footprint

Summary:
➢ Water footprint • Additionally, through targeted scientific research, it has been proven that people, livestock and wildlife are all dependent on wetlands. To conserve, restore and raise awareness about wetlands as an integral component of the environment, the Pakistan Wetlands Programme was initiated. It is a joint initiative, made possible by collaboration between UNOP, the Ministry of Environment and WWF Pakistan to protect and manage Pakistan's wetlands. This, and much more, is being accomplished for nature conservation and sustainable development throughout the country with various partnerships and initiatives by WWF – Pakistan. • He also informed that the Indus River Dolphin is an endangered species, only found in the Indus River with a population estimate of only 1,300, facing serious threats. A decrease in the water level is perhaps the most critical of all threats facing this species. Construction of dams and barrages, intensive agricultural practices, poor water management, municipal sewage, unsustainable fishing practices and mortalities in the fishing gear all had adverse affects on the habitat of the Indus River Dolphin. WWF - Pakistan developed this project to conserve the viable population of Indus River Dolphin by protecting the innate biodiversity of the lower Indus river basin Eco-system, and reducing the losses of Indus river dolphins by canal stranding through rescue operations. • Mr. Syed Ali Ghalib appreciated the initiatives taken by WWF for the conservation and protection of the Indus Dolphin. He also informed him that the EIA report will suggest appropriate mitigation measures to lessen impact due to project related activities on Indus Dolphins. .
• He also suggested independent monitoring of the project during construction phase to check the compliance of the mitigation measures suggested in the EIA report. • To this Dr. Syed Ali Ghalib replied that monitoring will be suggested in the EIA report to check compliance of the EMP.

Photographic Records: Consultation with stakeholders

Photograph 7-1: Meeting with SWD

Photograph 7-2: Meeting with NSUSC

Photograph 7-3: Meeting with SYWO

Photograph 7-4: Meeting with Hands

Photograph 7-5: Meeting with SPO

Photograph 7-6: Meeting with WWF

Annexure-F Noise Level Reading at Bukkur Island and Lansdowne Bridge

Time & Date	Location	Noise Level (dB)	Noise Level (dB)	Average Noise Level (dB)	Major Source of Noise
10.43am & 3.31pm 17-10-2012	Bukkur Island	59.7	60.5	60.1	No any Source of High Noise
11.12am & 4.06pm 17-10-2012	Lansdowne Bridge	84.3	86.7	85.5	Traffic
10.06pm 17-10-2012	Lansdowne Bridge	90.1		90.1	Train

Annexure-G: Draft- Indus Dolphin Game Reserve Management Plan-WWF Pak

Indus Dolphin Game Reserve

A part of Central Indus Wetlands Complex

Matrix showing interventions, their priority rating and responsibilities of each implementing partner for the implementation of Indus Dolphin Game Reserve Management Plan

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
1	Management Interventions						
1.1.	Lack of coordination between different line agencies working in the same area						
1.1.1.	Establishment of Sindh Provincial Wetlands Management Committee, as also highlighted in the National Wetlands Policy. This should be established under the Chairmanship of Secretary Forest and Wildlife, with representatives of other relevant Departments to guide wetlands conservation in the province.	High	Sindh Wildlife Department	Line Departments, WWF – Pakistan	√	-	-
1.1.2.	Establishment of "Indus Dolphin Game Reserve Conservation and Coordination Committee" under the Chairmanship of Deputy Conservator (Wildlife) Sukkur Region in order to guide wetlands conservation, with representatives of other relevant line Departments, in addition to the terms of reference defined for each Department. Specific discussions in the Committee, should be held in the presence of respective group of stakeholders e.g., fishermen, researchers, local landlords. etc.	High	Sindh Wildlife Department, WWF - Pakistan	Sindh Irrigation Department, Sindh Forest Department, Sindh EPA, Sindh Fisheries Department, Others	√	-	-
1.1.3.	A well organised coordination mechanism between senior police officers and the Conservator / DFO of Sindh Forest Department, in the region, needs to be established for avoiding the allotment of lands to encroachers and promote sharing of information	Medium	Sindh Forest Department	Sindh Police, Sukkur Region	√	-	-
1.2.	Lack of training and capacity of the field staff and others in wetlands and associated biodiversity related issues						
1.2.1.	Organise specific trainings for the staff of Forest, Wildlife and Fisheries in defining Laws, Ordinance and Acts	Medium	Sindh Wildlife, Forest and Fisheries Departments	WWF - Pakistan	-	√	-
1.2.2.	Train local community activists in watch and ward to support wetlands and biodiversity conservation in and around the Protected Area. Help in notification of community activists as "Honorary Game Watchers" for enhanced protection.	Medium	WWF – Pakistan	Sindh Wildlife Department	√	-	-

1.2.3.	Train field Wildlife Watchers in "Wildlife Identification Techniques, Survey Techniques, Data Recording and Compilation, Use of Binoculars and Spotting Scope, First Aid, Emergency Services, Dolphin Handling and Stranding and Effective Watch and Ward"	Medium	WWF - Pakistan	Sindh Wildlife Department	-	√	-
1.3.	Lack of necessary field / technical equipment for effective monitoring of the Protected Area.						
1.3.1.	Fish testing labs needs to be established for enhancing the capacity and	Medium	Sindh Fisheries Department	Government of Sindh	-	-	√

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	skills of the Sindh Fisheries Department, which may help them in analysing specimens for identifying threats to the Protected Area.						
1.3.2.	Provision of necessary field equipment to the field staff of the Protected Area especially deputed at Guddu Dolphin Centre, Kandhkot field office and Indus Dolphin Centre based at Sukkur. The equipment may include Binoculars, GPS, Camera and others.	High	Sindh Wildlife Department	WWF - Pakistan	-	√	-
1.3.3.	EPA field staff should be provided with field testing labs (mobile) in order to provide on spot check of the various water parameters affecting the quality of Indus River water. This should be carried out on a regular basis.	Low	Sindh EPA	Government of Sindh, District Government, Sukkur	-	-	√
1.4.	Lack of clear understanding of the Sindh Wildlife Protection Ordinance (1972), Forest Act 1927 and Fisheries Law amongst the field staff for the effective implementation						
1.4.1.	Sindh Wildlife Protection Ordinance (1972) should be translated in SIndhi and Urdu languages in order to provide a clear understanding of various clauses of the Ordinance to the field staff, for its effective implementation.	Medium	Sindh Wildlife Department	WWF - Pakistan	-	√	-
1.4.2.	The Fisheries Licence (Shaheed Benazir Bhutto Fishing Card) does not contain necessary details related to fish catch, fishing duration and the specific area, where the fishing is carried out. The Card system needs to be replaced with the previous Contractor System where one person is held responsible for all the activities related to fishing, dolphin mortality, freshwater turtle catch and trade, and to avoid harmful fishing practices.	High	Sindh Fisheries Department	Government of Sindh	-	√	-
1.4.3.	The relevant staffs of the Fisheries Department is not taken into confidence when the licenses are issued to individuals regardless of their information related to their previous occupation, which needs to be determined in collaboration with all the stakeholders.	Medium	Sindh Fisheries Department	Government of Sindh	-	√	-

1.4.4.	In order to implement Forest Act 1927 in this region in true spirit, it is highly recommended to the Government of Sindh to establish a “Riverine Forest Protection Force” in order to establish the writ of the Government of Sindh, Sindh Forest Department and to have a minimum deterrence.	High	Sindh Forest Department	Government of Sindh	-	-	√
1.4.5.	Departmental training workshops need to be organised for the field / technical staff of the different departments for their understanding, defining their roles and responsibilities and implementing legislations.	Medium	Sindh Forest, Wildlife and Fisheries Departments	WWF - Pakistan	-	√	-
1.5.	Inadequate field staff of the relevant line agencies to cover the entire Protected Area for conservation of natural resources						
1.5.1.	Three field offices of the Sindh Wildlife Department are located on the right bank of the Indus River with a total field staff capacity of approx. 20 watchers and inspectors to cover a huge stretch of the Protected Area (200 km in length). Additional field staff is needed to cover the gaps	High	Sindh Wildlife Department	Government of Sindh	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	and to maintain an effective link with the tribal leaders to avoid harmful fishing practices in the Protected Area which is not only a threat to the endangered Indus Dolphin, fish and freshwater turtles but also adds to the degradation of the water quality.						
1.5.2.	Fisheries department has an existence in Sukkur with its few field staff, which is not enough to enforce the legislations in the entire Protected Area. Additional staff needs to be recruited at Dolphin hotspots in order to avoid mortality due to use of illegal netting and harmful fishing practices. In addition, local community activists also need to be trained in above mentioned issues.	High	Sindh Fisheries Department	Government of Sindh, WWF – Pakistan	-	-	√
2	Ecological Interventions						
2.1.	Degradation of Riverine Forests, habitat shrinkage / fragmentation						
2.1.1.	Wood cutting in Kacha areas – The riverine communities of the Protected Area need to be provided with alternate energy units (biogas plants, solar energy) in order to reduce pressure on riverine forests, which not only serves as an effective floodplain but also provides an important habitat for hog deer in addition to other biodiversity.	High	WWF - Pakistan	Sindh Forest Department, Sindh Wildlife Department	√	-	-
2.1.2.	Forcible encroachment in floodplains – Negotiations at the highest level needs to be established with the influential landlords to create awareness of the role of floodplains in managing risks and disasters. In addition, operations may also be launched to establish the writ of the government in such areas.	High	Sindh Forest Department	Parliamentarians, WWF – Pakistan	-	-	√
2.1.3.	Illegal allotment of forest areas – The local influentials have allotted riverine forest lands to different people in their constituencies for different land uses. Negotiations with these influentials need to be initiated for vacating the forest lands which is an essential component of the riverine ecosystem.	Medium	Sindh Forest Department, Sindh Wildlife Department	WWF - Pakistan	-	-	√

2.1.4.	Lack of water for riverine forest regeneration – Water is a scarce commodity in the downstream Indus River and additionally illegal encroachments in the forest lands have further exacerbated the problems related to forest regeneration. Extensive water uses for various agricultural crops have reduced the water that is required for forest regeneration. Existing land use practices within the floodplains need to be discussed and negotiated with the local tribal leaders to recover the ecosystem.	Medium	Sindh Forest Department, Sindh Irrigation Department	WWF - Pakistan	-	-	√
2.1.5.	Extension of agricultural practices to the river bank – The local	High	Sindh Forest Department	Local influentials, WWF	-	-	√

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	communities have cleared forest lands for agricultural uses and have reached to the bank of the river in the Protected Area. Disaster and flood risks are obvious and may cause significant damage to the agricultural crops and other infrastructure. A well targeted awareness campaign coupled with livelihood development initiatives need to be discussed with communities to avoid altering the natural landscape, which is equally important for their long-term survival.			- Pakistan			
2.2.	Illegal and harmful fishing practices in the Indus Dolphin Game Reserve						
2.2.1.	Unauthorised fishing – A few communities living on the edge of the Protected Area are involved in fishing in the region without licenses, which is an illegal activity. The locals should apply for a proper license with the Fisheries Department and should observe all the restrictions imposed by the Department, with regards to fish catch, duration and areas.	High	Sindh Fisheries Department	Government of Sindh, WWF – Pakistan	-	√	-
2.2.2.	Illegal use of nets – Different kinds of nets, which are prohibited and the timings of the nets used to catch maximum fish are not being observed accordingly. This causes a significant threat to the Dolphins, which is caught following its prey. Due to the longer duration, the dolphin gets trapped and dies. This is effectively handled through watch and ward by field staff, negotiations with fishermen and local tribal leaders and education through awareness campaigns and meetings.	High	Sindh Fisheries Department	Local tribal leaders, WWF - Pakistan	-	-	√
2.2.3.	Fishing during closed/ban seasons – Local communities and fishermen do not observe closed seasons, which is a threat to the next generation of fish population, which is a breeding season. May – August are closed seasons and fishing during these seasons are highly prohibited. Strict watch and ward mechanism should be established with local activists of the region.	High	Sindh Fisheries Department	Local tribal leaders, Community activists	-	-	√

2.2.4.	Poisoning in deeper pools for maximum fish catch – harmful fishing practices are on the rise in the Protected Area through poisoning and other baits for maximum fish catch. This should be strictly monitored in collaboration with local community activists, partners and influential tribal leaders to ensure sustainable fish catch, maintain water quality and improve the riverine ecosystem.	High	Sindh Fisheries Department	Sindh Wildlife Department, Community activists, influentials and tribal leaders	√	-	-
2.2.5.	Illegal net mesh size - Illegal nets of various mesh sizes are being used in the Protected Area, which is a threat to the existing populations of fish, dolphins and freshwater turtles. Training and an awareness campaign should be launched to generate awareness regarding the issue in addition to an effective watch and ward mechanism coupled	High	Sindh Fisheries Department	Sindh Wildlife Department, WWF - Pakistan	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	with implementation of fisheries law to avoid the problems.						
2.2.6.	Shaheed Benazir Bhutto Fishing Card – The communities who even do not qualify for the license acquires them leading to over exploitation of resources through all means. This practice has exacerbated the dolphin mortality and also has resulted in an increased capture and trade in freshwater turtles. Sindh Fisheries Department has strongly opposed this idea of licenses, which has degraded the resources. The contract system needs to be revived, where the responsibility of harmful fishing practices lies on a single contractor which is held for all the activities. The contractor observes areas, duration and seasons through its well organised network. It may also be suggested that the Government of Sindh may also think of banning fishing activities in the Protected Area to help conserve the world's largest Indus River Dolphin population, which needs lot of negotiations at the decision and policy level actors.	High	Sindh Fisheries Department, Pakistan Fisherfolk Forum	Sindh Wildlife Department, Parliamentarians, Policy makers	-	√	-
2.3.	Inadequate species conservation efforts and over-exploitation of wildlife species in the Protected Area leading to local extinctions						
2.3.1.	Inadequate baseline information of major wildlife species – No comprehensive baseline assessment of the entire Indus Dolphin Game Reserve has been carried out so far. A few species specific surveys i.e. Indus Dolphin etc. were carried out. There is a dire need to undertake a complete socio-ecological baseline assessment of the Protected Area, in order to set benchmarks for further conservation efforts in the region.	High	WWF - Pakistan	Sindh Forest, Wildlife and Fisheries Departments, Academia, Research Organisations	√	-	-
2.3.2.	Lack of regular monitoring mechanism – Except for a few surveys of Indus Dolphin (2001, 2006 and 2011), where a regular monitoring mechanism of 5-year interval has been set, no other species or habitat parameters are being studied to that level. There is a need to establish monitoring mechanism for major wildlife species for management purposes.	Medium	WWF - Pakistan	Sindh Wildlife Department	-	√	-

2.3.3.	Lack of species specific management plans (See species specific Management Plans for a few major wildlife species i.e. Indus Blind Dolphin, Hog Deer, Marsh Crocodile, Gavial, Freshwater turtles, Indian Smoot-coated Otter, Cranes) – Ad hoc arrangements are being made with regards to species conservation in the Protected Area. There is a need to develop and implement comprehensive species specific management plans in consultation with all the line departments, dependent communities and other stakeholders.	High	WWF - Pakistan	Sindh Wildlife Department	√	-	-
2.3.4.	Lack of awareness amongst the masses regarding the species significance and its role in the Protected Area – The local stakeholders are unaware of	High	WWF - Pakistan	Sindh Wildlife Department, Sindh	-	-	√

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	the role the species (dolphins, freshwater turtles etc.) have in maintaining the riverine ecosystem. A well-targeted and a focussed awareness campaign should be launched in order to signify the role of major components of the biodiversity and to link them with their livelihoods for effective adoption.			Fisheries Department			
2.3.5.	Lack of participatory planning and management – Line agencies and other stakeholders are working in different directions according to their objectives. There is a duplication of efforts and also results in effective planning. There is a need to plan initiatives in collaboration with stakeholders so that right interventions may reach at the right place with one strong message to all the concerned authorities.	Medium	Sindh Wildlife Department, Sindh Forest Department, Sindh Fisheries Department	District Government, WWF - Pakistan	-	-	√
2.3.6.	Lack of scientific research studies and programme related to species of special concern – Scientific research has been a very weak area in wildlife management in Pakistan. Strong scientific evidences lead to an effective management. Lack of involvement of academia and the lack of interest and funding by other major research institutions in the country has hampered effective management. It is therefore strongly recommended initiate negotiations with academia and research institutions to launch research studies to meet the objectives of the Protected Area	High	Shah Abdul Latif University, Khairpur, WWF - Pakistan	Other Academia, Research institutions.	-	-	√
2.3.7.	Inadequate information regarding changes in land use affecting species habitat – Habitat shrinkage and fragmentation is on the fast track in the Protected Area. Illegal wood cutting, encroachment, leasing out of riverine forests to the influentials, clearing of land for agriculture etc. has played a pivotal role. It is highly recommended to the Government of Sindh to monitor such land use changes at regular intervals through effective GIS based mapping in order to reach logical conclusions for effective management.	High	Sindh Forest Department	WWF - Pakistan	-	√	-
2.4.	Non-biodegradable pollution originating from a broad range of human activities – Industrial Effluents / Water Pollution						

2.4.1.	Self monitoring reports should be adopted by the industries located on the bank of River Indus inside the Protected Area, in order to avoid industrial hazards, which poses a serious threat to the existing population of Indus Dolphin.	High	Industries	Sindh EPA	√	-	-
2.4.2.	Random third party evaluation should also be carried out by EPA or by any other recognised institution to verify and cross check the results of the self monitoring reports.	Medium	Sindh EPA	Industries	-	√	-
2.4.3.	Detailed analyses need to be done for heavy metals in the Indus Dolphin Game Reserve. Bioaccumulation studies in Dolphins and Birds may	Medium	Academia	Sindh EPA	-	-	√

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	also need to be conducted to determine toxicity impacts for effective management of the pollution related issues.						
2.4.4.	Limnological studies should be carried out at regular intervals to determine the impact of industrial effluents on the wetlands micro- biodiversity and water quality.	Medium	Academia	WWF - Pakistan	-	-	√
2.4.5.	An Indus River Pollution Disaster plan needs to be developed and implemented in order to avoid such risks and determine preparedness and response of relevant institutions to handle emergency situations, as this is an important habitat of endangered Indus Dolphin	High	WWF - Pakistan	Provincial EPAs,	-	-	√
2.5.	Non-biodegradable pollution originating from a broad range of human activities – Sewage discharge / Water Pollution						
2.5.1.	Sukkur data should be collected from NSUC (North Service Urban Corporation). Further collaboration with stakeholders need to be established for effective implementation of sewage plan for Sukkur District and adjoining areas.	High	NSUC	Sindh EPA	√	-	-
2.5.2.	Solid waste management in Sukkur and other high populated places located on the bank of the river Indus at Sukkur should be carried out. Implementation of the Solid Waste Management Plan for the Sukkur region.	Medium	NSUC	Sindh EPA	-	-	√
2.5.3.	The local communities living on the edges of the Protected Area using water for their domestic purposes should use the indigenous water treatment methods, which is cost effective and efficient. This is necessary to avoid any health related issues. In this regard, Sindh EPA may guide and advise the communities of such small scale interventions.	High	Sindh EPA	Local fishermen communities	-	√	-
2.6.	Non-biodegradable pollution originating from a broad range of human activities – Agro-chemical Pollution						
2.6.1.	Sustainable agricultural practices needs to be introduced in collaboration with local communities. Farmer schools should be established in the entire Protected Area in order to reduce the use of agro-chemicals in their agricultural lands.	Medium	WWF – Pakistan, Sindh Agricultural Extension Department	Sindh EPA	-	√	-

2.6.2.	A well targeted awareness campaign for the farmers should be initiated to generate awareness regarding the use of harmful activities i.e. pesticides and fertilisers.	High	WWF – Pakistan, Sindh Agricultural Extension Department	Sindh EPA, Local communities	-	-	√
2.6.3.	There is an urgent need for improving coordination with other projects being implemented in the region and enhancing linkages with Agriculture Extension Department	High	Sindh Agricultural Extension Department	Local Communities, other project partners	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
3	Socio-economic Interventions						
3.1.	Lack of community empowerment, mobilisation to take ownership of the resources – Except a very few initiatives, community mobilisation process has been very weak especially from the natural resource conservation and management perspectives. A few existing community based organisations are in place organised by different agencies but have little role to play in NRM.						
3.1.1.	It is therefore high recommended to organise communities (CBOs / VCCs) with respect to the management of natural resources of the Protected Area, so that the communities may take ownership of the resources and use them wisely.	High	WWF – Pakistan, Local partners	SRSP, other organisations, SYWO	-	√	-
3.1.2.	Comprehensive training programme for these CBOs is essential in office and project management, proposal development and negotiations with donors etc.	High	WWF - Pakistan	SRSP, SYWO	-	√	-
3.1.3.	Sign Terms of Partnerships with organised communities for implementation of wetlands management interventions	High	WWF - Pakistan	Communities, SYWO	-	-	√
3.1.4.	Develop a social maturity index for the organised communities in order to ensure their sustainability	High	WWF - Pakistan	Communities, SYWO	-	-	√
3.2.	Tribal conflicts – Local communities belonging to different castes have conflicts over resource uses, which are resulting in degradation of natural resources of the Protected Area. Dolphin mortality due to extensive netting, poisoning, wood cutting etc. are some of the issues being faced due to these conflicts in addition to their social and cultural issues.						
3.2.1.	As far as the conflicts of the tribal leaders are concerned, it is strongly recommended to initiate dialogues with them regarding dolphin entanglement, freshwater turtles capture and trade, over-exploitation of riverine forests, hunting / shooting of wildlife. These tribal leaders can also work as “Conservation Ambassadors” in their own regions.	High	WWF - Pakistan	Sindh Forest Department	-	-	√
3.3.	Lack of alternate sources of energy – Excessive wood cutting from the remaining riverine forest is also a threat to its associated biodiversity. People living on the edges of the Protected Area have no access to alternate energy programmes except the use of wood.						

3.3.1.	There is a dire need to make an assessment of the wood usage by these communities and initiate the process of providing alternate energy units (Biogas plants, fuel-efficient stoves, solar energy units including solar cookers, solar geysers etc.) in order to protect the remaining natural forests of the Protected Area. In addition, there is a need to negotiate at least 20% of the total cost of the unit with the local communities.	High	Livestock Department, Government of Sindh, WWF - Pakistan	Government of Pakistan's major initiatives	-	-	√
3.3.2.	Energy plantations (agro-forestry) also need to be established in order to overcome the issues of fuelwood in the region. Every household who owns land should meet their energy requirements from their own farmlands.	Medium	Sindh Forest Department	WWF - Pakistan	-	√	-
3.4.	Lacks of alternate livelihood opportunities – The local communities living on the edges of the Protected Area are extensively dependent on the natural resources for generating their livelihood, which has resulted in loss and local extinction of species.						

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
3.4.1.	One of the interventions is to promote eco-tourism in the Protected Area as the region has the highest potential of nature based tourism, dolphin watch, bird watch, historical bridge, cultural sites etc. This may include providing training to the local communities as guides and boatmen.	High	WWF – Pakistan, STFP	Government of Sindh	√	-	-
3.4.2.	In certain regions along the Indus River, the riverine communities are highly dependent on the natural resources and their products. This include a range of products including Typha mats, baskets, promotional material etc. but these need to be enhanced through improved market linkages for livelihood generation.	High	WWF - Pakistan	Sindh Wildlife Department	-	√	-
3.4.3.	Improved fishing practices may help generate additional opportunities for income that may include good quality fish, storage capacities, less involvement of middlemen etc.	High	Sindh Fisheries Department	WWF - Pakistan	-	√	-
3.4.4.	A few development aid agencies are involved in helping the poor communities of the Indus River, especially after the floods of 2011. Cattle farming have become one of the major incomes generating opportunity for the poor fishermen and communities, if introduced effectively.	High	Development projects by Development Aid Agencies, Livestock Department, Government of Sindh	Government of Sindh	-	-	√
3.4.5.	A wide range of training opportunities i.e. net making, enterprise development, micro-finance, kitchen gardening, nursery raising, orchard development, eco-tourism, poultry farming, apiculture, livestock management through vaccination and de-worming, establishing vocational training centres and improved fishing practices may be provided to the local communities for improvement in their livelihood.	High	WWF - Pakistan	Government Line Agencies	-	√	-
3.5.	Lack of public awareness and education regarding the natural resources of the Protected Area – No such initiative exist in the region except a few education programmes were conducted in joint collaboration of Sindh Wildlife Department and WWF – Pakistan. These are not enough keeping in view the wide range of issues and extent of problems being faced by the ecosystem and the communities.						

3.5.1.	A school level education programme needs to be established within the Protected Area. These include the establishment of Nature Clubs which may help in organising various school level events and where children can be involved in green activities. These young students can become the future leaders of conservation in their respective areas and act as agents in their sphere.	High	WWF - Pakistan	Education Department, Government of Sindh	-	√	-
3.5.2.	Introductory and interactive education material needs to be produced in local languages to enhance the value of the biodiversity of the Protected Area. These should include posters, small booklets, brochures, and activity books for school going children.	High	WWF - Pakistan	Sindh Wildlife Department	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
3.5.3.	Installing standard Protected Area signage at appropriate places within the region may also contribute in raising awareness of the local communities.	High	WWF - Pakistan	Sindh Wildlife Department	-	√	-
3.5.4.	In order to address communities at large, two Dolphin Conservation and Information Centres have been established in the Protected Area. These need to be enhanced and should be made interactive to attract communities, school groups, visitors etc.	High	WWF - Pakistan	Sindh Wildlife Department	-	√	-
3.5.5.	Exposure Visits are an important tool in creating awareness amongst the local communities, where a wide range of initiatives are being undertaken in order to address NRM related issues in the region. This has proved very effective and is recommended for the fishermen communities and other stakeholders to WWF – Pakistan's sites in the Sindh province.	High	WWF - Pakistan	Other large programmes and conservation and development projects by different aid agencies	-	√	-
3.5.6.	In order to create awareness amongst the hunters and fishermen of the Protected Area, an introductory booklet entailing hunting/fishing code of ethics in local language may need to be developed in collaboration with respective line departments, which may be handed over to the licensee at the time of issuance of license.	High	Conservation and Hunting Association of Pakistan (CHAP)	WWF – Pakistan, Government Line Departments	-	-	√

Central Indus Wetlands Complex
Species Specific Management Plans
A. Indus River Dolphin – Platanista minor

#	Threat	Possible set of prescriptions	Means of Verifications	Lead Agency	Other partners	Timeline
Indus River Dolphin	1.1. Limited information about dolphin distribution, population dynamics and habitat use	1.1.1. Undertake comprehensive population surveys (5 – years interval)	Survey reports with GIS-based maps	PWP, ZSD (MoE) with the support of Provincial Wildlife Departments	Conservation agencies (WWF- P), research institutions, Cetacean Specialist Group, Academia	Feb.-Mar., 2011 (On-going)
			Publications in refereed journals			Two months after the survey
		1.1.2. Carry out annual monitoring of hotspots as already identified	Annual Adhoc reports			Adhoc Surveys after 2011 population assessment
		1.1.3. Undertake habitat assessment (e.g. Environ. Flow, prey availability, Water quality etc.) in different sections of the Indus River at 5-years interval	Habitat assessment reports based on pre-determined parameters			Feb.-Mar., 2011 (On-going)
			GIS-based maps			
	1.2. Inadequate technical and operational capacity of the staff of the Federal, Provincial and Territorial Wildlife Agencies especially in surveys	1.2.1. Conduct a Training Need Assessment of the stakeholders	Training Need Assessment Report with implementation mechanism	MoE with the support of Provincial Wildlife Departments	WWFP (PWP, Indus for All and other programmes), Provincial, territorial and Federal agencies, Other conservation partners	2011
		1.2.2. Organise specialised training courses as per the Training Need Assessment	Number of trainings conducted			Ongoing (immediate)
			Number of professionals trained			Ongoing (immediate)

	and research		Number of training reports			Two weeks after the training
		1.2.3. Help develop sectoral plans / PC-1's of the wildlife agencies for the provision of equipment, trained professionals and specialised trainings	Provision of budget for training, equipment etc. in Sectoral Plans / PC-1's			2011-2012
	1.3. Stranding of Dolphins in canals	1.3.1. Carry out rescue operations of stranded Dolphins using already established standardised protocols	Certified event reports	Sindh and Punjab Wildlife Departments	WWFP (PWP etc.), Communities, Media, Provincial, territorial and Federal agencies	Each year after canal closures
	1.4. Suspected inbreeding	1.4.1. Translocate stranded dolphins to other potential segments	Certified activity reports	Sindh, Punjab and NWFP Wildlife Departments, MoE	WWFP, Local communities, Media	Soon after rescue operations based on assessment of animal's
		1.4.2. Get formal provincial approvals for translocation outside provinces	Correspondence between the provinces for approvals			Immediate, for translocation outside provinces
	1.5. Entanglement in fishing nets / by-catch	1.5.1. Establishment of no-fishing zones	Notification of No Fishing Zone (PA)	Sindh Wildlife Department, MoE	WWFP, Local communities, Media, Local conservation partners	Immediate
		1.5.2. Awareness of fishing community	Published awareness material			Immediate
			Media reports			Ongoing

ANNEXURE-H: Indus River Blind Dolphin Sighting Survey Report (2nd Survey)

attached separately to this report

ANNEXURE-G

INDUS RIVER BLIND DOLPHIN SIGHTING SURVEY REPORT

THIS IS SECOND SURVEY CARRIED OUT UNDER SUPERVISION OF NSUSC BY RCC CONSULTANTS TOGETHER WITH SINDH WILDLIFE DEPARTMETN IN ORDER TO INCORPORATE RESULTS IN THE UPDATED EIA FOR SUKKUR INTAKE WORK

AUGUST - 2012

SINDH WILDLIFE DEPARTMENT

RCC CONSULTANTS & ARCHITECTS

North Sindh Urban Services Corporation Limited

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1. EXECUTIVE SUMMARY

The Sukkur Raw Water Intake Works project area is located within protected area of Indus Dolphin Reserve and is habitat for a variety of wildlife. For collection of relevant data regarding Indus Dolphin, two baseline Surveys are required in seasons of Winter and Summer as mentioned in the Environmental Impact Assessment Report. Data collected during winter was incorporated in that EIA Report. However second survey is being conducted now in the Month of August 2012 and its results shall be incorporated in the Updated EIA.

2. INDUS RIVER BLIND DOLPHIN SIGHTING SURVEY

The survey was mutually conducted by project consultants M/s RCC Consultants, client NSUSC and stakeholder Sindh Wildlife Department. The general area of interest for survey was set about 3.0 Kilometer downstream of proposed Intake Works and about 2.5 kilometer upstream side of the Intake Works. The survey was conducted over a course of three days from morning to evening.

3. PRIMARY SURVEY FOR DOLPHIN OBSERVATIONS

The Observational Survey was carried out from 30th July 2012 to 1st August 2012 for Surfacing of Dolphin by team of RCC Consultants along with the Sindh Wildlife Department members in one Boat for three days. The Observation is the only method for the Survey of Dolphin used in morning and afternoon and was focused on 200 meter zone as given in Map.

Following parameters were observed

1. Surfacing
2. Size of Dolphin (Small , Medium or Large)
3. Sex of Dolphin (Male, Female or Child)
4. Frequency of Observation

The Result of the Survey is provided in below Tables below;

DAY-1 (Date:- 30-7-2012)			
S.no	**GPS Coordinate**	**Sex**	**Timing (Evening)**
1	**N** 27° 41' 02.26" **E** 68° 51' 38.81"	M	3:25 PM to 4:45PM
2	"	M	3:25 PM to 4:45PM
3	"	M	3:25 PM to 4:45PM
4	"	M	3:25 PM to 4:45PM
5	"	M	3:25 PM to 4:45PM
6	"	M	3:25 PM to 4:45PM
7	"	M	3:25 PM to 4:45PM
8	"	M	3:25 PM to 4:45PM
9	"	M	3:25 PM to 4:45PM
10	"	M	3:25 PM to 4:45PM
11	**N** 27° 41' 40.26" **E** 68° 52' 43.53"	M	5:00 PM to 6:15PM
12	"	M	5:00 PM to 6:15PM

Total No Dolphin Sighted	12

DAY-2 Date:- 31-7-2012							
Morning Data				**Evening Data**			
S.no	**GPS Coordinate**	**Sex**	**Timing (Morning)**	**S.no**	**GPS Coordinate**	**Sex**	**Timing (Evening)**
1	**N** 27° 41′ 57.48″ **E** 68° 54′ 07.94″	M	8:15 AM to 9:40 AM	1	**N** 27° 41′ 57.48″ **E** 68° 54′ 07.94″	M	3:50 PM to 4:30 PM
2	"	M	8:15 AM to 9:40 AM	2	"	M	3:50 PM to 4:30 PM
3	"	M	8:15 AM to 9:40 AM	3	"	M	3:50 PM to 4:30 PM
4	"	M	8:15 AM to 9:40 AM	4	"	M	3:50 PM to 4:30 PM
5	"	M	8:15 AM to 9:40 AM	5	"	M	3:50 PM to 4:30 PM
6	"	M	8:15 AM to 9:40 AM	6	**N** 27° 41′ 37.19″ **E** 68° 53′ 17.81″	M	4:35 PM to 4:55 PM
7	**N** 27° 41′ 37.19″ **E** 68° 53′ 17.81″	M	9:50 AM to 10:10 AM	7	"	M	4:35 PM to 4:55 PM
8	"	M	9:50 AM to 10:10 AM	8	**N** 27° 41′ 40.26″ **E** 68° 52′ 43.53″	M	5:05 PM to 5:25 PM
9	**N** 27° 41′ 40.26″ **E** 68° 52′ 43.53″	M	10:15 AM to 10:25AM	9	"	M	5:05 PM to 5:25 PM
10	"	M	10:15 AM to 10:25AM	10	**N** 27° 41′ 02.26″ **E** 68° 51′ 38.81″	M	5:35 PM to 6:20 PM
11	**N** 27° 41′ 02.26″ **E** 68° 51′ 38.81″	M	10:30 AM to 11:00AM	11	"	M	5:35 PM to 6:20 PM
12	"	M	10:30 AM to 11:00AM	12	"	M	5:35 PM to 6:20 PM
13	"	M	10:30 AM to 11:00AM	13	"	M	5:35 PM to 6:20 PM
14	"	M	10:30 AM to 11:00AM	14	"	M	5:35 PM to 6:20 PM
15	"	M	10:30 AM to 11:00AM	15	"	M	5:35 PM to 6:20 PM
16	"	M	10:30 AM to 11:00AM	16	"	M	5:35 PM to 6:20 PM
17	"	M	10:30 AM to 11:00AM	17	"	M	5:35 PM to 6:20 PM
18	"	M	10:30 AM to 11:00AM	18	"	F	5:35 PM to 6:20 PM
19	"	M	10:30 AM to 11:00AM	19	"	F	5:35 PM to 6:20 PM
20	"	M	10:30 AM to 11:00AM	20	"	F	5:35 PM to 6:20 PM
21	"	F	10:30 AM to 11:00AM	21	"	C	5:35 PM to 6:20 PM
22	"	F	10:30 AM to 11:00AM	**Total No Dolphin Sighted**		**21**	
23	"	F	10:30 AM to 11:00AM				
24	"	F	10:30 AM to 11:00AM				
25	"	C	10:30 AM to 11:00AM				
26	"	C	10:30 AM to 11:00AM				
27	"	C	10:30 AM to 11:00AM				
28	"	C	10:30 AM to 11:00AM				
Total No Dolphin		**28**					

Sighted		

DAY-3 Date:- 01-8-2012							
Morning Data				**Evening Data**			
S.no	**GPS Coordinate**	**Sex**	**Timing (Morning)**	S.no	**GPS Coordinate**	**Sex**	**Timing (Evening)**
1	**N** 27° 41’ 40.26” **E** 68° 52’ 43.53”	M	8:20 AM to 8:35AM	1	**N** 27° 41’ 40.26” **E** 68° 52’ 43.53”	M	3:45 PM to 4:00 PM
2	“	M	8:20 AM to 8:35AM	2	“	M	3:45 PM to 4:00 PM
3	**N** 27° 41’ 37.19” **E** 68° 53’ 17.81”	M	8:40 AM to 8:50 AM	3	**N** 27° 41’ 37.19” **E** 68° 53’ 17.81”	M	4:15 PM to 4:25 PM
4	“	M	8:40 AM to 8:50 AM	4	“	M	4:15 PM to 4:25 PM
5	**N** 27° 41’ 57.48” **E** 68° 54’ 07.94”	M	9:00 AM to 9:20 AM	5	**N** 27° 41’ 57.48” **E** 68° 54’ 07.94”	M	4:35 PM to 5:00 PM
6	“	M	9:00 AM to 9:20 AM	6	“	M	4:35 PM to 5:00 PM
7	“	M	9:00 AM to 9:20 AM	7	“	M	4:35 PM to 5:00 PM
8	“	M	9:00 AM to 9:20 AM	8	“	M	4:35 PM to 5:00 PM
9	“	M	9:00 AM to 9:20 AM	9	“	M	4:35 PM to 5:00 PM
10	**N** 27° 41’ 02.26” **E** 68° 51’ 38.81”	M	9:30 AM to 9:55AM	10	**N** 27° 41’ 02.26” **E** 68° 51’ 38.81”	M	5:25 PM to 6:35 PM
11	“	M	9:30 AM to 9:55AM	11	“	M	5:25 PM to 6:35 PM
12	“	M	9:30 AM to 9:55AM	12	“	M	5:25 PM to 6:35 PM
13	“	M	9:30 AM to 9:55AM	13	“	M	5:25 PM to 6:35 PM
14	“	M	9:30 AM to 9:55AM	14	“	M	5:25 PM to 6:35 PM
15	“	M	9:30 AM to 9:55AM	15	“	M	5:25 PM to 6:35 PM
16	“	M	9:30 AM to 9:55AM	16	“	M	5:25 PM to 6:35 PM
17	“	M	9:30 AM to 9:55AM	17	“	M	5:25 PM to 6:35 PM
18	“	F	9:30 AM to 9:55AM	18	“	M	5:25 PM to 6:35 PM
19	“	C	9:30 AM to 9:55AM	19	“	F	5:25 PM to 6:35 PM
Total No Dolphin Sighted		**19**		20	“	C	5:25 PM to 6:35 PM
				Total No Dolphin Sighted		**20**	

The results are further presented in Maps attached at Annex-A with original survey data sheet attached at Annex-B

4. INTRODUCTION TO INDUS RIVER BLIND DOLPHIN (BULHAN)

Indus River Dolphin is one of the unique species of mammals, it is a predator, it's a unique cetacean that occurs in Pakistan, most Blind Dolphins and whales are found in the sea but this Blind Dolphin found in only Indus River that's why we call it Indus River Blind Dolphin. The Indus River Blind Dolphin lives through a sophisticated sonar system known as echolocation, which it uses to steer and hunt under deep water.

5. PHYSICAL DISCRIPTION OF INDUS RIVER DOLPHIN

Indus River Blind Dolphin is top predator in the food chain of the river but selective in feeding, it's a mammal not a fish just like a humans, they breath over and give birth to live calve which feeds on their mother's milk.

COLOUR: Mostly mid grey and pinkish brown.

SIZE: The maximum size is 2.5 meters but the males are little smaller then female.

TEETH: Adults have 30 to 32 sharp teeth's on each side of the upper and lower jaws. The teeth end of the rostrum are very long protruding.

EYES: Indus River Blind Dolphin is functionally blind and has no lens in its tiny eyes, that's why we call Indus Blind Dolphin.

ROSTRUM: Indus River Blind Dolphin have a much long rostrum then oceanic Blind Dolphin, it can be up to one fifth of his body.

BLOWHOLE: Blind Dolphin breath through a blowhole located on the top of their head.

NECK: The neck is relatively narrow and very flexible which helps the Blind Dolphin to move in a complicated river environment.

FLIPPERS: Indus River Blind Dolphin has very broad flippers which stabilize them at slow speed in the fast flowing water.

FEEDING: The Indus River Blind Dolphin feeds in a way to stay in the deeper areas of the river, they prefer to find their food on the bottom of the river, and they do it by swimming to one side and simply opening their mouth whenever they assure that food is near to them. The diet of

Blind Dolphin is wide variety of fishes such as carp fish and catfish as well as fresh water prawns and shrimps. It's a predator which cleans the river water.

REPRODUCTION: The reproduction features of the Indus River Blind Dolphin is similar to other Blind Dolphin species, they begin to sexually mature when they are six to seven years old. Mating rituals will lead most pregnancies to occur between the months of January to April, they carrying their calves in their embryo for a period of 9 to 10 months and continue nursing up to one year. They feed calves for a period of one and half month.

STATUS: The Sindh Wildlife Department notified the area between GUDDU to SUKKUR barrage as WILDLIFE RESERVE area for Indus River Blind Dolphin in 1974. The Indus River Blind Dolphin is announced as protected animal in schedule 11 of the Sindh Wildlife protection ordinance 1972 under section 7 and will be punished with fine or imprisonment or with both.

The area of Indus River Blind Dolphin was also declared as RAMSER SITE. The IUCN declared Indus River Blind Dolphin as an endangered species in the following years;

1. 1970 to 1994 as Endangered
2. 1996 to 2002 as Endangered
3. 2004 to 2006 as Endangered

6. CONSERVATION INITIATIVES IN SINDH

After the recommendation of Wildlife Commission (1967), Government of Sindh declared Indus River portion between Guddu Barrage to Sukkur Barrage (190 Km) as Dolphin Reserve in 1974.

A research project funded by WWF- International and Volkert Foundation and G. Pilleri, Professor of Brain Anatomy Institute of Switzerland is running this project. A three year annual development program 2003-2006was funded by Government of Sindh and Sindh Wildlife Department ran this project.

Salient Features of this Project were;

- Establishment of Dolphin Information Centers at Sukkur and Guddu
- Establishment of Field Office at Kandhkot for data collection
- Developing information material for education and awareness
- Purchase of Motor boats for patrolling, protection and survey
- Monitoring fishing activities and identifying non-selective fishing methods
- Survey and census

7. SURVEYS

The plight of Indus River Blind Dolphin conservation spread in Pakistan during 1970s, when first time these Dolphins were reported in 1972 by G. Pilleri. He reported a total of 132 Dolphins in River Indus.

Rest of the surveys are depicted in the following tables;

Table No. 1: Survey from 1972 to 1999			
S No	**Year**	**No of Dolphins with Location**	**Survey Team**
1	1972 (April)	132 Guddu to Sukkur	Pilleri-Zbinden
2	1974 (April)	150 Guddu to Delta	Pilleri and team
3	1995 (April)	182 Guddu to Delta	Kasuya and Nishiwaki
4	1979 (April)	291 Guddu to Kotri	Bhatti and PIlleri
5	1980 (April)	346 Guddu to Korti	Bhatti and PIlleri
6	1981 (April)	381 Guddu to Kotri	Abdul Fateh, Shahzado and Niaz
7	1986 (April)	429 Guddu to Kotri	Bhaagat and Shahzado
8	1989 (April-May)	368 Guddu to Sukkur	Bhaagat and Shahzado
9	1990 (March-April)	387 Guddu to Sukkur	Bhaagat and Shahzado
10	1991 (March-April)	398 Guddu to Sukkur	Bhaagat and Shahzado
11	1992 (March-April)	410 Guddu to Sukkur	Bhaagat and Shahzado
12	1993 (March-April)	426 Guddu to Sukkur	Bhaagat and Shahzado
13	1994 (March-April)	435 Guddu to Sukkur	Bhaagat and Shahzado
14	1995 (March-April)	447 Guddu to Sukkur	Bhaagat and Shahzado
15	1996 (April-June)	458 Guddu to Delta	Bhaagat-Najam-Munaf (WWF-Pakistan-SWD)
16	1999 (March-April)	499 Guddu to Sukkur	Bhaagat and Shahzado

Table No. 2: Survey - 2001				
S No	**Section of River**	**Minimum Abundance**	**Distance (Km)**	**Density/Km**
1	Jinnash to Chashma Barrage	02	68.2	0.03
2	Chashma to Tounsa Barrage	84	303.2	0.28
3	Tounsa to Guddu Barrage	259	348.8	0.74
4	Guddu to Sukkur Barrage	602	160.1	3.60
5	Sukkur to Kotri Barrage	18	494.3	0.04
	Total	**965**	**1374.6**	-

Table No. 3: Survey Results of 2006				
S No	**Section of River**	**Minimum Abundance**	**Distance (Km)**	**Density/Km**
1	Guddu to Sukkur Barrage	810	190	4.218
2	Sukkur to Kotri Barrage	11	498	-
	Total	**821**	**960**	-

Table No. 4: Survey Results of 2011				
S No	**Section of River**	**Minimum Abundance**	**Distance (Km)**	**Density/Km**
1	Guddu to Sukkur Barrage	918	190	4.831
2	Sukkur to Kotri Barrage	29	300	0.096
	Total	**947**	**490**	4.927

8. STRANDINGS AND RESCUES

Being heavily populated area in between Guddu and Sukkur Barrage, Dolphins do slip away into the canals during June-Sept every year. The causes of stranding are either Water Current of Scarcity of Food. First Dolphin Rescue Program was conducted in year 1995 by Sindh Wildlife Department. Since then from 1995 to 2000, Sindh Wildlife Department recued 13 live and collected 05 dead Dolphins from different canals of the Sukkur Barrage.

In Nov-2000 to Nov-2005 a Rescue Program was funded by UNDP's small grant program and it was run by Lahore Zoo. Under this program 56 live Dolphins were rescued and 19 dead Dolphins were collected.

After the completion of UNDP funded program, Sindh Wildlife Department has continued self funded rescue program without any other help from 2006 till to date. During this period 17 alive Dolphins have been rescued.

Table No. 5: Rescue Account of Indus Blind Dolphin for the period from 1995 to 2012				
S No	**Year**	**No. of Dolphins Rescued**	**Live**	**Dead**
1	1995	02	01	01
2	1996	02	01	01
3	1997	01	0	01
4	1998	01	01	0
5	1999	04	02	02
6	2000	11	06	05
7	2001	13	10	03
8	2002	02	01	01
9	2003	0	0	0
10	2004	26	17	09
11	2005	17	15	02
12	2006	01	0	01
13	2007	02	02	0
14	2008	01	01	0
15	2009	05	05	0

16	2010	01	01	0
17	2011	05	05	0
18	2012	03	03	0
	Total	97	91	26

Table No. 6: Dead Dolphin Account of Last Five Years from 2008 to 2012

S NO	Year	No of Dead Dolphins	Male	Female
1	2008	02	01	01
2	2009	00	00	00
3	2010	04	01	03
4	2011	24	12	12
5	2012	12	08	04
	Total	**42**	**22**	**20**

9. THREATS TO DOLPHIN

The Indus River Blind Dolphins are under threat due to two types of threats Natural and Man-made;

Natural

- Water Scarcity
- Low Rainfall
- Habitat Fragmentation and small channel formation due to change of river course in absence of forest cover.
- River siltation due to water currents
- Carrying capacity
- Stranding and Ultimate deaths

Man-made

- Construction of Dams and Barrages
- Over exploitation of fish resources
- Agriculture run-off carrying insecticide and pesticide residues
- Industrial effluents and big cities water sewage carrying heaving metals and solid waste
- Weak enforcement of law
- Accidental deaths in fishing nets
- Hunting and poaching

PHOTOGRAPHIC RECORD OF SURVEY & MEETINGS


Group Photo at Indus Dolphin Conservation Center (I.D.C.C), Sukkur


Meeting held in the office of Incharge I.D.C.C, Sukkur

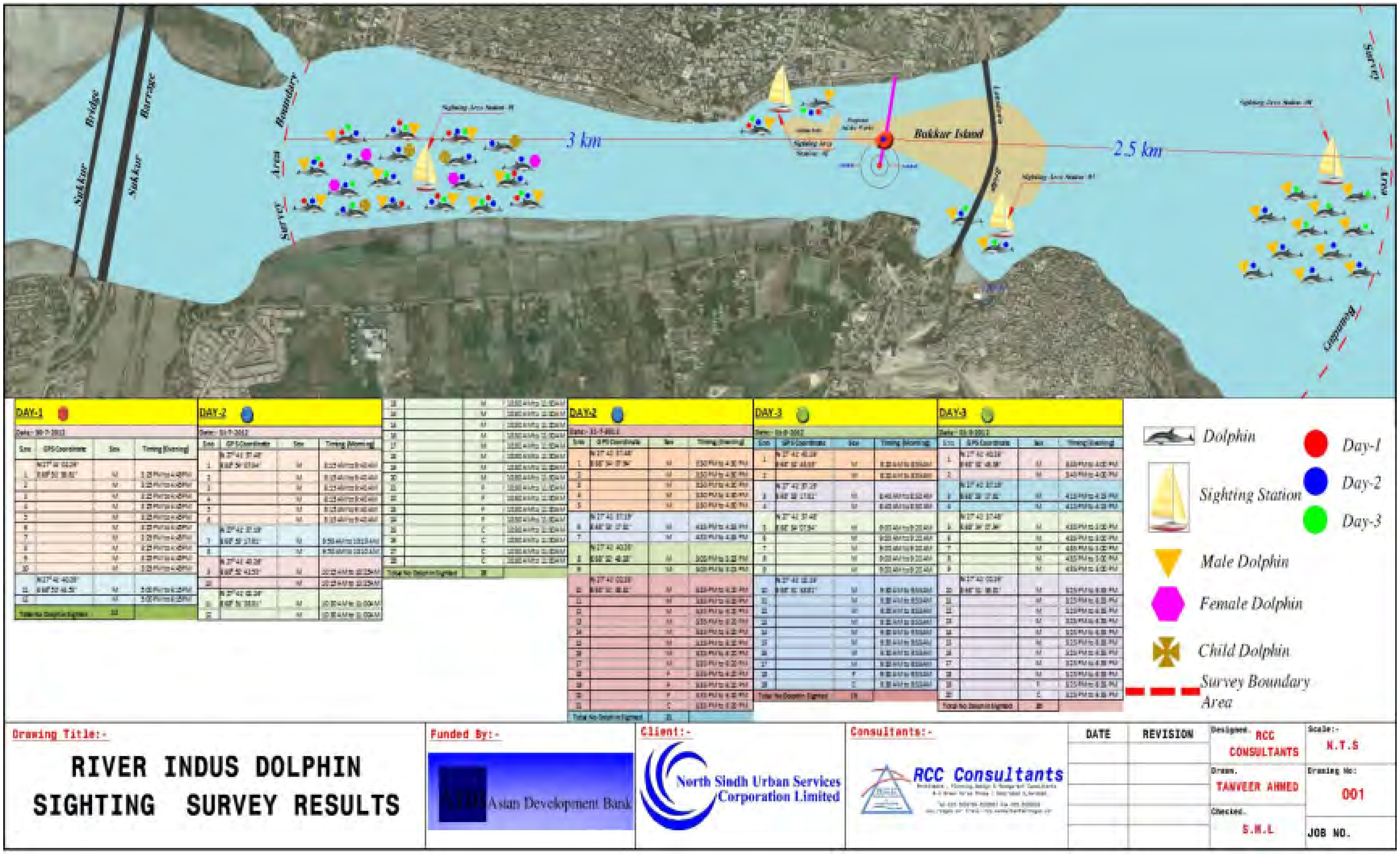

RCC Consultants team meeting with Deputy Conservative Wildlife Department

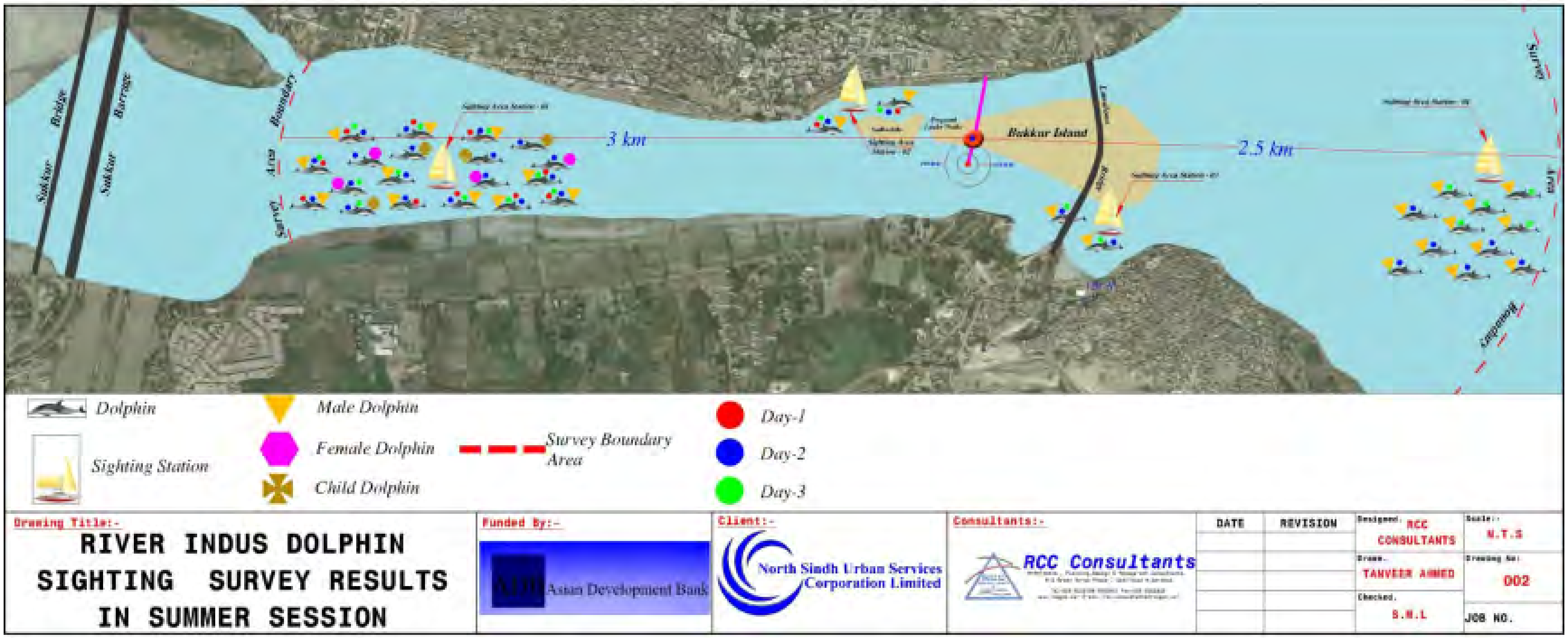

RCC Consultants Survey Team working under supervision of Dir O&S, NSUSC


Indus River Dolphin


Sindh Wildlife Dept member accompanying the Survey team

ANNEX-A MAP & PLANS


Sukkur Bridge
Sukkur Barrage
Survey Area Boundary
3 km
Bukkur Island
2.5 km
DAY-1
DAY-2
DAY-3
Dolphin
Sighting Station
Male Dolphin
Female Dolphin
Child Dolphin
Survey Boundary Area
Day-1
Day-2
Day-3
Drawing Title:-
RIVER INDUS DOLPHIN SIGHTING SURVEY RESULTS
Funded By:-
Asian Development Bank
Client:-
North Sindh Urban Services Corporation Limited
Consultants:-
RCC Consultants
DATE
REVISION
Designed. RCC CONSULTANTS
Drawn. TANVEER AHMED
Checked. S.M.L
Scale:- N.T.S
Drawing No: 001
JOB NO.


Sukkur Bridge
Sukkur Barrage
Survey Area Boundary
3 km
Bukkur Island
2.5 km
Survey Area Boundary
Dolphin
Sighting Station
Male Dolphin
Female Dolphin
Child Dolphin
Survey Boundary Area
Day-1
Day-2
Day-3
Drawing Title:-
RIVER INDUS DOLPHIN SIGHTING SURVEY RESULTS IN SUMMER SESSION
Funded By:-
ADB Asian Development Bank
Client:-
North Sindh Urban Services Corporation Limited
Consultants:-
RCC Consultants
DATE
REVISION
Designed: RCC CONSULTANTS
Drawn: TANVEER AHMED
Checked.
Scale: N.T.S
Drawing No: 002
JOB NO.

ANNEX-B ORIGINAL SIGNED SURVEY DATA SHEETS

Date	Time	Sighting Frequency						✓ 1st ,2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	1st day
30/07/2012	3:25 P.m			✓				
	to 6:15 P.m			✓				
				✓				
				✓				
				✓				
				✓				

Sign:___________________
Designation:

Sign:___________________
Designation:

Sign:___________________
Designation:

Date	Time	Sighting Frequency						✓ 1st ,2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
						✓		
				✓				
				✓				
						✓		
				✓				
				✓				Total = 12 Nos

Sign:______________
Designation:

Sign:______________
Designation:

Sign:______________
Designation:

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
31/7/012	8:15 to 11:00	M	F	M	F	M	F	2cond day
				✓				
				✓				
				✓				
				✓				
				✓				
				✓				

Sign:
Designation:

Sign: 31/7.
Designation: (Engineer, HQ NSUSE)

Sign: 31-7-2012
Designation: I.D.L.C Wildlife.

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
				✓				
		✓					✓	
		✓					✓	
				✓				
				✓				
				✓				

Sign:
Designation:

Sign:
Designation:

Sign:
Designation:

Date	Time	Sighting Frequency						✓ 1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
				✓				
						✓		
						✓		
						✓		
						✓		
						✓		

Sign:
Designation:

Sign: 31/7
Designation:

Sign:
Designation:

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
		✓					✓	
				✓				
				✓				
		✓					✓	
				✓				
				✓				Total = 28 Nos

Sign:

Designation:

Sign: 31/7

Designation: (Engineer, HQ, NSUSC)

Sign: 31-7-2012

Designation: IDCC Wildlife.

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
31/07/2012	3:50 pm	M	F	M	F	M	F	
	to 6:20			✓				
				✓				
							✓	
								Total = 21 Nos

Sign:
Designation:

Sign: 31/7
Designation: (Engineer, HQ, NSUSC)

Sign: 31-7-2012
Designation: IDC wildlife

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
	3:50 pm to 6:20			✓				
		✓					✓	
				✓				
							✓	
							✓	
				✓				

Sign:_______________
Designation:

Sign:_______________ 31/7 (Engineer, HQ, Nowse)
Designation:

Sign:_______________
Designation:

Date	Time	Sighting Frequency						1st, 2nd ✓ & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
31/07/012	3:50 pm to 6:20 pm			✓				
				✓				
				✓				
				✓				
				✓				

Sign:
Designation:

Sign: 31/7
Designation: (Engineer, HO, NENSE)

Sign:
Designation:

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
	3:50 pm							
	to 6:20					✓		
						✓		
				✓				
				✓				
				✓				
						✓		

Sign:
Designation:

Sign: 31/7
Designation: (Engineer, HQ. NESPAK)

Sign:
Designation: IDCC Wildlife

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
01/8/2012	8:10 Am to 9:55 am							3rd day
				✓				
				✓				
				✓				
							✓	
				✓				
				✓				

Sign:

Designation:

Sign: 01/8.

Designation: (Engineer, HQ, NSUSC)

Sign:

Designation:

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
				✓				
						✓		
				✓				
				✓				
				✓				
						✓		

Sign:____________
Designation:

Sign:____________
Designation:

Sign:____________
Designation:

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
01/8/2012	8:10 Am to 9:55 Am			✓				
				✓				
		✓		✓				
						✓		
				✓				
				✓				Total = 19 Nos

Sign: 01/8
Designation: (Engineer, HQ, NESPAK)

Sign:
Designation: R.CC

Sign: 1.8.2012
Designation: IDCC Wildlife

Dir OD

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
01/8/012	3:45 Pm to 6:35 Pm			✓				
				✓				
						✓		
				✓				
				✓				
				✓				

Sign:

Designation:

Sign:

Designation:

Sign:

Designation:

Date	Time	Sighting Frequency						1st, 2nd & 3rd ✓ Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
				✓				
				✓				
				✓				
		✓					✓	
				✓				
				✓				

Sign:__________
Designation:

Sign:__________
Designation:

Sign:__________
Designation:

Date	Time	Sighting Frequency						1st, 2nd & 3rd Day
		S (Sex)		M		L		
		M	F	M	F	M	F	
01/8/012	3:45 Pm to							
	6:35			✓				
						✓		
				✓				
				✓				
		✓				✓		
				✓				Total = 20 Nos

Sign:
Designation:

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Designation:

Sign:
Designation:

1.8.2012
IDCC

ANNEX-C: RESULTS OF FIRST DOLPHIN SURVEY (FEB-2012)

The First Observational Survey was carried out in Feb 2012 for Surfacing of Dolphin by team of Consultants along with the SWM department members in Two Boats for three days. The Observation is the only method for the Survey of Dolphin used in morning and afternoon and was focused on 200 meter zone.

The Survey was conducted in the impacted zone for the survey purpose only. The Impact Zone is 200 meters .

Following parameters were observed

1. Surfacing
2. Zone 1
3. Size of Dolphin (Small , Medium or Large)
4. Frequency of Observation

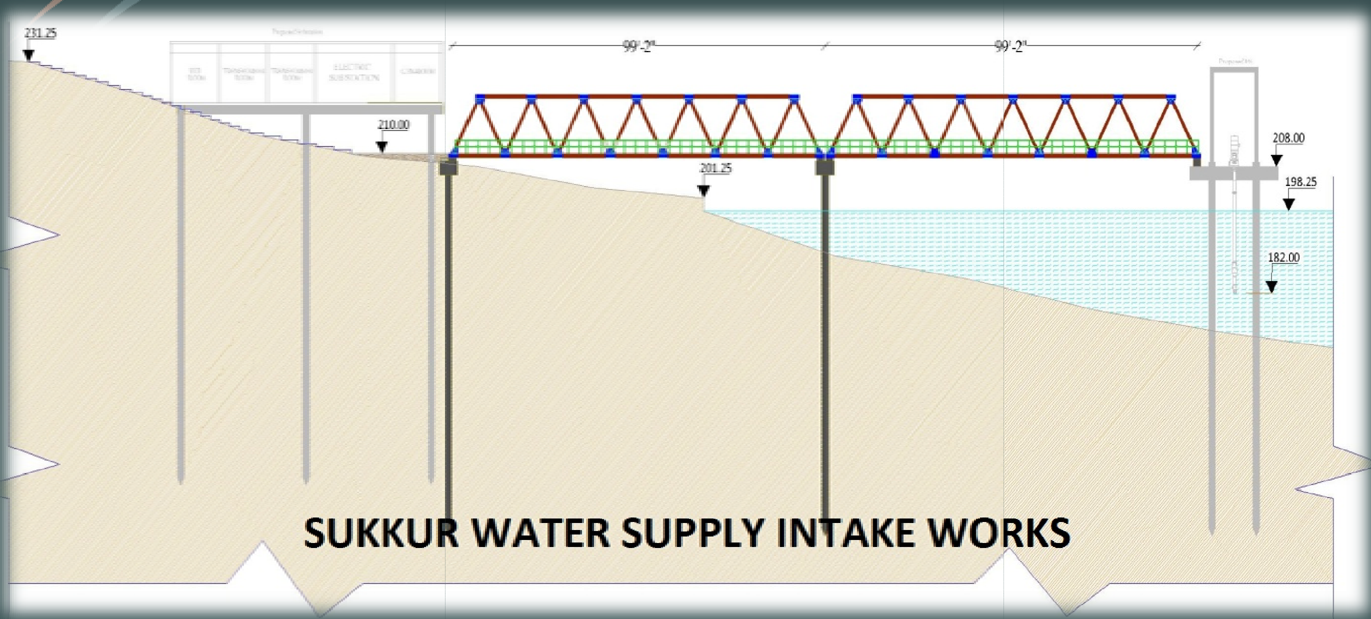
The Result of the Survey is provided in below Table in 200 Meter Zone

Day	Time of survey	Surfacing	Size of Dolphin			Total Sighting
			S	M	L	
1	0800-1000 1400-1800	5 6	1	3	2	6
2	0800-1000 1400-1800	3 4	1	2	1	5
3	0800-1000 1400-1800	4 6	1	3	2	6

ANNEXURE-I: Alternatives Technical Analysis and Alternatives Cost Analysis Report

CONSULTING SERVICES FOR OPTIMAL APPROACHES REVIEW AND FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN: 2499-PAK)

ALTERNATIVE TECHNICAL ANALYSIS & ALTERNATIVE COST ANALYSIS REPORT



PROJECT CLIENT

North Sindh Urban Services Corporation Limited

REPORT PREPARED BY
PROJECT CONSULTANTS

RCC CONSULTANTS & ARCHITECTS

PROJECT FUNDING

ADB Asian Development Bank

ABBREVIATIONS

ADB - Asian Development Bank
AMP- Ampere
BOD- Biological Oxygen Demand
BSWC- Basic Sub-Work Components
BOQ- Bill of Quantities
DG- Diesel Generators
ERS- Electrical Resistivity Survey
EIA- Environmental Impact Assessment
GPS- Global Positioning System
HSC- Hunting Survey Corporation
HESCO- Hyderabad Electric Supply Corporation
HP- Horse Power
IPS- Intake Pumping Station
IPD- Irrigation & Power Department
IEE- Initial Environmental Examination
KVA- Kilo Volt Ampere
MWL- Mean Water Level
M.cu.ft- Million Cubic Feet
mg/Liter- Milligram per Liter
MAF- Million Acre Feet
NSUSC-North Sindh Urban Services Corporation
NTU- Nephelometric Turbidity Unit
O&M- Operation & Maintenance
PHED- Public Health Engineering Department
pH- Potential of Hydrogen
Rs. –Rupees
SIDA- Sindh Irrigation Development Authority
TOR- Terms of Reference
TSS- Total Suspended Solids
TDS- Total Dissolved Solids
T-HP- Total Horse Power
TKW- Total Kilo Watt
WHO- World Health organization
WAPDA- Water & Power Development Authority
WTP- Water Treatment Plant

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INTRODUCTION

SECTION 01

IN THIS SECTION:

1.1 GENERAL

1.2 OBJECTIVES OF ASSIGNMENT

1.3 STUDY AREA

1.4 WATER DEMAND

1. INTRODUCTION

1.1 GENERAL

The existing main municipal water supply of Sukkur city and part of New Sukkur is provided through two conventional water treatment plants (WTPs) at Bunder Road WTP and Numaish Gah WTP. The source of raw water supply for these two plants is an intake pumping station(IPS) located on the right bank of the River Indus just across the road from the Bunder road WTP and at a distance of about 3 km from Numaish WTP.

The Existing intake is not ideally located for several reasons.

(i) It is located on the bank of the River Indus and may in extreme conditions be subject to flooding.

(ii) It is located downstream of untreated waste water outfalls which dispose of about one third of the total waste water flow of the city.

(iii) The raw water quality of River Indus is highly turbid throughout much of the year which causes major problems and expenses in its treatment.

(iv) At certain times of the year the level of River Indus falls to a point that river bed dries up completely at the location of existing intake pipes.

(v) There is a strong probability that in the near future the low water level of Indus will frequently fall below that of the intake pipes, which will result in failure of the municipal water supply.

The existing intake is located on a right hand channel due to bifurcation of the Indus around an island and this channel has lower flow than the main left hand channel.

1.2 OBJECTIVES OF THE ASSIGNMENT

Sindh Cities Investment Program (SCIP) aims to provide the participating towns which reliable, cost-effective, financially sustainable and environmentally sound water supply, sanitation and SWM services. The program will introduce 24/7 water supply to coverage areas in phases, beginning with 6 pilot distribution net work improvement (DNI) zones in 4 towns under Traanche-1 .

The overall objective of all the assignment is to conduct a study to determine an optimal solution for the raw water intake at Sukkur, since the current intake is inadequate during the dry season. Identify various solutions and assess technical, operational, financial, environmental and social aspects of these solutions. Based on the analysis suggest a solution that can be implemented as a sub project in Tranche-2.

- *Under this assignment, following works are required viz:*
  - (i) Investigate the problems of raw water collection for supply to the main water treatment works of Sukkur (i.e. Bunder Road WTP and Numaish WTP) serving about 2/3rd of total projected (year 2050) population of 1.8 million particularly at times of low flow in the River Indus.
  - (ii) Undertake the Hydrological studies (based on a hydraulic mode) of the River Indus that will enable the consultant to assess the probability of exceedence of various low water levels (for periods up to 50 years) in the vicinity of the Sukkur Bunder Road WTP intake.
  - (iii) Undertake hydro geological studies by using a well established hydraulic model/program of the potential for the use ground water from the left bank of the River Indus and the intervening island based on ongoing test wells and ERS in Rohri etc.

(iv) Undertake limited survey of the river bed profile in areas considered most suitable for a possible new intake.

(v) Under take water quality data collection and survey of assess water quality issues associated with location of intake including biological, chemical and physical characteristics and stratification of river water during high and low flows, along with another parameters such a water depth, steam of current velocities, sediments transportations.

(vi) Carry out alternative technical analysis of possible solutions, the consultant should take account of issues related to foundation stability, access, power availability, proximity to Water Treatment Plant, hazard to navigation if any, and fishing consideration.

(vii) Carry out alternative cost analyses of most appropriate technical solutions with risk assessment derived from above (including present value comparable of capital and operating costs for a range of discount rates)

(viii) Prepare detailed cost estimate of lowest overall cost alternative including contingencies and necessary land acquisition.

(ix) Complete feasibility assessments preliminary and detailed design for Tranche-2 sub project related to the recommended (as agreed with the client) intake works/alternative source and bidding document based on ADB requirement.

(x) Prepare IEE/EIAs for proposed works if considerable necessary under the law.

- *The following are some consideration that are required to be studied;*

(i) The possibility of relocating the intake pump station and/or pipes to reach waters at low river flow and waters with less turbid quality.

(ii) The possible alternative types of raw water draw-off

(a) Direct draw-off from side to river.

(b) Direct pipe draw-off (on jetty/piers)

(c) Floating pipe/ platform

(d) Suspension bridge support across to island

(e) Underwater pipe line to chamber in river

(f) Infiltration chambers / galleries in/under/beside river

(g) Location of intake pump station/ galleries on island (possible far side)

(iii) The possible use of tube wells water from the island or Rohri to replace the existing raw water source for Sukkur.

(iv) The effects of geology, topography (siltation, etc) historical flooding and hydraulics on the possible location and stability of deep zones in the river bed.

(v) The effects of Sukkur Barrage gate openings and diversions on the available low water level for water supply.

(vi) The long term aspects of River Indus Flows- partially due to global warming and flooding.

1.3 STUDY AREA

The study area is within the pond area created by Sukkur Barrage. The pond area stretches from Sukkur Barrage gate to about 5 Kilometer up stream upto Lansdowne Bridge. In this pond high water level is maintained so as to feed several irrigation canals on both banks of the river Indus. The general area of interest for fetching water supply for Sukkur city is about 3.5 Kilometer long by about 1 kilometer wide starting around Lansdowne bridge up to end of Sadhu Bela.

At this pond area the River Indus flows through a gap in a range of low limestone hills and gets divided into two channels (Sukkur and Rohri channels) by an Island called Bukkur named as such by pious saint Sayed Muhammad Makili in 7th Century of Hijra (13th Century AD). The Island is a limestone rock, oval in shape. At present it is occupied by Army Public School, Rangers Offices. Presently its area is about 81 acre. Sadhu Bela is part of this Island but presently separated by short stretch of river. Both islands are preserved sites.

For this study, the area of interest is earmarked as 2000 ft downstream of present location of Intake Pumping Station, and 2100 ft on upstream side of present Intake Pumping Station that is upto about 1000 ft on upstream side of Lansdowne Bridge. It may be mentioned that river area outside the area of interest as described above is insignificant for several reasons, for instance any river area downstream of our study boundary is restricted area due to close proximity with Sukkur Barrage and seven irrigation canals. Whereas river area upstream of study boundary is free flowing river with shallow depths and frequent meandering.

‘1.4 WATER DEMAND

The scope of this study is restricted to meet water demand of area feed through Bunder road and Numaish Gah Water Treatment Plants (WTPs). It is stated in Terms of Reference (TOR) for this study section 5 item 9(i) as quote “Investigate the problems of raw water collection for supply to the main water treatment works of Sukkur (i.e. Bunder Road WTP and Numaish WTP), serving about 2/3rd of total projected (Year 2050) population of 1.8 million particularly at time of low flow in the River Indus”.

It is further noted that Bunder Road WTP supplies twice the supply through Numaish Gah. Based on these figures following table summaries the water demand till 2050, to be met at each of the two WTPs.

TABLE 1.1: PROJECTED POPULATION & WATER DEMAND (SUKKUR + NEW SUKKUR)

Year	Annual Growt h Rate	Population	Total Demand (MGD)	Demand for 2/3rd Population (MGD) (Ref T.O.R 9 (I) Section 5) For Combined demand at Bundar Road + Numaish WTP	Bundar Road WTP 45%	Numaish WTP 22%	Others 33%
1999		335,551	10.07	6.7	4.5	2.2	3.3
2000	3.38%	346,893	10.41	6.9	4.7	2.3	3.4
2001	3.38%	358,618	10.76	7.2	4.8	2.4	3.6
2002	3.38%	370,739	11.12	7.4	5.0	2.4	3.7
2003	3.38%	383,270	11.50	7.7	5.2	2.5	3.8
2004	3.38%	396,225	11.89	7.9	5.3	2.6	3.9
2005	3.38%	409,617	12.29	8.2	5.5	2.7	4.1
2006	3.38%	423,462	12.70	8.5	5.7	2.8	4.2
2007	3.38%	437,775	13.13	8.8	5.9	2.9	4.3
2008	3.38%	452,572	13.58	9.1	6.1	3.0	4.5
2009	3.38%	467,869	14.04	9.4	6.3	3.1	4.6
2010	3.38%	483,683	14.51	9.7	6.5	3.2	4.8
2011	**3.38%**	**500,031**	**15.00**	**10.0**	**6.8**	**3.3**	**5.0**
2012	3.38%	516,932	15.51	10.3	7.0	3.4	5.1
2013	3.38%	534,404	16.03	10.7	7.2	3.5	5.3
2014	3.38%	552,467	16.57	11.0	7.5	3.6	5.5
2015	3.38%	571,140	17.13	11.4	7.7	3.8	5.7
2016	3.38%	590,445	17.71	11.8	8.0	3.9	5.8
2017	3.38%	610,402	18.31	12.2	8.2	4.0	6.0
2018	3.38%	631,034	18.93	12.6	8.5	4.2	6.2
2019	3.38%	652,363	19.57	13.0	8.8	4.3	6.5
2020	3.38%	674,413	20.23	13.5	9.1	4.5	6.7
2021	3.38%	697,208	20.92	13.9	9.4	4.6	6.9
2022	3.38%	720,774	21.62	14.4	9.7	4.8	7.1

2023	3.38%	745,136	22.35	14.9	10.1	4.9	7.4
2024	3.38%	770,322	23.11	15.4	10.4	5.1	7.6
2025	3.38%	796,359	23.89	15.9	10.8	5.3	7.9
2026	3.38%	823,276	24.70	16.5	11.1	5.4	8.2
2027	3.38%	851,103	25.53	17.0	11.5	5.6	8.4
2028	3.38%	879,870	26.40	17.6	11.9	5.8	8.7
2029	3.38%	909,610	27.29	18.2	12.3	6.0	9.0
2030	**3.38%**	**940,355**	**28.21**	**18.8**	**12.7**	**6.2**	**9.3**
2031	**3.38%**	**972,139**	**29.16**	**19.4**	13.1	6.4	**9.6**
2032	3.38%	1,004,997	30.15	20.1	13.6	6.6	9.9
2033	3.38%	1,038,966	31.17	20.8	14.0	6.9	10.3
2034	3.38%	1,074,083	32.22	21.5	14.5	7.1	10.6
2035	3.38%	1,110,387	33.31	22.2	15.0	7.3	11.0
2036	3.38%	1,147,918	34.44	23.0	15.5	7.6	11.4
2037	3.38%	1,186,718	35.60	23.7	16.0	7.8	11.7
2038	3.38%	1,226,829	36.80	24.5	16.6	8.1	12.1
2039	3.38%	1,268,296	38.05	25.4	17.1	8.4	12.6
2040	3.38%	1,311,164	39.33	26.2	17.7	8.7	13.0
2041	3.38%	1,355,481	40.66	27.1	18.3	8.9	13.4
2042	3.38%	1,401,296	42.04	28.0	18.9	9.2	13.9
2043	3.38%	1,448,660	43.46	29.0	19.6	9.6	14.3
2044	3.38%	1,497,625	44.93	30.0	20.2	9.9	14.8
2045	3.38%	1,548,245	46.45	31.0	20.9	10.2	15.3
2046	3.38%	1,600,576	48.02	32.0	21.6	10.6	15.8
2047	3.38%	1,654,675	49.64	33.1	22.3	10.9	16.4
2048	3.38%	1,710,603	51.32	34.2	23.1	11.3	16.9
2049	3.38%	1,768,421	53.05	35.4	23.9	11.7	17.5
2050	**3.38%**	**1,828,194**	**54.85**	**36.6**	**24.7**	**12.1**	**18.1**

REVIEW OF KEY POINTS FROM OTHER PART OF THE STUDY

SECTION 02

IN THIS SECTION:

2.1 RIVER BED REPORT KEY POINTS

2.2 WATER QUALITY REPORT KEY POINTS

2.3 HYDROLOGY REPORT KEY POINTS

2.4 HYDROGEOLOGY REPORT KEY POINTS

2.5 STUDIES BEING CARRIED OUT BY OTHER AGENCIES TO STREGTHEN SUKKUR BARRAGE

2. REVIEW OF KEY POINTS FROM OTHER PART OF THE STUDY

2.1 RIVER BED REPORT KEY POINTS

All figures and Tables referred in Section 2.1 refer to River Bed & Water Quality Study Report.

2.1.1 River Bed profile between Bukkur Island and Left Bank (Rohri Channel) is deeper than River Bed between Bukkur Island and Right Bank (Sukkur Channel) by about 20 feet. Refer River cross-sections color plan and 3D images in figures 2.5 to 2.35.

2.1.2 River Bed levels in Rohri Channel just upstream of Lansdowne Bridge are deeper than all River Bed levels on upstream side. See figures 2.10.

2.1.3 River main flow stream occurs on Rohri Chanel side and peak velocity occurs closer to Island on the same side. Refer figure 3.13. The river flow on right bank side is due to creation of pond from gates control at Sukkur barrage.

2.1.4 The longitudinal River Bed profile on Sukkur Channel side downstream of the existing location of IPS is almost flat with an average level at 190.0 ft. Refer figure 2.3 & 2.4. However around Sadhu Bela Island on Sukkur side River Bed forms a local deep pocket with bed level of about 185.0 ft. Refer figure 2.29.

2.1.5 At existing location of IPS River Bed rises towards the near side of the Island to about 195.0 ft level. Refer figure 2.20.

2.1.6 Bunder wall on Sukkur side is being raised from original level of 204.0 ft to 208 ft level. Existing IPS floor level is at 103.32 ft while Bukkur Island ground level outside the fort varies from 200.0 to 203.0 ft and the top of protection wall of Sadhu Bela is at 207-0 ft. The bottom of IPS intake pipes is at 191.0 ft and etc.

2.2 WATER QUALITY REPORT KEY POINTS

All Figures and Tables referred in Section 2.2 refer to River Bed & Water Quality Study Report.

2.2.1 Turbidity Data Analysis of 50 years indicates that the average turbidity of river water at Sukkur pond during Kharif period (June to September) is 2119 mg/lit and during Rabi period (November to April) turbidity is around 565.7 mg/lit. Refer Table 3.2.

2.2.2 The peak turbidity occurs in months of August when peak discharge occurs. During the study water samples were tested on 18th August 2011 and result showed that turbidity was around 3200 NTU at the deeper layers and it was about 2900 NTU near the surface. Refer Table 3.1.

2.2.3 In order to establish quantitative relationship between Turbidity measured in NTUs and total suspended solids (TSS) in mg/lit regression analysis was carried out between NTU and TSS to arrive at the equation i-e TSS (mg/liter) =0.708 x NTU + 15.85. This equation is to be used to compute silt load generated at respective water treatment plants. The procedure and results are shown at section 3.1.4 and displayed in figure 3.5 and Table 3.1.

2.2.4 River Bed stability is ensured within pond area due to bounded area with restricted escape for meandering, and due to uniformity of silt content and grain sizes throughout the years. Stability of Limestone Islands since centuries is proven against any erosion and on the other hand stability of left right river banks within the study area is ensured by concrete cum stone robust walls. Refer section 4.0 for details.

2.2.5 River Bed silt litho logy shows it is predominantly fine silt with clay traces, and Red rock Limestone layer lies underneath at depths varying form 14.0

m to 30 meters while some intermediate layers of fine to medium fine sand also exist. Refer section 5.0 for detailed report.

2.2.6 The turbidity in bottom layers is about 12% higher than surface water levels. (Refer figures 3.1 to 3.4)

2.2.7 During Kharif period at Bunder water treatment plant (WTP) by the year 2050 about 200 tons of silt per day will be generated, while at Numaish WTP the figure will be about 100 ton/day. In Rabi the figure will be 55 tons/day and 28 tons/day respectively. Refer Table 3.4.

2.2.8 Water is being contaminated through dumping of city sewerage at several locations along Right Bank. Ref section 3.2.1.

2.2.9 Water samples test result indicated that surface water within Sukkur Chanel side is highly contaminated with coli-form & E-coli. However at lower depths the contamination is significantly reduced. Refer table 3.5 and figure 3.7 to 3.10.

2.2.10 The water sample test result indicated that river water in Rohri side Channel is contamination free on upstream side of Sadhu Bela. However at Sadhu Bela even on Rohri side some contamination was observed. This indicates that contaminated water from Sukkur side is mixing with Rohri Channel through the gap between Bukkur Island and Sadhu Bela. Refer figure 3.7 to 3.10.

2.2.11 Water sample test result indicate that Indus River water within the study area except turbidity meets the WHO standards in respect of pH, Alkanity, TDS, Calcium, Magnesium, Chloride, Sulphur, Conductivity, Salinity, Odor (except at points of contamination), Fluoride, Mercury, Arsenic, Sodium, Potassium, Iron, Nitrate, OD etc. Refer Table 3.5.

2.3 HYDROLOGY REPORT KEY POINTS

All Figures and Tables referred in Section 2.3 & 2.4 refer to Hydrological & Hydrogeological Investigation Report.

2.3.1 Record of River Indus historical data for last 50 years (1961-2011) was collected that included information in respect of Gauge reading, Daily with-drawls and discharges at Sukkur Barrage. Some limited data was also found in respect of River hydraulic gradients, pH values, Solvable salt, Silt load and velocity measurements.

2.3.2 The data part pertaining to gauge readings, discharges, silt load were then digitized and printed in hard copy containing about 400 A4 size pages. The hard copy data volume in single copy is also supplied to NSUSC as part of document submittals for this study.

2.3.3 About 96% of the available water in the Indus basin system is used for agriculture purposes, leaving 2% for domestic and other 2% for Industrial use. (Section 1.3.1)

2.3.4 The water availability in the Indus basin system for irrigation use is highly erratic and unreliable. The highest annual water availability in the recorded history was 186.79 MAF (million acre feet) in the year 1959-60 as against the minimum of 95.99 MAF in the year 2001-2002. This high variation in river flows is due to typical climatic conditions where most of the rainfall occurs during the monsoon season (June 15 to September 15), while rest of the period gets very little rain. This is the reason that high water consuming crops like rice, banana & sugarcane are sown in the Kharif season (April to September) while less water consuming crops like wheat & cotton are sown during the Rabi season. (Section 1.3.1)

2.3.5 The Indus River is known for its typical meandering nature. The direct distance of River Indus across Pakistan is only 1200 km but it traverses about 1800 km due to its snake-like route until its mergence into the Arabian Sea. The highly meandering nature of River Indus with sinuosity value of about 1.5 and above is essentially due to big variance in bed slope at different sections and typical flow pattern where river gets high flows during monsoon season otherwise remains dormant most of the time. (Section 1.4.2)

2.3.6 Sukkur, located on the right bank of River Indus, is an important commercial and industrial city of Sindh province. This 3rd big city of Sindh is famous for its 66 gated barrage, made of yellow stone and steel across the Indus, which controls one of the largest irrigation systems in the world. (Section 1.4.3)

2.3.7 Estimate for projected high flow were computed for 1, 2, 5, 10, 20, 50 and 100 years return periods for yearly, monthly, weekly and daily flows. (Section 3.1).

2.3.8 Estimate for projected high flow were computed for 1, 2, 5, 10 and 20 year return periods for monthly, weekly and daily low flows.

2.3.9 The result show that Estimates of project yearly, monthly, weekly and daily low flows with return period of 20 years, are, 3549.50, 2965.0, 2965.0 cusecs respectively. This indicates that sufficient water shall be available for Sukkur city needs of about 100 cusecs per day. It further shows that water level can go down to 180.78 ft. Thus there shall be no water on almost entire area of river bounded by Lansdowne Bridge and end of Sadhu Bela on one side and Right Bank and near side of both Islands on other side. (refer Tables 3.7 to 3.10 and figures 4.2, 4.3, 4.4 and 4.5)

2.3.10 The estimate of High Flow Return Period as in shown in figures indicate that for 5 year return period and higher all area around outside of the Bukkur island Fort will be inundated. This means that even if IPS is located on far side of island where water will be available round the year the IPS will be likely inaccessible during every 5 years when water level will rise above 200.0ft. (Refer figure 3.20 to 3.24)

2.3.11 Figures further show that existing IPS with present floor levels at 203.23ft will get submerged every 10 year when the water level is likely to exceed 204.28ft. (Refer figures 3.21)

2.3.12 The table 3.9 further shows that for every 5 year Return Period the lowest flow in river Indus will be less than 7000 cusecs with water level of falling to about 184.80ft. At this levels River Indus bed between right bank and Bukkur Island from Lansdowne Bridge upto Sadhu Belo will dry up. (Refer figure 4.5)

2.3.13 The figure 3.17, figure 3.30 and figure 3.43 show that during the lowest flows for Return Period of 50 years sufficient water is available on far side of island with water level not dropping below 180.0ft. The river bed level on that side varies between 170ft along the island and upto to 160ft just upstream of Lansdowne Bridge. The lowest river flow for that return period is about 3500 cusecs but sufficient to provide projected requirement of Sukkur city of 100.0 cusecs by the year 2054.

2.3.14 The figure 3.11, 3.24 and 3.37 further show that water level can rise to 206.06 ft with return period of 100 years. This level is just short of 2 feet below the presently raised Bunder wall and just few inches below the Sadhu Belo protection wall. For these reasons the future IPS floor levels has to be fixed at around 208.0 ft. The data showed that during last 50 years the water level has topped IPS floor levels on 3 occasions.

2.3.15 Daily flow duration curves (FDC) are typically established at an un-gauged site where only a simulated or calculated monthly time series is available. In our case we are in possession of all gauged data, of daily flows for last 50 years. FDC is a relationship between any given discharge value and the percentage of time that this discharge is equaled or exceeded. It gives a summary of the flow variability at a site. FDC may be constructed from either daily (1d FDC) or monthly (1m FDC) data. Both I d and 1m FDCs may be calculated on the basis of the whole available record period or on the basis of all similar calendar months from the whole period (e.g. all Januaries).

2.3.16 Flow duration curve of monthly, weekly and daily discharges are drawn using actual 50 year data procedure and methodology is given at section 3.3.

2.3.17 Flow duration curve indicate that 97% of the time flow exceeds 20,000 cusecs for daily, weekly and monthly flows.

2.3.18 The data further showed that for 1 year return period i-e every year water level falls below 185.0 ft. This period coincides with annual barrage gate opening when all the canals are closed. The lowest flow ever occurred was 3490 cusecs which occurred on 17th January 2005 that also fell in closure period. During closure period all canals are also closed and the only use of this low flow is for domestic use. Thus demand of Sukkur city of 100 cusecs by 2050 can be easily met from available water in similar situations.

2.3.19 The canals of Sukkur Barrage close for annual repair normally form 25th December to 10th January, however delayed closures from January 6th to 21st are also seen in the data collected for last 50 years. During canal closures the gates of Sukkur Barrage are fully opened for annual maintenance thus pond water is all drained down the downstream side.

2.3.20 The 50 year record of closure periods indicate that total commutative closure period days since 1961 upto June 2011 have been about 784 days, with average closure days per year as 15.86, with minimum closure days were 7days during 1971-72and maximum ever closure period was 25 days during 1980-1981.(refer Section 4.3).The data analysis further revealed that other than closure periods there have been some rare occasions when due to abnormal gates regulation the pond water was drained out due to Sukkur Barrage gate openings. On other occasions water level dropped to the point (below 195.0) that at location of present Intake contamination levels went high causing shut down of water intake for drinking purposes.

2.3.21 Figure 4.3 displays the areas within pond area where river bed will dryup during closure periods. This further identifies potential location where around the year water shall be available and these are but not limited to, opposite to present IPS on far side of Bukkur Island and on immediate upstream or downstream sides of Lansdowne Bridge.

2.3.22 Water is involved in all components of the climate system (atmosphere, hydrosphere, cryosphere, land surface and biosphere). Therefore, climate change affects water through a number of mechanisms. The hydrological cycle is intimately linked with changes in atmospheric temperature and radiation balance. Warming of the climate system in recent decades is unequivocal, as is now evident from the observation of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea level. It is estimated that there has been a linear trend in global surface temperature from 1906 to 2005, where a warming of 0.74°C (likely range 0.56 to 0.92°C) is observed, with a more rapid warming trend over the past 50 years. This observed increase in global temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. At the continental scale, it is likely that there has been significant anthropogenic warming over the past 50 years averaged over each of the continents except Antarctica. The cold days, cold nights and frost have become less frequent, while hot days, hot nights and heat-waves have become more frequent over the past 50 years.

2.3.23 Similarly, large scale deforestation and increased in population and urbanization have altered the balance in Pakistan. This has resulted in higher water consumption, more water vaporization and increased rainfall-runoff.

2.3.24 Global mean sea level has been rising and there is high confidence that the rate of rise has increased between the mid-19th and the mid-20th centuries. The average rate was 1.7 ± 0.5 mm/yr for the 20th century, 1.8 ± 0.5 mm/yr for 1961–2003, and 3.1 ± 0.7 mm/yr for 1993–2003. It is not known whether the higher rate in 1993–2003 is due to decadal variability or to an increase in the longer-term trend.

2.3.25 Pakistan has a very long coast. Hence Sindh Irrigation & Drainage Authority (SIDA) carried out a study and monitored the behavior of Arabian Sea in the Badin coastal belt for two years from August 2006 to August 2008. An interesting feature is observed that sea has intruded into the coastal land. Similar observation is found in the riverine area of River Indus. It is apprehended that this could be due to rise in sea level.

2.3.26 It was expected that discharge in Indus would decline after the construction of Tarbella Dam due to storage of flood water. However, River Indus experienced very high flows in 1970s. It reached the maximum ever recorded discharge of 12 lac cusecs in 1976 and for six consecutive years crossed the super flood of 10 lac cusecs. Indus again witnessed such a long period of high flows between 1986 & 1995. There is a large variation of flows in River Indus as given in the figure 5.9 where maximum flow is found upto 12 lac cusecs while lowest flow had been 23,000 cusecs during the cited period. This phenomenal variation in flows of River Indus at Sukkur is attributed to global warming.

2.3.27 Another interesting thing observed over Indus is its late surge in the recent times. This historical 80 year data from 1932 to 2010 would show that Indus usually reached peaks during June & July. It may be added that Monsoon Season in Pakistan starts from 15th June and finishes in 15th October. During this period, all the concerned organizations are put on alert to meet with flood situations. However, Indus is moving to August and September to attain super flood situation.

2.3.28 Global warming due to an increasing concentration of green gases in atmosphere will effect temperature and rain fall, and hence river flows and water resources. Progressive changes in river flows over the next few decades would be small compared with year-to-year variability (Figure 5.8 & 5.9), but would be noticeable on a decade to decade basis. Snowfall and hence snow melt could be almost entirely eliminated resulting is greater concentration of flow in Winter. Monthly flows charge could be greater than annual flows.

However all these factors, though will affect water availability for agriculture, these will have insignificant effect on water availability for drinking purposes at Sukkur. The total demand of Sukkur city 2050 shall be merely 0.001% of Kharif River flow and about 3% of lowest ever record flow (in 50 years) in Rabi.

2.3.29 In Pakistan, according to a study, more than 90% of the extracted groundwater is used for irrigation purposes [Khan et al. (2002)]. Groundwater reservoirs are recharged from rivers as well as seepage losses from canals, watercourses, farm channels and fields. Most of the ground water abstraction occurs in the Punjab. This was of the order of 34 MAF in 1999-2000, followed by Sindh, which was estimated at 5 MAF, NWFP at 2.1 MAF and Baluchistan at 0.5 MAF.

2.4 HYDROGEOLOGICAL REPORT KEY POINTS

2.4.1 Development of private Tube Wells in Sindh has not been as intensive as in the Punjab. The main reason behind this is that groundwater is very saline in large parts of Sindh. However, in many areas of Sindh, especially in the north, a substantial layer of fresh water floats on the more saline layers. Although Ahmad (1993) has argued that, even so, shallower tube well development is possible. Hence, in several parts of Sindh, shallow tube wells are already exploiting the thin upper layer using the fresh recharge from canals and distributaries. At present, however, private tube well densities in Sindh are increasing day-by-day, due to ever increasing water stained situation.

2.4.2 The finding of Electrical Resistivity Survey (ERS) conducted by M/s ROCKMORE Private Limited described in Fig 1B of its report is shown in Figure 6.5. The resistivity range, groundwater quality and layer depths for the studied area I and II having ERS1 to ERS10 are summarized (see Table 6.2). It is to mention here that depth of water table in both areas (I and II) is at about 2.5 and 5.0 ft.

2.4.3 In Area-I, the aquifer is sandy with a few intervening clay layers having the resistivity 15 to 30 $\Omega - m$with a good quality of groundwater (i.e. TDS 500 – 1000 ppm or mg/lit). This range of TDS is suitable for drinking purpose as it is near the WHO standard (i.e. TDS < 500mg/l). The aquifer depth of the area-I is varying from 20 to 25m. Hence in this area has a potential to install number of tube wells to get quality groundwater. However in absence of prolong pumping tests effect of salinity rise cannot be ruled out. The pumping test performed by M/s ROCKMORE is not of sufficient duration.

2.4.4 In Area-II, ERS-6 to ERS-8 sites have a good quality water aquifer but the layer thickness is varying from 7 to 10 m. In addition to this, ERS-9 and ERS-10 show salty water or bad quality aquifer throughout their aquifer that may deteriorate their neighboring areas or sites. The fresh quality aquifer of the area-II is limited; hence it is not suitable for installing the tube wells at large numbers.

2.4.5 Based on ERS survey, Rock More Private Limited (RMPL) report shows that in the left bank of river Indus, the TDS value is varying from 500 – 1000 ppm that is acceptable. From lithology, it is clear that there is a thin layer of 20–25 m which is overlying a thick layer of salt water having TDS more than 2000mg/liter. Hence, there is a chance of upcoming of this salt/ saline water which is underlying this thin fresh groundwater lenses. Hence it is concluded that the tube wells if installed should be monitored regularly to check the quality and should run for a safe pumping duration, in order to avoid upcoming of the highly saline water.

2.4.6 They indicated that the project area from the groundwater resource is not very good because as we move away from any water storage source the discharge was falling down, the draw down increased and the recovery time also extended. The above statement of RMPL report is quite clear that groundwater resource is not adequate. In spite of that, Table 6.4 and Figure 6.6 have been developed regarding aquifer yield, drawdown and the recovery time.

2.4.7 Area-I having Northing from 27^{0}40’51.5” to 27^{0}41’21.3” and Easting from 68^{0}51’54.5” to 68^{0}52’45.5” have a potential of good quality of groundwater in the upper limited lens up to 25 m deep. However Area-II is not suitable for a number of tube wells.

The tube wells, if installed between the recommended area should be monitored regularly to check the quality of groundwater and should run for a safe pumping duration in order to avoid upcoming of highly saline water, which is underlying below this thin fresh groundwater lens of 20 – 25 m. The only suitable well that is NSUR5, which has a maximum yield of 20 lit/sec and minimum recovery time of 2 hours after pumping of 10 hrs. The second suitable well is NSU R6 which is near to river Indus having discharge of 15 lit/sec and recovery time of 4 hours. The NSU R3, which is also near to river Indus, has a yield of only 6 lit/sec which is recovered in 2 hours. Its recovery time is ok, but its yield is insufficient.

2.4.8 M/s ROCKMORE studies have shown that saturated zone is available at an average depth of about 5 to 10ft. However water quality deteriorates when moved away from water bodies. Thus there are exciting possibilities that infiltration galleries can be tried on the inside of the right bank of river Indus. Several other potential sites can also be identified.

2.4.9 M/s RCC Consultants have designed these infiltration galleries though at small scale at Hyderabad and Kotri for private clients and since last 15 years these are being successfully operated. Technical detail of this option shall be discussed in third report "Alternative Technical Analysis Report & Drawings".

2.5 STUDIES CARRIED OUT BY OTHER AGENCIES TO STREGTHEN SUKKUR BARRAGE

It is highly pertinent to our study to report that a study is being carried out on Sukkur barrage to look into ways of protecting and strengthening the 80-yearold structure, lifeline of the province's agricultural sector, and enable it to withstand increasingly dangerous levels of flood in the river.

Part of a larger study of three barrages of Sindh, the exercise is being conducted jointly by Atkins, National Development Consultants (NDC) and Associated Consulting Engineers under the Water Sector Improvement Project (WISP) phase-I of the Sindh Irrigation and Drainage Authority (SIDA). Sukkur Barrage withstood a flow of over 12.0 million cusecs of water against its capacity of 900,000 cusec during last year`s flood.

Water experts believe the barrage's structure needs to be strengthened in view of increased flood levels recorded last year. They propose to reopen its 10 gates closed in 1945 after the barrage started operation in 1932 to cope with increased flows. The experts believe that it is time to look into a new theory called Khosla's theory as the barrage was built in line with Bligh`s theory and its structure has withstood the test of times.

It is anticipated commonly in irrigation circles though without any scientific evidence that with changing weather patterns, It can't be ruled out a flow of 1.4 million cusecs reaching Guddu Barrage.

Immediately after inception of the barrage 10 gates of Sukkur barrage had to be closed and a bifurcated point was created upstream to reduce flows of water with strong silt content, It had to be done because right bank canals were having heavy silt content. Additionally an island was created upstream with a submerged regulator to bifurcate flow of waters with lesser silt towards the right bank canals and the remaining flow towards main current. A tail channel which was needed to operate this system efficiently was also created. At the bifurcation point, the levels of tail channel and riverbed were different which ensured diversion of one third of water to the right bank canals with lesser silt deposit and the remaining to tail channel. That Island was created at the barrage's upstream and it was decided that 1.5 times higher water flows than allocation of the right bank canals would be sent to tail channel so that the canals did not receive silt deposits. The tail channel ensures sending water with lesser amount of silt to the right and the remaining to the downstream The tidal channel had not been operating since 1999 because of water shortage and as a result the right bank canals are receiving silt deposits. Thus there is a need to increase capacity of Sukkur barrage which has passed 12.0 million cusecs twice so far in 1976 and last year. Additionally the tail channel had to be operated under certain rules that directly involved availability of water.

The study will also deal with several damages suffered by the barrage in the past. For instance Piers No's 1, 2 and 3 of Sukkur barrage had suffered damage and during annual closure officials discovered large scour pit before the gates' right pocket, which had caused collapse of stone apron, sheet piles and concrete floor. As an interim measure, the pit was filled with stone and cavities were filled with pressure concrete. Actual work of rehabilitation was started in November 2004 and completed in May 2005.The study would also include an environmental management plan to discuss issues relating to water shortage and its impact on flora and fauna and measures to mitigate them. It would also see how to address seepage problem.

The Consultants team is conducting baseline study and they will collect data of last 100 years historical record. About the problem of silt deposits on the right bank canals, the consultants would see how to revive the use of tail channel and island. As there was insufficient flow of water and problem of excess silt deposits therefore, the consultants would also examine this issue, and the possibility to reopen 10 closed gates to enhance barrage capacity and etc.

NSUSC have to keep an eye on this study to foresee effect on their present or future intake works due to execution of the Sukkur Barrage strengthening work if any.

ALTERNATIVE OPTIONS FOR PROJECT SELECTION

IN THIS SECTION:

3.1 LIST OF ALTERNATIVE OPTION AS PROPOSED IN T.O.Rs FOR THIS STUDY

3.2 KEY FINDINGS ATTRIBUTING VIABILITY OF THE FINAL PROJECT SELECTION

3.3 INTRODUCTION OF EMERGING VIABLE OPTIONS

3.4 DESCRIPTION OF IMPROBABLE OPTION PROPOSED IN T.O.Rs

SECTION 03

3. ALTERNATIVE OPTIONS FOR PROJECT SELECTION

3.1 LIST OF ALTERNATIVE OPTION AS PROPOSED IN T.O.Rs FOR THIS STUDY

A. Rebuilding of Intake Pump Station (IPS) and / or Pipes to reach waters at low river flow and water with less Turbid Quality

A.1. Using existing location of IPS

A.2. IPS location moved downstream

A.3. IPS on Island (Bukkur) opposite Bunder on near side

A.4. IPS on Island (Bukkur) opposite Bunder on far side

A.5. Alternative types of raw water drawn-off

A.5.1. Direct draw-off from side of River

A.5.2. Direct pipe drawn-off (On jetty/pipers)

A.5.3. Floating pipe/platform

A.5.4. Suspension Bridge support across to Island

A.5.5. Underwater pipeline to chamber in river

A.5.6. Infiltration chambers/galleries on Island (Possibly far side) or river bed

A.6. Use of tube well water to replace the existing raw water source of Sukkur

A.6.1. From the Island

A.6.2. From the Rohri Area

A.6.3. From Indus River Bed aquifer

3.2 KEY FINDINGS ATTRIBUTING VIABILITY TO THE FINAL PROJECT SELECTION

Historical data analysis and field studies carried out have found following five basic parameters that shape our final project selection and these are

(1) River Bed Profile
(2) Water Availability Scenario
(3) Quality of Water
(4) Turbidity Issue
(5) Sub Soil Water

(1) River Bed Profile

The River Indus within Pond area of Sukkur barrage bifurcates into two channels, Sukkur channel and Rohri channel created by Bukkur Island a range of low limestone hill. The river main stream flows through Rohri channel and flow through Sukkur channel is due to water head up created by Sukkur Barrage for feeding irrigation canals on its Right Bank. The field study results indicated that flow velocities along right bank of river are lower than Rohri side. As a consequence due to excessive silt deposits on that side the river bed level at Sukkur channel are about 20ft higher than Rohri channel bed levels. These facts have been revealed supported by data analysis in the previously submitted River Bed & Water Quality Study Report.

(2) Water Availability Scenario

The data analysis indicated that during last 50 years, there has been never an occasion that water availability in River Indus was ever less than to meet Sukkur City drinking water needs of about 100 cusecs (demand by 2050).

However, water availability is not uniform throughout Pond area. On Sukkur channel side, water is not available during canal closure periods, when canal gates are closed and Sukkur Barrage gates are fully opened resulting in lowering of the water level in the pond area to about 185.0 ft, where as average river bed level at Sukkur side from Lansdowne upto Sadh Belo is about 190.0 ft.

It is shown in the Hydrological & Hydrogeological Investigation Report that at an average for 15 days every year water is not available in Sukkur side channel of River Indus. This duration some times is as low as 7 days and other times as high as 22 days. Figure 3.1 graphically displays areas where water is not available during closure periods.

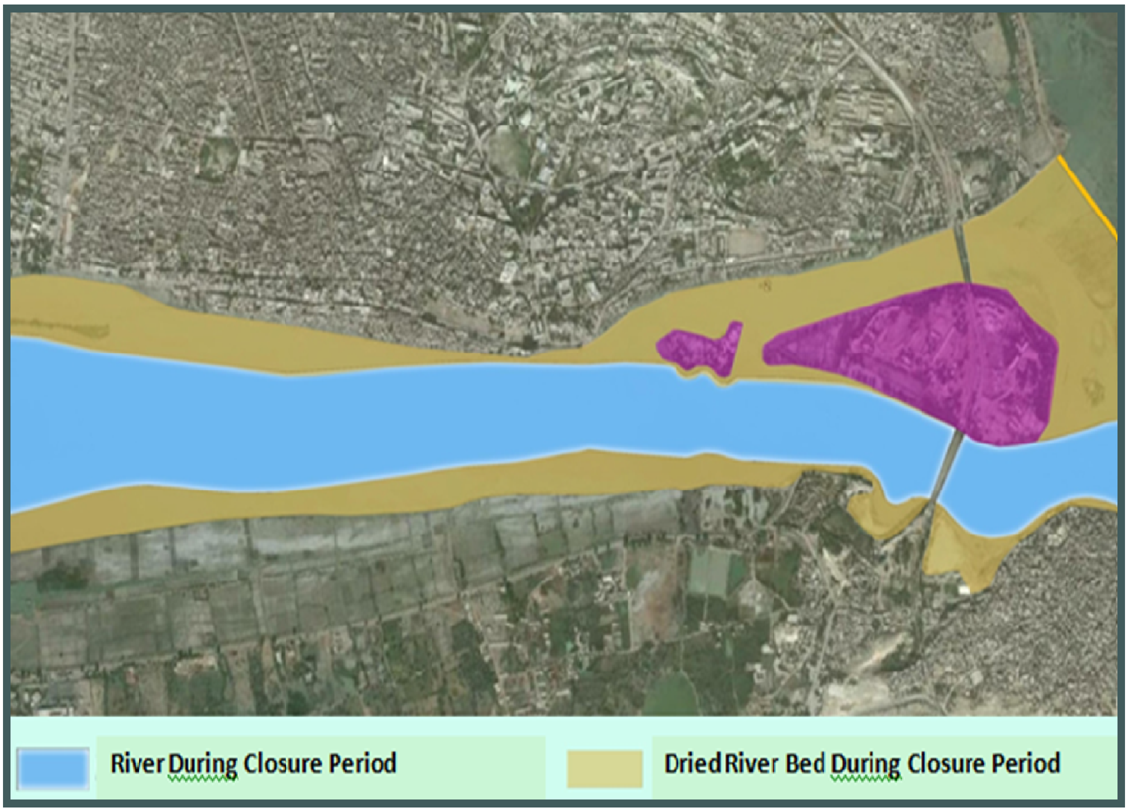


Figure: 3.1 Effects of Sukkur Barrage Gate Openings (Closure Period) on the available Low Water Level for Water Supply (Figure simulated based on 50 years data)

It is further pointed out that there have been some occasions during which Sukkur channel has dried up at point of existing IPS even during non closure periods. Table 3.1 displays river flow data and dates on which water level fell below 190.0 ft (present Intake pipe levels).

Table 3.1: Record Of River Indus Pond Level (Upstream Of Sukkur Barrage) At Sadhu Belo Gauge Station Falling Below 190.0 Ft Level From 1961-2011

YEAR	Closure days	Total No of Closure Days	Guage Level	Closure Period	
				From	To
1961-1962	16	16	185.56	01-01-1962	16-01-1962
1962-1963	8	15	184.22	24-12-1962	17-01-1963
	7				
1963-1964	6	17	185.57	26-12-1963	11-01-1964
	11				
1964-1965	5	20	184.88	27-12-1964	15-01-1965
	15				
1965-1966	6	17	183.94	26-12-1965	11-01-1966
	11				
1966-1967	6	15	183.33	26-12-1966	09-01-1967
	9				
1967-1968	6	11	187.20	26-12-1967	06-01-1968
	5				
1968-1969	4	13	184.96	28-12-1968	06-01-1969
	9				
1969-1970	6	14	184.72	26-12-1969	06-01-1970
	8				
1970-1971	13	13	193.43	26-12-1970	06-01-1971
1971-1972	7	7	185.11	12-01-1972	18-01-1972
1972-1973	5	15	185.86	27-12-1972	10-01-1973
	10				
1973-1974	15	15	185.23	11-01-1974	26-01-1974
1974-1975	15	15	185.23	13-01-1975	28-01-1975
1975-1976	6	15	184.61	26-12-1975	11-01-1976
	9				
1976-1977	15	15	185.23	11-01-1977	26-01-1977

1977-1978	15	15	184.18	02-01-1978	16-01-1978
1978-1979	15	15	185.22	07-01-1979	21-01-1979
1978-1979	**3**	**3**	**188.18**	**27-06-1979**	**29-06-1979**
1979-1980	14	14	185.90	07-01-1980	21-01-1980
1980-1981	25	25	185.80	07-01-1981	31-01-1981
1981-1982	14	14	185.39	07-01-1982	20-01-1982
1982-1983	12	18	185.20	20-12-1982	06-01-1983
	6				
1983-1984	15	15	187.46	07-01-1984	21-01-1984
1984-1985	16	16	185.28	06-01-1985	21-01-1985
1985-1986	16	16	186.58	06-01-1986	21-01-1986
1986-1987	16	16	183.58	06-01-1987	21-01-1987
1987-1988	16	16	184.48	01-01-1988	16-01-1988
1988-1989	15	15	184.28	06-01-1989	20-01-1989
1989-1990	16	16	186.53	05-01-1990	20-01-1990
1990-1991	16	16	184.08	07-01-1991	21-01-1991
1991-1992	15	15	184.28	07-01-1992	20-01-1992
1992-1993	15	15	185.98	06-01-1993	20-01-1993
1993-1994	16	16	187.08	06-01-1994	21-01-1994
1994-1995	18	18	182.28	06-01-1995	23-01-1995
1994-1995	**6**	**6**	**187.54**	**25-09-1995**	**30-09-1995**
1995-1996	15	15	187.28	11-01-1996	25-01-1996
1996-1997	13	13	183.78	08-01-1997	20-01-1997
1997-1998	16	16	184.68	06-01-1998	21-01-1998
1998-1999	16	16	185.98	06-01-1999	21-01-1999
1999-2000	14	14	184.38	07-01-2000	20-01-2000
2000-2001	13	13	182.48	06-01-2001	18-01-2001
2001-2002	16	16	180.62	07-01-2002	22-01-2002
2002-2003	19	19	181.48	06-01-2003	24-01-2003
2003-2004	17	17	180.98	07-01-2004	23-01-2004
2004-2005	24	24	182.88	02-01-2005	25-01-2005
2005-2006	21	21	182.08	07-01-2006	27-01-2006
2006-2007	15	15	184.78	07-01-2007	21-01-2007
2007-2008	16	16	184.28	07-01-2008	22-01-2008
2008-2009	15	15	183.48	07-01-2009	21-01-2009
2009-2010	16	16	185.68	07-01-2010	22-01-2010
2010-2011	14	14	184.48	07-01-2011	20-01-2011

It can be seen in this table that pre-dominantly such situation has occurred in months of December and January coinciding with closure periods. However it can seen that on two occasions during last 50 years water level fell below 190.0 ft during non closure periods. Firstly it occurred in June-1978 for three days and then in Sept-1995 for six days. It is startling to note that river flow discharge values during these two rare occasions have been between 68,000 cusecs to 1183,000 cusecs. At these discharges pond area should be of order 198 feet or so. It indicates that water levels fell in pond during non closure period not because of low flows but due to regulation of gates that may be required during heavy rains, floods or for other reasons. Table 3.2 contain selected data to show that gates regulation cause different pond levels at equal discharges.

Table 3.2 Gauge Levels at different dates for River discharge between 30,000 to 30,100 cusecs

Date	RIVER LEVELS Right Bank		RIVER LEVELS Left Bank		DISCHARGE		With Drawals	Sadhu Belo R.L
	U/S	D/S	U/S	D/S	U/S	D/S		
14-01-1962			183.70		30054			184.18
19-01-1962			192.70		30057			193.18
29-04-1962			194.20		30079			194.68
17-11-1962			193.50		30064			193.98
18-11-1962			193.30		30020			193.78
03-12-1962			194.20		30023			194.68
01-01-1963			183.10		30004			183.58
19-02-1965			194.10		30052			194.58
14-12-1965			193.50		30072			193.98
27-02-1966			193.90		30063			194.38
24-02-1968			193.50		30043			193.98
30-01-1970			194.50		30003			194.98
09-12-1970			193.40		30047			193.88
25-04-1972			194.50		30054			194.98
17-10-1974			194.20		30041			194.68
21-02-1976			194.00		30020			194.48

05-04-1977	196.3	180.2	195.9	180	30063	1318	28745	196.38
14-02-1980	194.55	176.20	194.35	176.00	30014	0	30014	194.83
29-12-1982	184.15	184.05	184.05	184	30051	30051	0	184.53
25-01-1985	195.00	186.2	194.8	186.1	30050	21530	8520	195.28
15-03-1985	195.70	179.4	195.5	179.3	30072	772	29300	195.98
19-02-1990	196.00	179.5	195.80	179.4	30042	1252	28790	196.28
13-12-1992	197.00	184	196.80	183.9	30022	457	29565	197.28
14-12-1992	197.00	184	196.80	183.9	30085	480	29605	197.28
15-01-1993	187.00	186.9	186.80	186.9	30085	30085	0	187.28
20-12-1993	197.00	179.8	196.80	179.7	30017	179	29840	197.28
31-12-1993	195.50	178.8	195.30	178.7	30009	59	29950	195.78
01-01-1994	195.20	178.8	195.00	178.7	30074	54	30020	195.48
30-12-1995	197.60	180.4	197.40	180.3	30040	300	30340	197.88
20-03-1997	197.50	184.00	197.30	183.90	30016	14116	15900	197.78
11-04-1999	198.00	180.40	197.80	180.30	30053	5038	25015	198.28
15-04-1999	197.90	180.30	197.60	180.20	30061	4286	25775	198.08
06-11-1999	198.00	182.40	197.80	182.30	30067	7397	22670	198.28
07-11-1999	198.00	182.40	197.80	182.30	30070	440	29630	198.28
09-11-2000	193.20	180.2	193.00	180.1	30009	7944	22065	193.48
21-04-2003	193.50	180.6	193.30	180.5	30021	9341	20680	193.78
22-02-2004	194.80	181.4	194.60	181.3	30032	3582	26450	195.08
26-02-2004	194.60	181.4	194.40	181.3	30011	3576	26435	194.88
24-10-2004	195.30	181.3	195.10	181.2	30020	7545	22475	195.58
17-02-2005	195.45	180.4	195.25	180.3	30080	5050	25030	195.73
07-02-2006	195.80	179.7	195.60	179.6	30020	500	29520	196.08
16-02-2007	195.30	179.5	195.10	179.4	30008	1048	28960	195.58
07-03-2007	197.60	181.4	197.40	181.3	30002	4187	25815	197.88
08-03-2007	197.60	181.4	197.40	181.3	30032	4187	25845	197.88
24-02-2009	195.2	182	195.00	181.8	30005	3150	26855	195.48
04-11-2009	195.9	184.4	195.70	184.4	30080	8000	22080	196.18
14-03-2010	196	183.5	195.80	183.2	30020	5150	24870	196.28
15-03-2010	196	183.5	195.80	183.2	30040	5150	24890	196.28
16-03-2010	196	183.5	195.80	183.2	30040	5150	24890	196.28

For instance the table lists pond levels on various days when the river flow value on upstream side of barrage was about 30,000 cusecs. The widely varying pond levels on same discharge indicates that regulation of gates is responsible for low pond level at high discharges or vice versa.

However under all scenarios of low flows or fluctuations in pond levels due to erratic regulations, on Rohri channel side water is always available to meet Sukkur water supply needs round the year. It is shown that such availability of water is at a distance of about 200ft off the shore of the Bukkur Island towards Rohri side Figure 3.2 shows this reality.

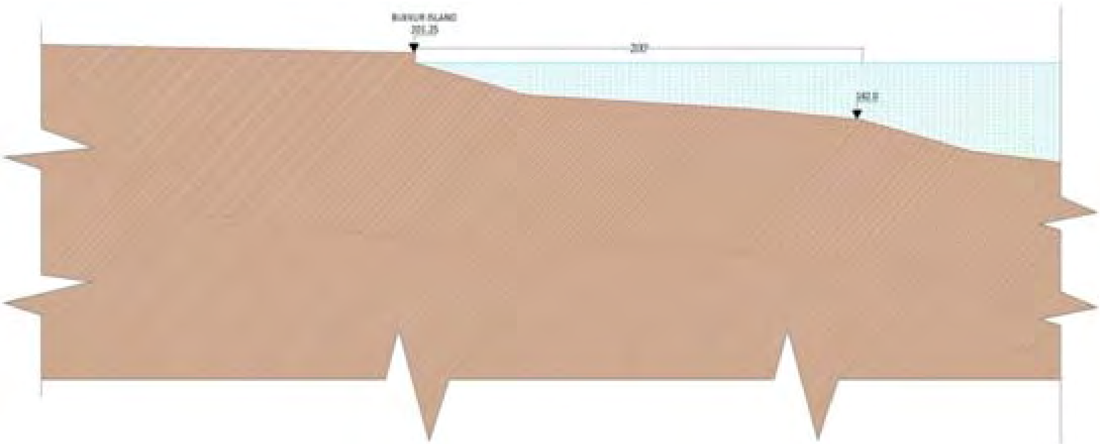
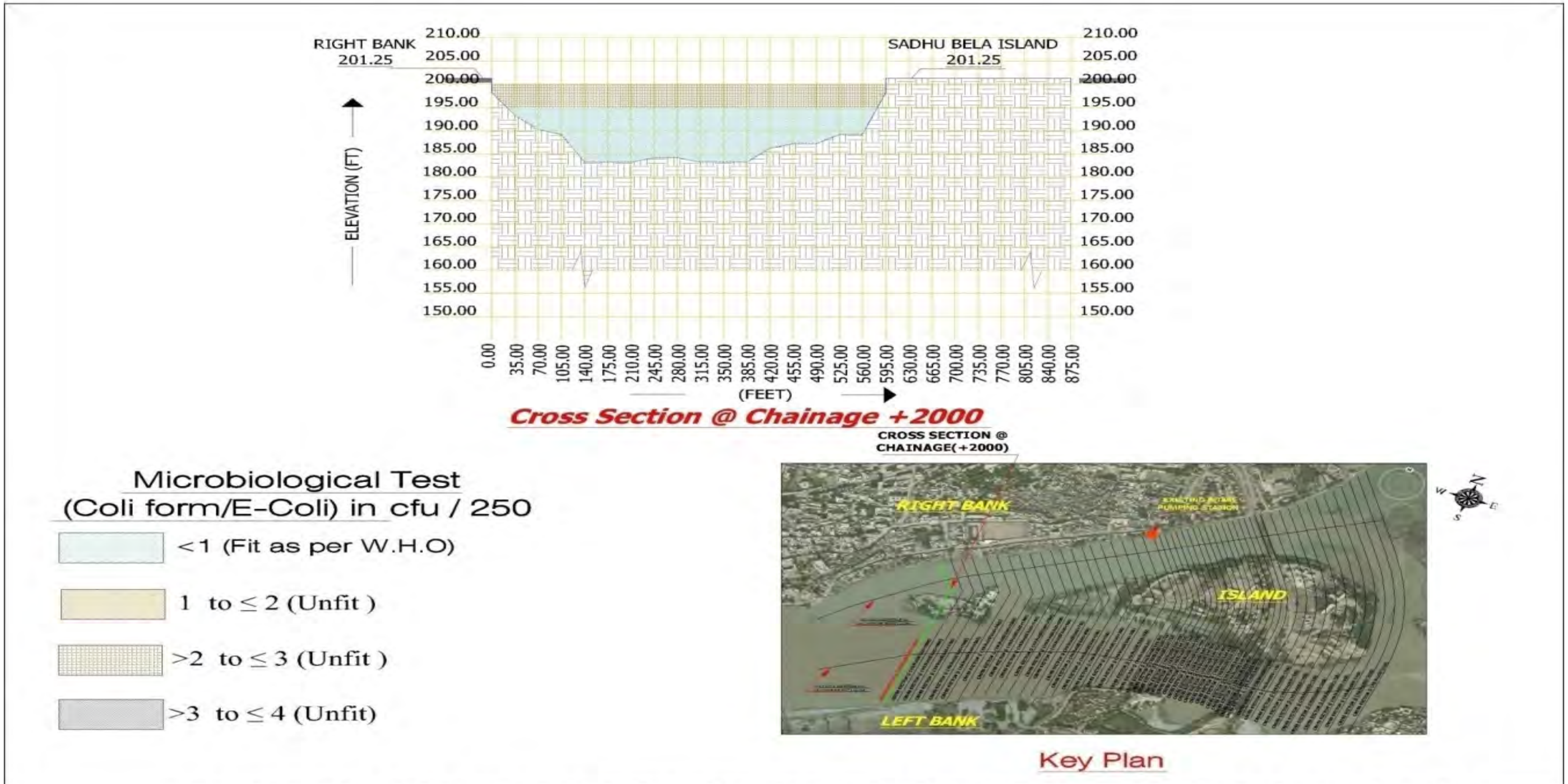


Figure 3.2: Location of deep water (point of intake) on far side of Island

(3) Water Quality

It is shown in the River Bed Report that River Indus water meets all quality requirements as per W.H.O standards except turbidity. However it was found that due to disposal of domestic sewerage at around seven locations on Right Bank, the Sukkur side channel water was found contaminated microbiologically with unacceptable coli-formed and E-coil levels. On the day samples were taken it was found that Rohri side of channel water was free from microbiological contamination. It was further found that microbiological contamination was higher at surface and water became almost contamination free at depths exceeding 10 to 15 feet. See figure 3.3.



MICROBIOLOGICAL TEST RESULTS AT VERIOUS DEPTHS MEASURED ON 18-08-2011

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2449-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

Figure 3.3

At location of present Intake pumping station contaminations levels fall and rise in prorate to flow of water in Sukkur channel. During High flows contamination levels reduces due to dilution and vice versa. During extremely Low flows (pond levels less than 195.0 ft) water may become unfit to lift for drinking purposes. Such recent case has occurred on 14th to 19th November 2011 when water levels fell in pond to about 194.0 ft while river discharge fell to about 30,000 cusecs.

Figure 3.4: Pond Color indicates excessive contamination (Period 14th to 19th Nov 2011)

Figure 3.5: Low Pond Level, High contents of sewage (Period 14th to 19th Nov 2011)

The water supply to city was stopped and irrigation authorities were requested to close Sukkur barrage gates to increase pond level to restore flow on right bank side. The problem was then resolved by 20th Nov due to co-operation of irrigation authorities.

Thus it is recommended in this report that either water Intake works to be shifted to far side of the island or lagoons be constructed to store at least 15 days daily demand to cover up eventualities including the one described above.

(4) Turbidity Issue

It is found that turbidity is high and typical of River Indus water. During Kharif (April to October) turbidity touches about 2000 mg/liter and during Rabi (November to March) it is less than 1000 mg/liter. Based on this data silt load likely to be removed from raw water at filter plants is shown in table 3.3 below.

Table 3.3 Suspended Sedimentation (TSS) Load Computation At Bunder Road And Numaish WTPs By 2050

A.	**Bunder Road Water Treatment Plant (Demand by 2050: 24 Million Gallon per day)**			
S.No		Measured average turbidity as on 18 August, 2011 (NTU)	Average annual Turbidity during Kharif (June to September) average of 48 Years (1931-1979) (mg/litter)	Average Annual Turbidity during Rabi (November to April) average of 48 Years (1931-1979) (mg/litter)
1.	Turbidity / TSS values	3000 NTU	2119.47	565.72
2.	Sedimentation Load tons/day	214.737	212.254	56.654
3.	Sedimentation Volume m^3	128.01	126.53	33.774
B.	**Numaish Road Water Treatment Plant (Demand by 2050: 12 Million Gallon per day)**			
S.No		Measured average turbidity as on 18 August, 2011 (NTU)	Average annual Turbidity during Kharif (June to September) average of 48 Years (1931-1979) (mg/litter)	Average Annual Turbidity during Rabi (November to April) average of 48 Years (1931-1979) (mg/litter)
1.	Turbidity / TSS values	3000	2119.47	565.72
2.	Sedimentation Load tons/day	107.368	106.127	28.327
3.	Sedimentation Volume m^3	64.007	63.267	16.887

Such levels of turbidity removal require heavy doze of Alum. From various studies carried out previously it is likely that Alum dozes of about 40 mg/liter and 15 mg/liter may be required during Kharif and Rabi seasons respectively. The Cost to bear by 2050 on account of turbidity removal alone is computed to be about Rs.50.0 million a year to treat about 36.0 Million Gallons raw water from river Indus at Bandar Road and Nimaish WTPs.

However with provision of a pre-settlement lagoons, those Alum costs can be cut by 65%.

(5) Sub Soil Water

M/s ROCKMORE studies have shown that saturated zone is available at an average depth of about 5 to 10ft. However water quality deteriorates with depth and when moved away from water bodies.

Based on ERS survey, Rock More Private Limited (RMPL) report show that from lithology, it is clear that there is a thin layer of 5 to 10 m in Area-II and 20 to 25 m in Area-I, which is underlying a thick layer of salt water having TDS more than 2000mg/liter. Hence, there is a chance of upcoming of this salt/saline water which is underlying this thin fresh groundwater lenses. They further concluded in their report that within the project area the groundwater resource is not very good because as we move away from any water storage source the discharge from test tube wells was found falling down, the draw down increased and the recovery time also extended. The above statement of RMPL report is quite clear that groundwater resource is not adequate from point view of tube wells. However the thin sweet water zone can be extracted using horizontally installed filtration galleries specially if installed within the river bed area as being proposed in this report.

3.3 INTRODUCTION OF EMERGING VIABLE OPTIONS

The conclusion of various report as summarized at Section 1.0 of this report, has indicated that all the round year water is available only on far side of Island. On near side of Island river bed from Lansdowne Bridge upto Sadhu Bela dry up during closure periods that average about 15 days a year. At existing location of IPS water is unavailable during abnormal regulation of Sukkur barrage gates. During extreme low flows microbiological contamination increases to levels that extraction of water is stopped .Thus viable option for extraction of un-interruptible supply from River Indus reduces to following choices.

3.3.1 Re-location of Intake Pumping Station (IPS) on far side of Island. Here there are again two options, one is to situate the intake works, pumping house, electrical/mechanical works on Bukkur Island, the second one is to situate on upstream side of Lansdowne Bridge with all the related components.

3.3.2 Keep IPS at existing location and supplementing it with storage tanks (Lagoons) to supply water during all interruptions periods cited above. For this option it is proposed to construct storage lagoons on about 140 acres of land to store about 270.0 Million gallons of water to meet demand of both WTPs at 50% of daily demand during 15 days yearly closure period and also supply water during instances of high levels of contamination at intake point or during times of erratic Barrage gates regulation by Irrigation authorities The lagoons on the other hand would work as pre-settlement tanks during other times. Pre-settlement of Indus river raw water is known to save about 65% costs on alum consumption, other saving would occur on account of lesser chlorine feeds and on account of more production at Filter Plants due to infrequent interruptions from back washing operation and etc.

Existing IPS under this option would be required to undergo major modifications for Civil, Electrical and Mechanical works. Civil work will include new floor raised from present 203.23 ft level to 2080 ft. Change of present centrifugal pumps to turbine pumps and improvement of allied Electrical Mechanical works. A structure raised on piles with massive cantilever would be required to house turbines.

3.3.3 Construction of new IPS at location about 600 ft downstream of existing IPS on same river side. This option combines with use of deep gravity conduit either 3 x 36 inches pipes or pre-cast concrete conduits 5’ x 7’ clear dimensions to bring water from far side of Island. IPS is moved downstream to reduce gravity conduit lengths under river bed.

3.3.4 The fourth option is to use infiltration galleries under River Bed. M/s RCC Consultants with their experience in this field and on direction of their demised Hydrogeology Specialist Engr. Mula Bux Mirbaher who spent his life on designing tile drains had suggested a net work of infiltration galleries based on an empirical design. The net work will occupy about 40 acres of river bed area and house about 32,000 feet of net work of collection pipes. It is computed that, the proposed system can extract about 36 million gallons of filtered water. However prior to going for full scale project, it is recommended to initiate a pilot project consisting of about 500ft of typical infiltration gallery with collection pipe and a sump well to verify empirical concept. If it could yield about 50,000 gallons or above per day then full scale project consisting of about 32000 feet of galleries would definitely produce required 36 million gallons of water per day. In such case good quality drinking water can be produced at very low costs. This pilot scale trial system can be aimed at to address the knowledge gap (left behind by M/s ROCKMORE study) to include assessment of the lithology of the saturated and unsaturated zone. The characterization of physical and chemical heterogeneity, delineation of aquifer geometry, storage volumes, hydrochemistry and hydraulic properties, as well as data on water table fluctuations and ground water flow. The pilot project would further investigate the relationship between the hydro geological settings and the performance of the galleries in respect of quality and quantity in respect of time parameters.

3.4 DESCRIPTION OF IMPROBABLE OPTION PROPOSED IN T.O.RS

Some option as proposed in T.O.Rs and as listed at Section 3.1 contain some suggestions which are highly unpromising and these are:

3.1.1. Using existing location of IPS
3.1.2. IPS location moved downstream
3.1.3. IPS on Island (Bukkur) opposite Bunder on near side
3.1.6. Use of tube well water to replace the existing raw water source of Sukkur

All the above suggestions are not viable as a standalone option. However with exception of 3.1.3 other two options when combined with some add-ons may constitute a viable solution. For instance 3.1.1 when combined with storage cum pre-settling Lagoons of about 270 Million Gallons storage Capacity as proposed in Section 3.3.2 of this report form viable a option. Similarly 3.2.1 when combined with gravity conduit that will connect deep waters from far side of Island is also a viable option as proposed in this report. For option 3.1.3 no viable add-on is available.

The other option 3.1.6 in respect of use of tube wells has been fully discussed in Hydrological Report. The conclusions made in that report are based on limited study carried by M/s ROCKMORE on left bank of river Indus. Table 6.4 shown in Hydrological & Hydrogeological Investigation Report summarizes test tube well results. The results indicate that only promising well is NSUR5 that has maximum yield of 20 lit/sec that is about 0.5 million gallon/day. Assuring that one well works for 20 hours, number of tube well required to provide 54.0 million gallon/day (2050 demand) would be about 130 tube wells. This is quite impossible to find promising locations of so many tube wells, similar to NSUR5. For instance out of 6 tube wells tested only one tube well found the right spot. Additionally M/s ROCKMORE had conducted pumping test for very short duration thus additional tests are required to establish long term sustainability of these tube wells which draw water from thin lense of sweet water layer and that too near the water bodies only.

Not a single test tube well was sunk at Right Bank of river Indus nor at the Island, study conducted at these locations would have been quite relevant for Sukkur city. The tested tube wells have been shown in Hydrological Report that they are capturing thin lens of purged sweet water and such thin lens is only available near water bodies. The apprehensions have been expressed in our report that prolonged pumping may turn sweet water into saline. Due to lack of appropriate data in this respect this options is not further explored.

BASIC SUB-WORK COMPONENTS (BSWC) THAT WILL BE COMBINED TO FROM SEVERAL VIABLE OPTION FOR FINAL PROJECT SELECTION OF ALTERNATIVE SOLUTIONS

IN THIS SECTION:

4.1 LIST OF BASIC SUB-WORK COMPONENTS (BSWC)

4.2 DESCRIPTION OF BASIC SUB-COMPONENTS (BSWC) WITH CONCEPT PLANS

SECTION 04

4. BASIC SUB-WORK COMPONENTS (BSWC) THAT WILL BE COMBINED TO FROM SEVERAL VIABLE OPTION FOR FINAL PROJECT SELECTION OF ALTERNATIVE SOLUTIONS

Several viable alternative solutions contain certain sub work items that are common to various alternatives. Thus for purpose of ease of costing, such sub works items are priced separately as work units.

A simple list of such sub work is given at section 4.1. At Section 4.2, each sub work unit is described with Concept Plans, Rough Cost Estimates and Completion Times. It may be noted that below given sub works are options with lot of choices to select particular sub-work for particular alternative. Only a few of these Basic Sub-work Components (BSWC) will form the final selection of the project.

4.1 LIST OF BASIC SUB-WORK COMPONENTS (BSWC)

BSWC-A: Intake Works

BSWC A-1: Jacked Pipe Intake.

BSWC A-2: Steel Bridge Intake Arrangement.

BSWC-B: Transmission of Water from far side of Island to Right Bank through Gravity flow

BSWC B-1: Using Pre-Cast concrete Conduit.

BSWC B-2: Using 3x36” dia MS pipes as gravity conduit.

BSWC-C: Construction of new Intake Pump House

BSWC C-1: Construction of new Intake Pump House on Shore (Over River Bank/ Island)

BSWC C-2: Construction of new Intake Pump House off Shore (Inside at point of deepest water)

BSWC C-3: Construction of Pump House at side of Proposed Lagoons (for lagoon option)

BSWC C-4: Rehabilitation of existing IPS

BSWC-D:Construction of Substation, Generator and Transformer room (Civil Work)

BSWC D-1: Substation on Piles (Near River Indus).

BSWC D-2: Substation on strip Foundations (Near Lagoons).

BSWC-E: Delivery force mains from Pump House upto WTPs

BSWC E-1: Delivering force mains from Pump House on Island to WTPs buried in River Bed.

BSWC E-2: Delivering force mains from Pump House near Lansdowne Bridge. Pipes crossing Sukkur side river channel through and over the pedestrian space provided on both sides of Lansdowne Bridge.

BSWC E-3: Delivering force mains from Pump House near Lansdowne Bridge. Pipe crossing river over piles.

BSWC E-4: Delivering force mains from Pump House near Lansdowne Bridge. Pipe crossing buried under river bed.

BSWC E-5: Delivering pipes to Lagoons from existing pump house on Right Bank for Storage and settling of raw water.

BSWC E-6: Delivering Pipes from lagoons pump house to WTPs.

BSWC E-7: Delivering Pipes from Infiltration Galleries pump house to WTPs.

BSWC-F: Construction of Lagoons

BSWC-G: Construction of Infiltration Galleries

BSWC-H: Electrical Mechanical Works at IPS

BSWC-I: Access to IPS

BSWC I-1: Access to IPS at Bukkur Island (Road & Pedestrian Bridge)

BSWC I-2: Access to IPS on Lansdowne Bridge (Lifting Equipment & Stair)

4.2 DESCRIPTION OF BASIC SUB-WORK COMPONENTS (BSWC) WITH CONCEPT PLANS

BSWC-A: Intake Works:

This component include item of works through which water from deepest point (≤ 185.0 ft)in river Indus will be brought to the pump house nearby. Two types of intakes are studied.

BSWC A-1: Jacked Pipe Intake:

Description:

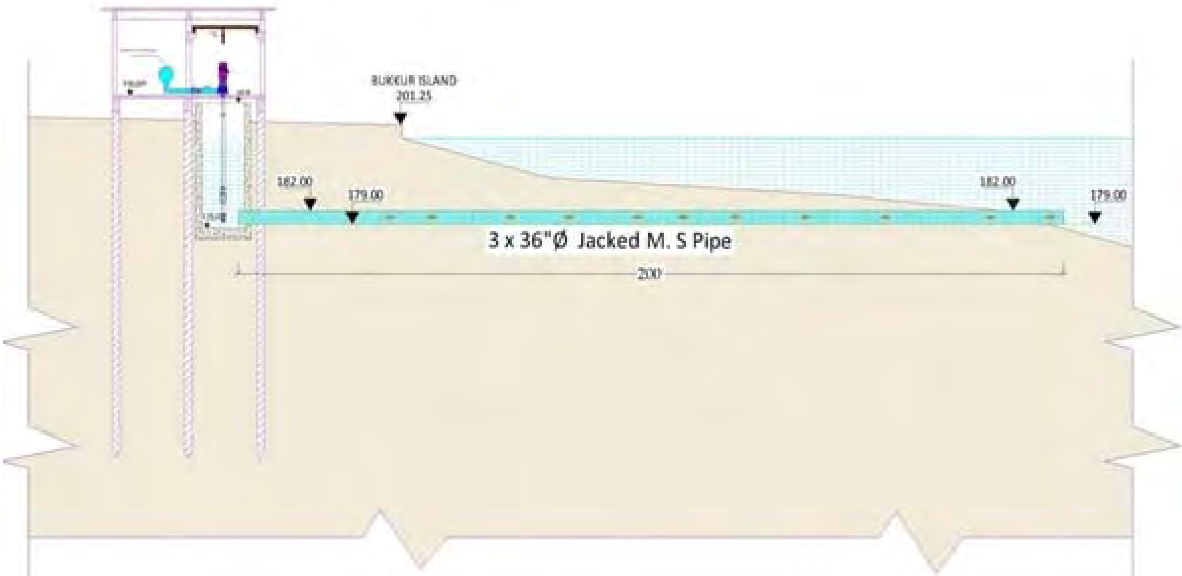


Figure 4.1: Jacked Pipe Intake work

As shows in figure 4.1, this intake component includes a set of 3x36" dia MS pipes each about 200 ft in length that will be Jacked from the shore of far side of Island into river bed horizontally at a depth of about 17 ft below the island ground till they emerge into free flowing water at the designated point. The other part of this component is construction of 20' x 10' sump well about 20' deep at the near end of Jacked Pipes. Pump house will be constructed above and around this sump and turbine suctions will be lowered into this sump. A 10 inch MS high pressure jetting line will be connected to each intake pipe for de-silting purposes.

Rough Cost Estimate: Rs. 20.68 Millions

Completion Period: Four (04) Months

BSWC A-2: Steel Bridge Intake Arrangement:

Description:

This component includes construction of steel bridge on piles from shore of far side of Island upto required depth in River Indus, as shown in figure 4.2.

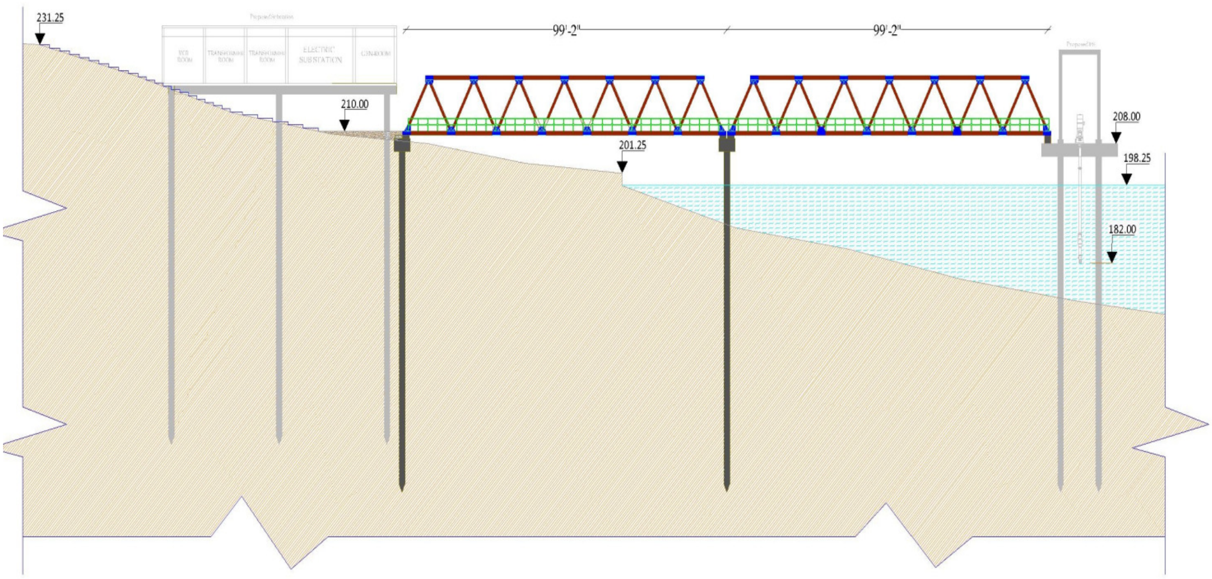


Figure 4.2: Steel Bridge Intake Arrangement

This bridge will support delivery pipes, electrical cables, pedestrian paths and over head gantry to carry turbines needing repairs etc. At the near end of this bridge will be electrical installations, at the far end will be pumping station platform supported on piles to house turbines and over head lifting gantry (BSWC C-2).This Intake component is the trouble free option to get uninterrupted water supply and similar structure is already in use over River Indus at some other place as shown in picture below.

Figure 4.3: Water Intake Works on River Indus for Jamshoro Power House

Rough Cost Estimate: Rs. 34.97 Millions

Completion Period: Six (06) Months

BSWC-B: Transmission of water from far side of Island to Right Bank through gravity flow.

Two options are presented below to draw water from far side of island and transmit it through gravity upto the right bank. This option will be combined with a new IPS, about 600ft downstream of existing IPS on Right Bank.

BSWC B-1: Using pre-cost concrete conduit:

Description:

This option is considered to provide construction of a pumping house (BSWC C-1) on right bank, on the Island under this option water from Jacked pipe intake (BSWC A-1) is brought directly to Right Bank through under bed pre-cast concrete conduit. A sump is required at the Right Bank to receive water from conduit.

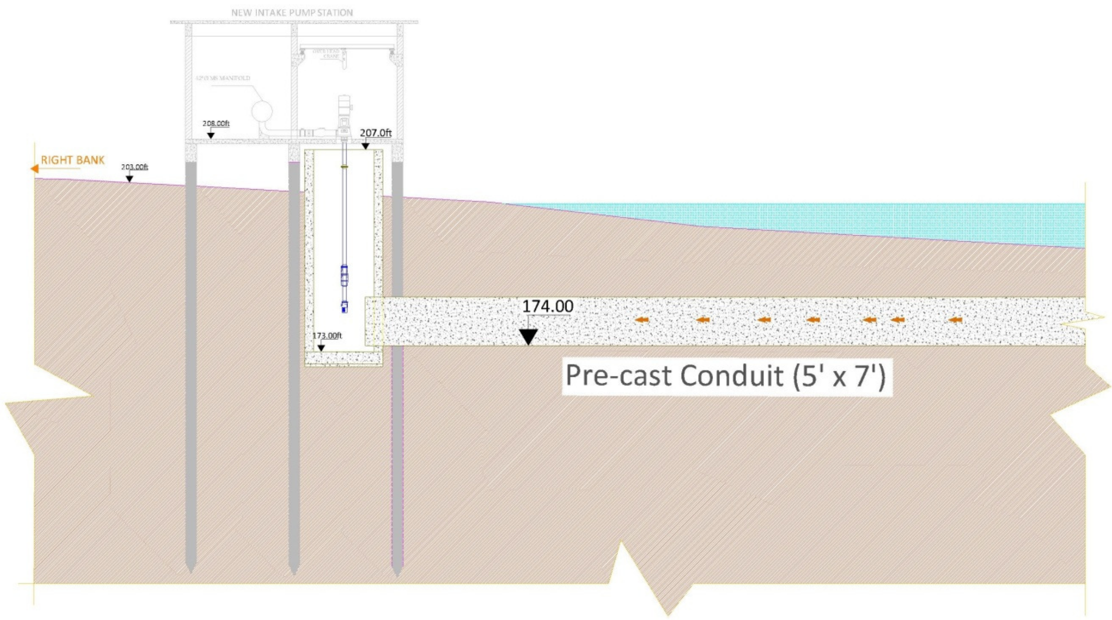


Figure 4.4: Pre-cast Concrete Conduit

A new pump house is proposed on the near end of these gravity conduits to shorten length of transmission and to meet requirement of raising pump house above high flood levels. During construction a temporary road will be constructed to carry load of vehicles used for laying of the conduits. Cost of this work is also included in this sub-work. Laying if conduits in river bed have to be completed within 15 days of annual closure period.

Rough Cost Estimate: Rs. 50.97 Millions

Completion Period: Four (04) Months

BSWC B-2: Using 3x36" dia MS pipes as gravity conduits:

Description:

The component is similar to (BSWC B-1) except that instead of concrete conduits, 3x36" dia MS pipes are used to transmit water from Intake works (BSWC A-1) upto Right Bank

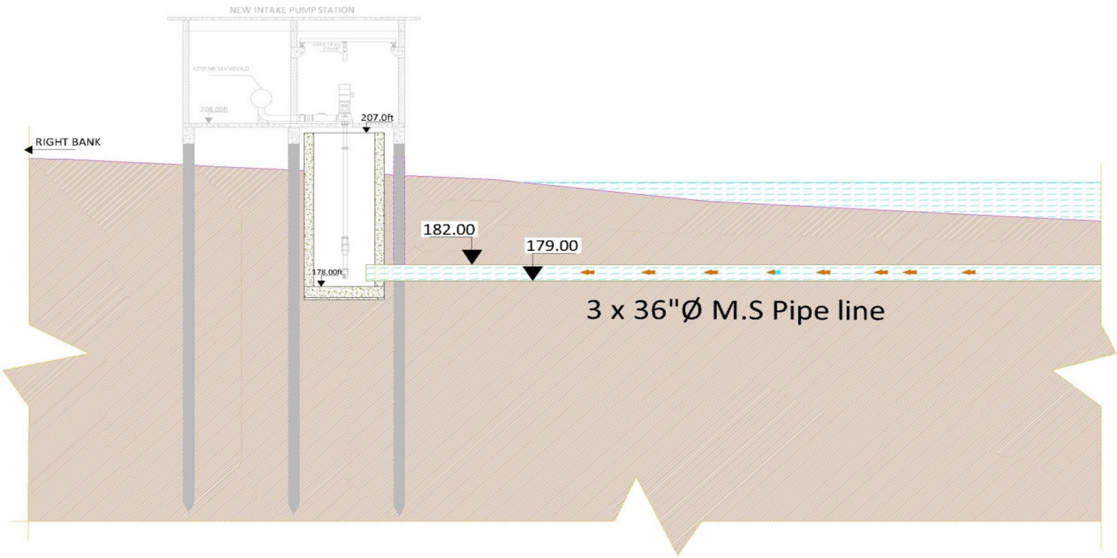


Figure 4.5: 3x36" Dia MS Pipe as Gravity Conduit

In this option a 10" diameter high pressure jetting lines is required to be laid along with these pipes to de-silt these gravity pipes from time to time. A new pump house is proposed on the near end of these gravity conduits to shorten length of transmission and to meet requirement of raising pump house above high flood levels. During construction a temporary road will be constructed to carry load of vehicles used for laying of the conduits. Cost of this work is also included in this sub-work. Laying if conduits in river bed have to be completed within 15 days of annual closure period.

Rough Cost Estimate: Rs. 78.85 Millions

Completion Period: Four (04) Months

BSWC-C: Construction of new Intake pump house.

Under this option a new intake pump house is proposed. Depending on location of pump house that could be either;

- Inside water
- On river bank or on island
- At side of proposed lagoons for delivering back settled water to WTPs

Different design and foundation details require categorizing these under different components as under:

BSWC C-1: Construction of New Intake Pump House on Shore (over River bank/Island)

Description:

This pump house is considered to be constructed on Island, or on Right Bank of River Indus. It is proposed to construct this pump house on piles with floor level at 208.0ft

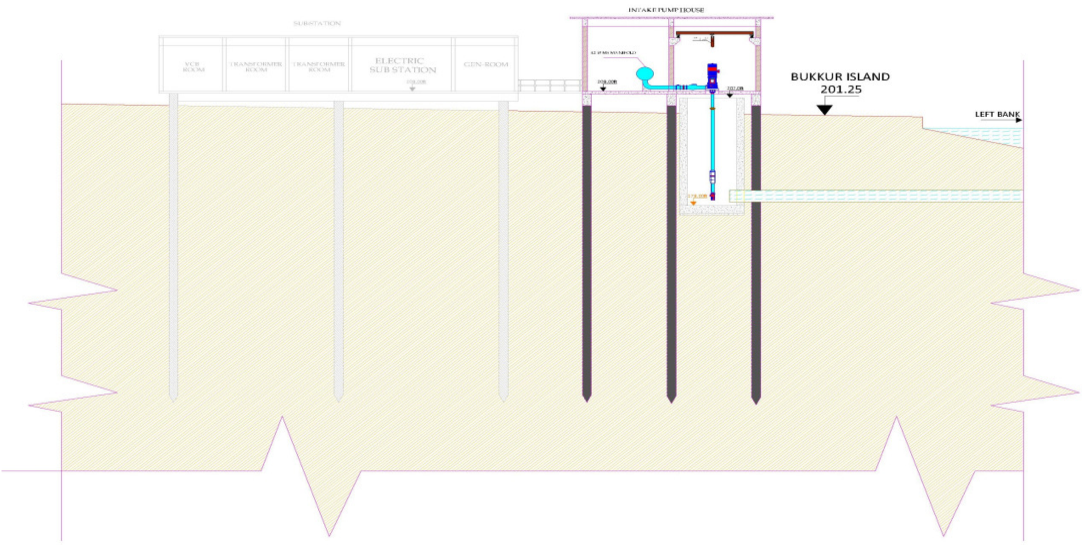


Figure 4.6: Construction of New IPS on Shore (over River Bank/Island)

This pump house will house vertical turbines that will draw water from intake sump underneath as shown in figure 4.6 above.

This component will be tried with several options that will be presented at appropriate sections.

Rough Cost Estimate: Rs. 19.41 Millions

Completion Period: Four (04) Months

BSWC C-2: Construction of New Intake Pump House on off Shore

Description:

This pump house is constructed on piles at the end of Steel Bridge (BSWC A-2) right at spot of deep waters. The concept is shown below in figure 4.7.

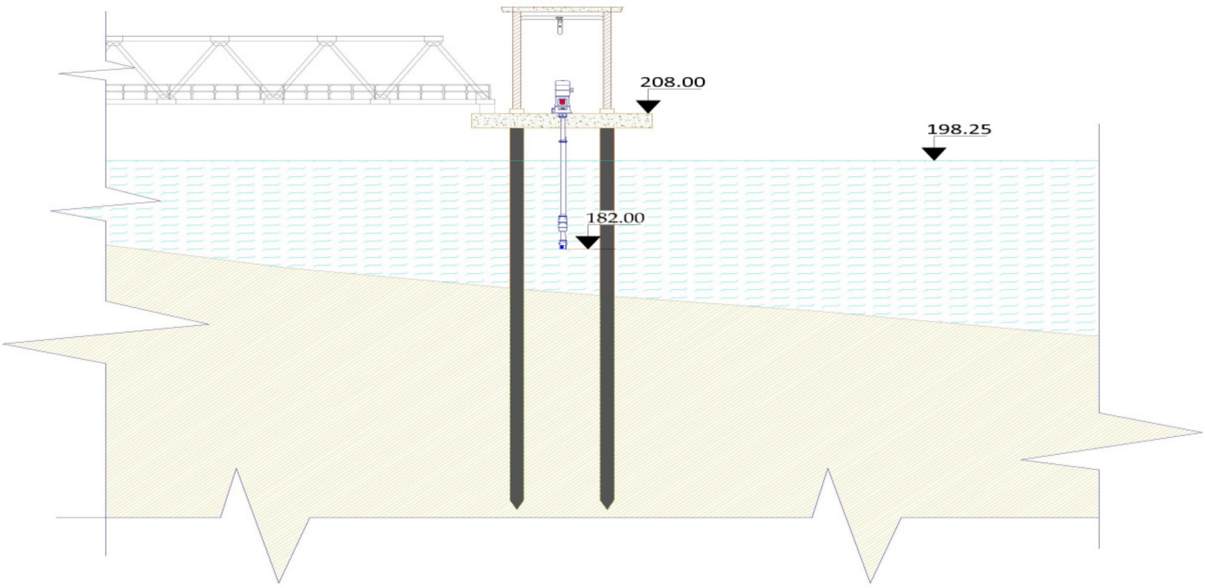


Figure 4.7: Construction of New IPS on Off Shore

Rough Cost Estimate: Rs. 20.08 Millions

Completion Period: Six (06) Months

BSWC C-3: Construction of Pump House at side of Proposed Lagoons

Description:

This pump house is similar to BSWC C-1 but instead of piles raft foundations will be used. Figure 4.8 below shows this concept. This is second pump house in the system, first one (existing IPS, BSWC C-4) will draw water from River Indus and this one under proposed option of lagoons will deliver settled water to WTPs.

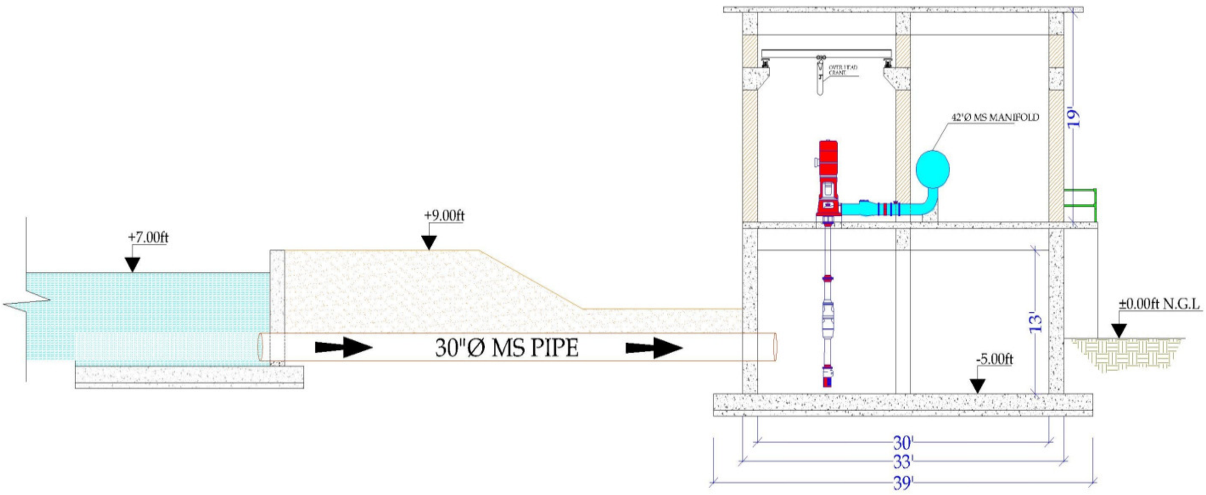


Figure 4.8: Construction of New IPS at side of Proposed Lagoons

Rough Cost Estimate: Rs. 16.48 Millions

Completion Period: Three (03) Months

BSWC C-4: Rehabilitation of Existing IPS

Description:

In case option of storage Lagoons is opted, then IPS at existing location can be used. However it needs massive re-habilitation.

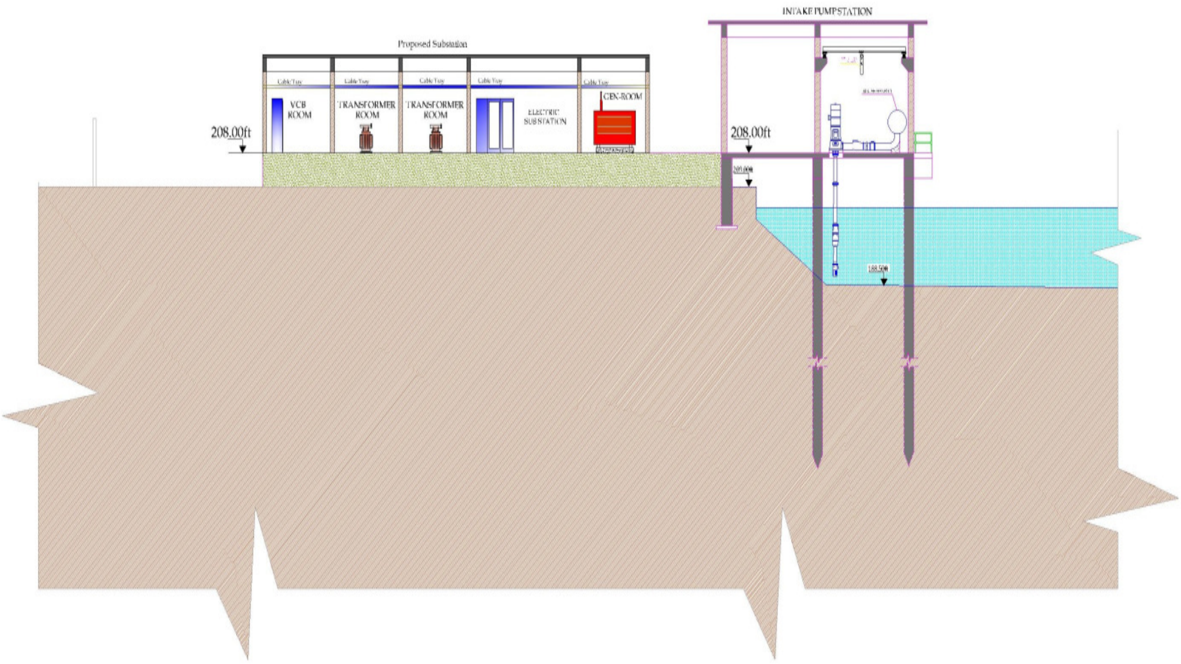


Figure 4.9: Rehabilitation of existing IPS

First of all its floor level is to be raised from existing 203.23 ft to 208.0 ft level. Secondly to installed turbines, a plat form is to be constructed party supported on piles to house turbines. For this purpose above given concept drawing is proposed.

Rough Cost Estimate: Rs. 26.41 Millions

Completion Period: Four (04) Months

BSWC-D: Construction of Substation, Generator and Transformer room (Civil Work).

This item of work is further divided into two options one is along the river bank that will be placed on piles and second is along proposed lagoons that would not require pile foundations.

BSWC D-1: Substation on Piles (Near River Indus):

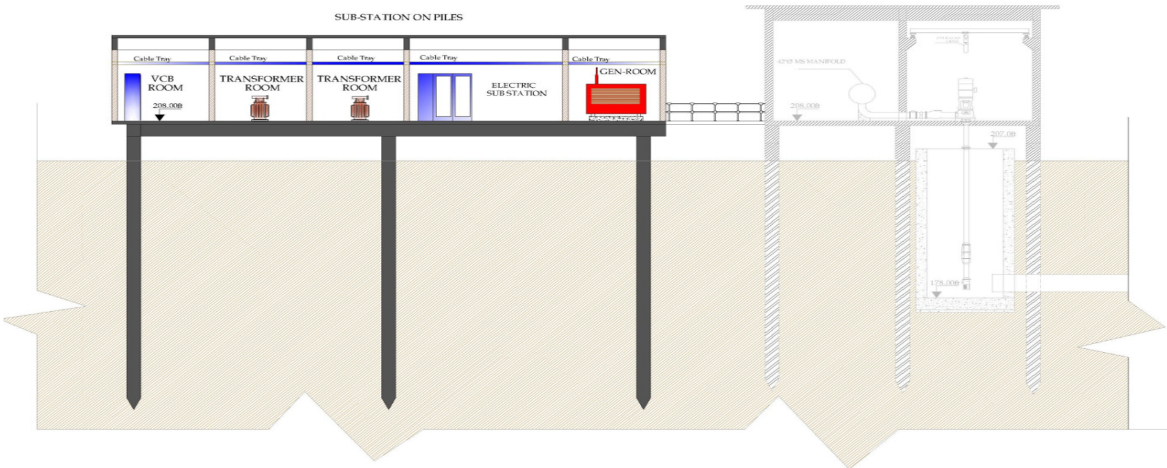


Figure 4.10: Substation on Piles

Rough Cost Estimate: Rs. 15.24 Millions

Completion Period: Four (04) Months

BSWC D-2: Substation on Strip Foundations (Near Lagoons):

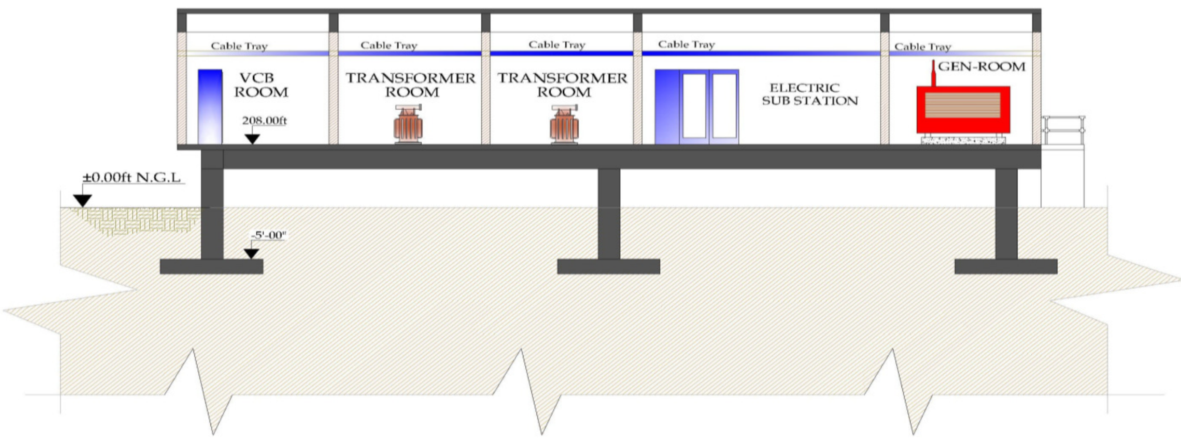


Figure 4.11: Substation on Strip Foundation

Rough Cost Estimate: Rs. 6.0 Millions

Completion Period: Four (04) Months

BSWC-E: Delivery force mains from Pump House upto WTPs.

This item of work is proposed to be carried out in variety of ways. The specific stress is on the part requiring crossing of the right stream (Sukkur stream) side of the River Indus that is about 500ft to 700ft wide. Following options are proposed.

BSWC E-1: Delivering force mains from Pump House on Island to WTPs buried in River Bed:

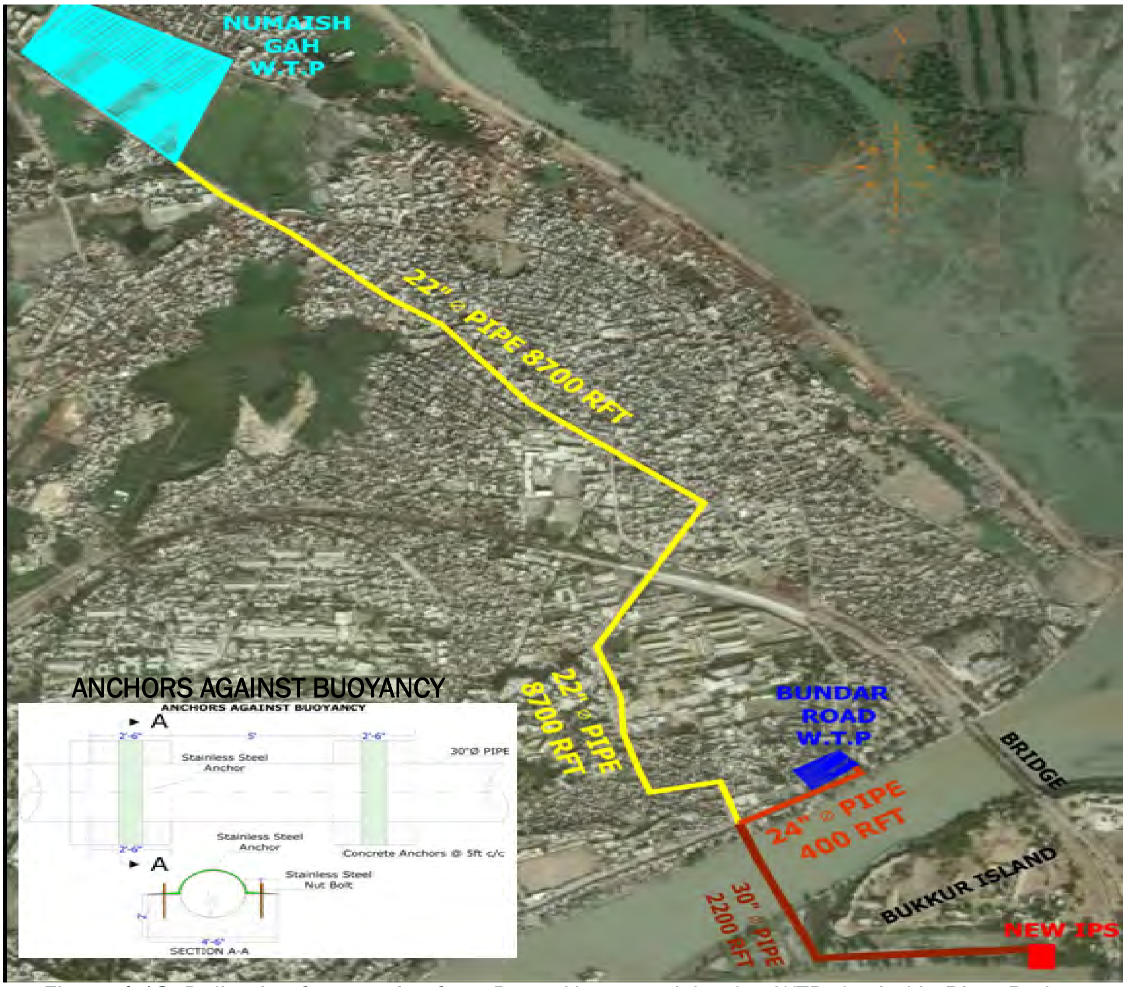


Figure 4.12: Delivering force mains from Pump House on Island to WTPs buried in River Bed

Rough Cost Estimate: Rs. 102.72 Millions

Completion Period: Six (06) Months

BSWC E-2: Delivering force mains from Pump House near Lansdowne Bridge. Pipe crossing river through the pedestrian space provided on sides of Lansdowne:

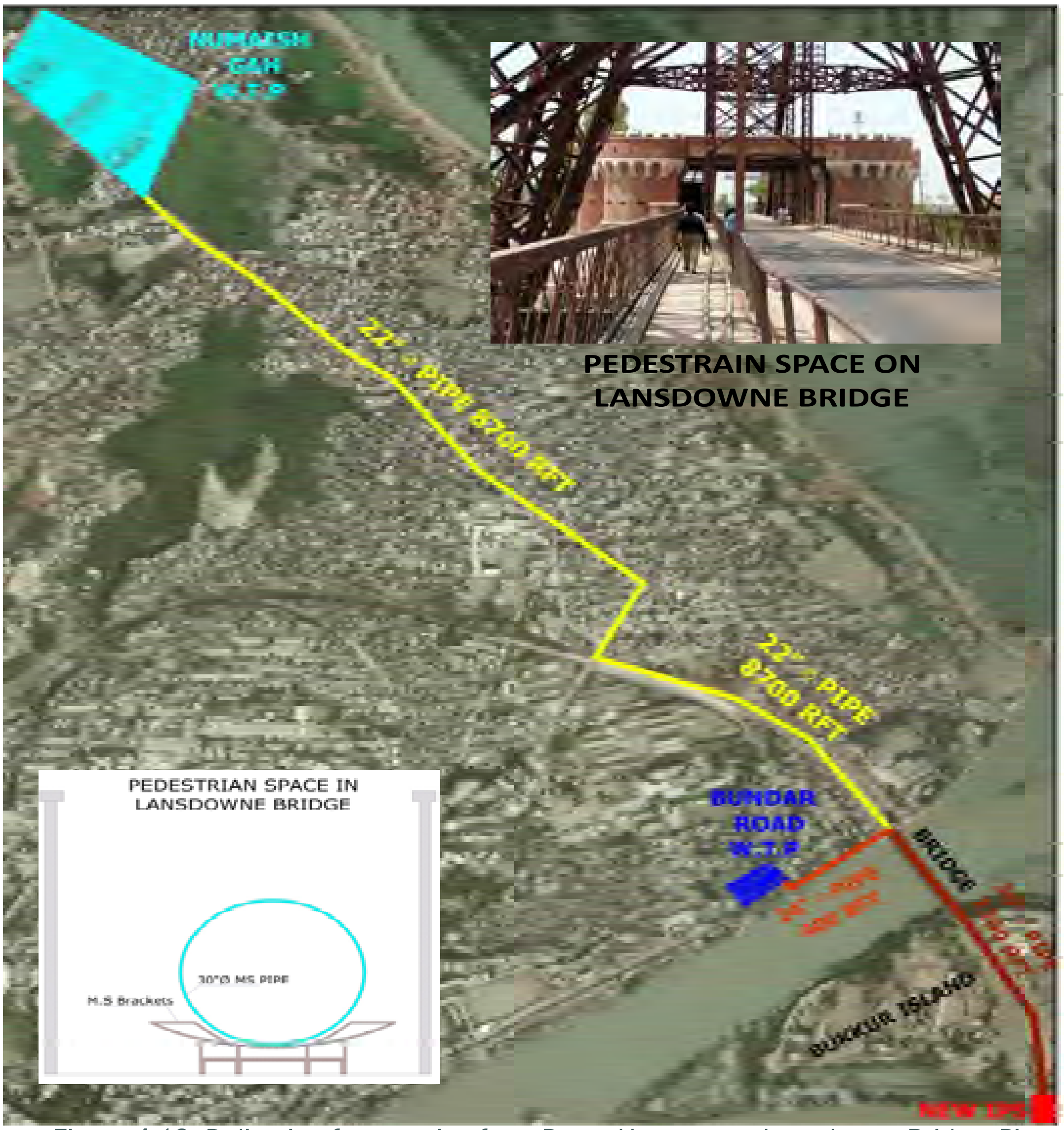


Figure 4.13: Delivering force mains from Pump House near Lansdowne Bridge. Pipe crossing river through the pedestrian space provided on sides of Lansdowne Bridge

Rough Cost Estimate: Rs. 106.43 Millions

Completion Period: Six (06) Months

BSWC E-3: Delivery force mains from Pump House near Lansdowne Bridge. Pipes crossing river over piles:

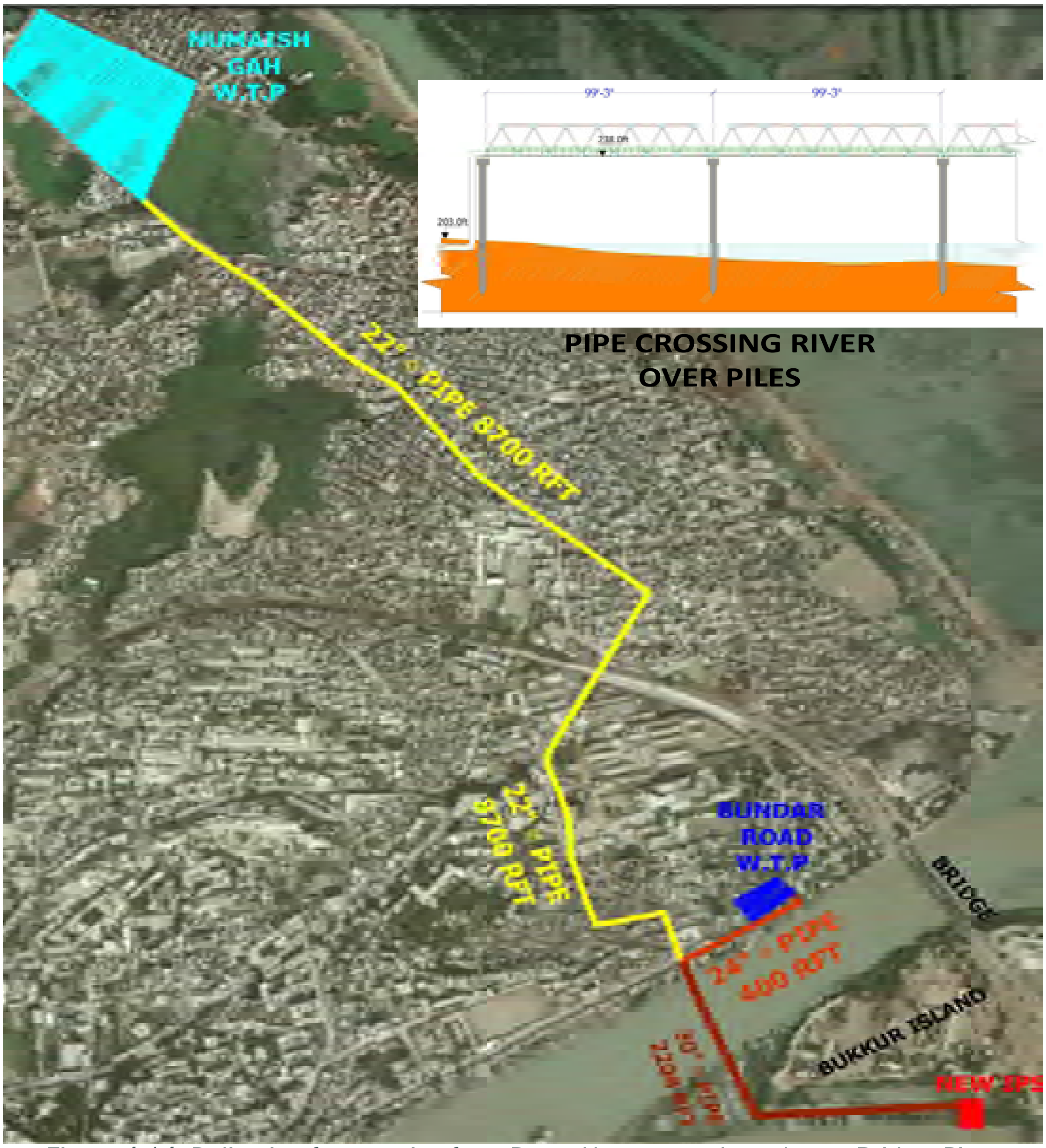


Figure 4.14: Delivering force mains from Pump House near Lansdowne Bridge. Pipe crossing river over Piles

Rough Cost Estimate: Rs. 223.62 Millions

Completion Period: Six (06) Months

BSWC E-4: Delivery force mains from Pump House near Lansdowne Bridge. Pipes crossing under river bed:

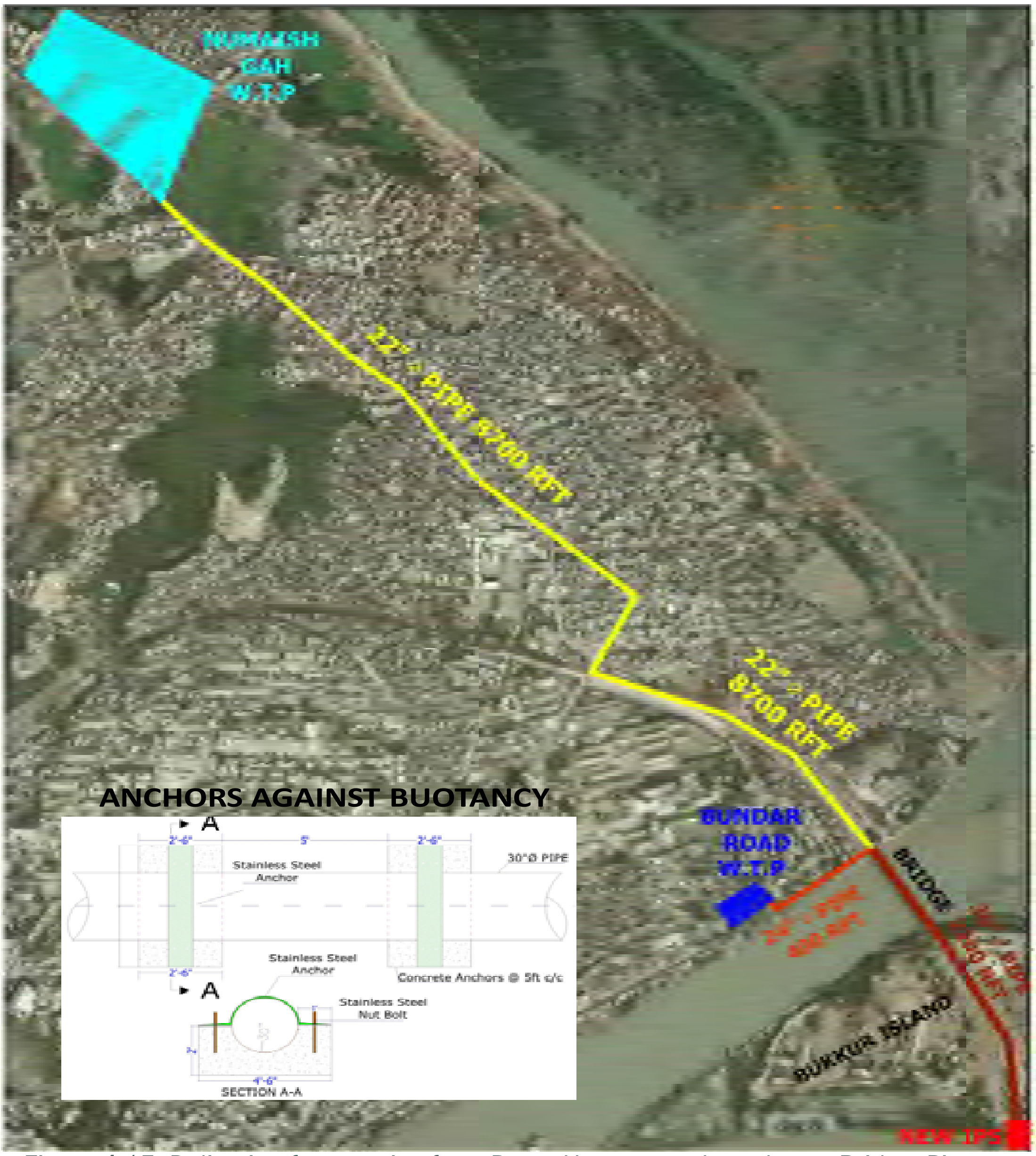


Figure 4.15: Delivering force mains from Pump House near Lansdowne Bridge. Pipe crossing under river bed

Rough Cost Estimate: Rs. 102.26 Millions

Completion Period: Six (06) Months

BSWC E-5: Delivery pipes to lagoon from existing pump house on right bank for storage and settling of raw water:

Figure 4.16: Delivering pipes to lagoons from existing Pump House on right bank for storage and settling of raw water

Rough Cost Estimate: Rs. 555.01 Millions

Completion Period: Six (06) Months

BSWC E-6: Delivery pipes from lagoon pump house to Water Treatment Plants:

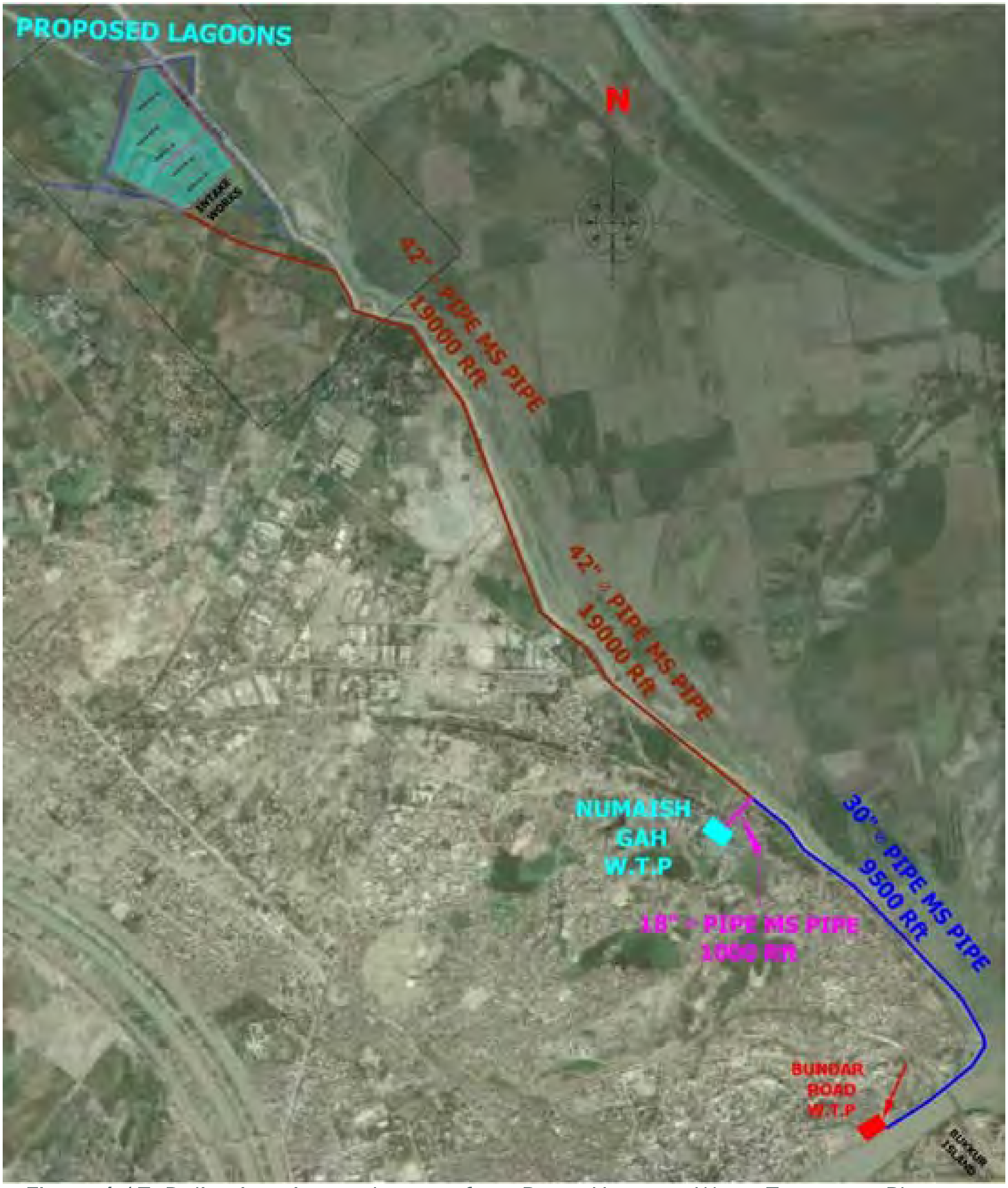


Figure 4.17: Delivering pipes to lagoons from Pump House to Water Treatment Plants

Rough Cost Estimate: Rs. 533.74 Millions
Completion Period: Six (06) Months

BSWC E-7: Delivery pipes from Infiltration Galleries pump house to Water Treatment Plants:

Figure 4.18: Delivering pipes to Infiltration Galleries Pump House to Water Treatment Plants

Rough Cost Estimate: Rs. 137.02 Millions
Completion Period: Six (06) Months

BSWC-F: Construction of lagoons

Description:

An option has been proposed in this report that pre-settling cum storage tanks (Lagoons) be constructed to store about 270 Million Gallons of water. This storage is sufficient to feed 50% daily demand of the city by 2050 during 15 days closure period. However Table 4.1 lists Lagoon capacity converted into days of supplies during different periods.

Figure 4.1: Lagoon Storage Capacity in terms of no. of days supply from 2011 upto 2050

Year	Demand per day at Bunder Road+Nimaish WTPs	Lagoon storage capacity	Storage days	Storage days at 50% demand
	MGD	MGD		
2012	10.7	270	25	50
2020	13.9	270	20	40
2030	19.4	270	14	28
2040	27.1	270	10	20
2050	37.8	270	7.5	15

About 140 acre of land is required to build these storage tanks. These will work as pre-settling yanks during normal days. Pre-settling of heavily silted river Indus water would reduce Alum, Chlorination and back wash costs. The saving in annual O&M costs shall be about Rs: 30.0 Million from Alum reduced consumption alone. During abnormal periods, i.e. annual barrage gate openings, pollution at Intake point and or during erratic regulation of Sukkur Barrage, stored water in these Lagoons shall be used to feed the city.

Figure 4.19: Construction of Lagoons

Rough Cost Estimate: Rs. 625.28 Millions

Completion Period: Six (06) Months

BSWC-G: Construction of Infiltration Galleries

Description:

Under this option costs for full scale work and cost of pilot project are computed. The reason for both option are reproduced as follows.

M/s RCC Consultants with their experience in this field and on direction of their demised Hydrogeology Specialist Engr. Mula Bux Mirbaher who spent his life on designing tile drains had suggested a net work of infiltration galleries based on an empirical design. The net work will occupy about 40 acres of river bed area and house about 32,000 feet of net work of collection pipes. It is computed that, the proposed system can extract about 36 million gallons of filtered water.

However prior to going for full scale project, it is recommended to initiate a pilot project consisting of about 500ft of typical infiltration gallery with collection pipe and a sump well to verify empirical concept. If it could yield about 50,000 gallons or above per day then full scale project consisting of about 32000 feet of galleries would definitely produce required 36 million gallons of water per day. In such case good quality drinking water can be produced at very low costs. This pilot scale trial system can be aimed at to address the knowledge gap (left behind by M/s ROCKMORE study) to include assessment of the lithology of the saturated and unsaturated zone. The characterization of physical and chemical heterogeneity, delineation of aquifer geometry, storage volumes, hydrochemistry and hydraulic properties, as well as data on water table fluctuations and ground water flow. The pilot project would further investigate the relationship between the hydro geological settings and the performance of the galleries in respect of quality and quantity in respect of time parameters.

The concept drawing of full option is as following;

Figure 4.20: Construction of Infiltration Galleries Full Scale

For pilot project following concept drawing is suggested.

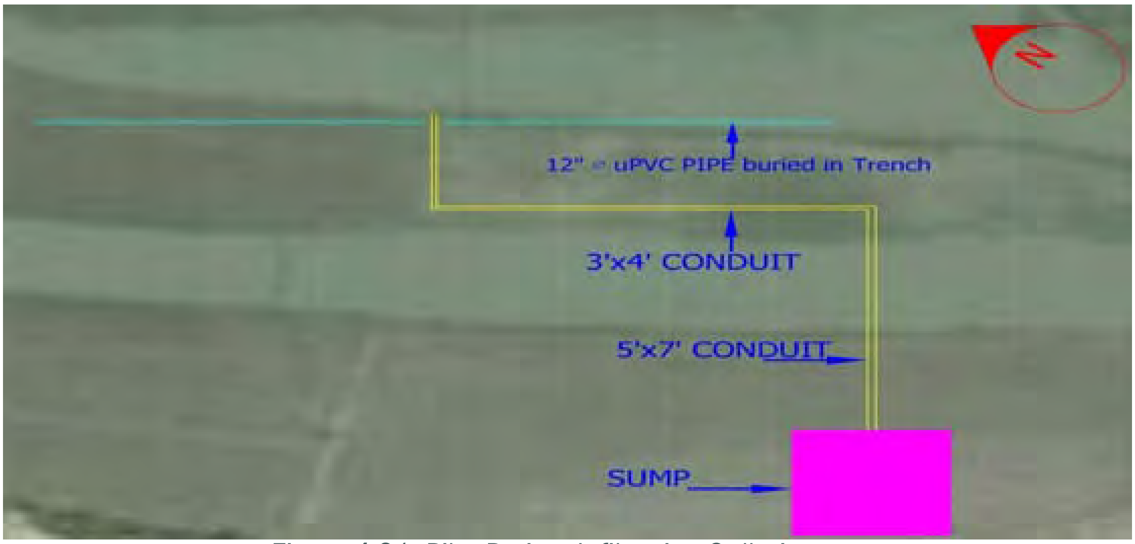


Figure 4.21: Pilot Project Infiltration Galleries

Rough Cost Estimate of Full Project: Rs.215.33 Millions

Rough Cost Estimate of Pilot Project: Rs.6.94 Millions

Completion Period Full Project: Nine (09) Months

Completion Period Pilot Project: Three (03) Months

BSWC-H: Electrical Mechanical Works at IPS

This sub-work constitute following items;

(1) Vertical Deep Well Turbines 270 HP, Discharge 3150 GPM, Head 200ft
(2) Manifold
(3) Flow meter
(4) Pipes & Valves
(5) DG Set 1500 KVA
(6) Transformer 1500 KVA
(7) VCB Panel
(8) Main Distribution Panels

(9) Cables

(10) Motor Control Panels

(11) WAPDA Connection

(12) Local Control Switch, Wiring and Earthing etc

TABLE 4.2: PHASE WISE REQUIREMENT OF ELECTRICAL / MECHANICAL EQUIPMENTS AT INTAKE WORKS SUKKUR

S. NO	YEARS	REQUIRED MGD	PUMPING MACHINERY: TOTAL TURBINES REQUIRED	TURBINES EXPIRED ON COMPLETION OF 20 YEARS SERVICE LIFE	NEW PURCHASE	HP	T-HP	T-KW	AMP	KVA	TRANSFORMER (KVA)	D.G SET (1500 KVA): TOTAL REQUIRED	DG SET EXPIRED ON COMPLETION OF 20 YEAR SERVICE LIFE	NEW PURCHASE	ESTIMATE ELECTRICAL / MECHANICAL WORKS (RS. MILLION)
1	2012	10.3	3	0	3	270	810	604.26	1,148.78	671.4	1500	1	0	1	144.02
2	2020	13.5	4	0	1	270	1080	805.68	1,531.71	895.2		1	0	0	12.62
3	2030	18.8	5	3	4	270	1350	1007.1	1,914.64	1119		1	1	1	172.23
4	2040	26.2	7	1	3	270	1890	1409.94	2,680.49	1566.6	1500	2	0	1	327.21
5	2050	36.0	9	4	6	270	2430	1812.78	3,446.35	2014.2		2	1	1	324.66

LIFE OF TURBINES: 20 YEARS
LIFE OF DG SET: 20 YEARS

Rough Cost Estimate: Rs. 144.04 Millions (For year 2012)

Completion Period: Four (04) Months

BSWC-I: Access to IPS

BSWC I-1: Access to IPS on Lansdowne Bridge (Lifting Equipment & Stairs):

Rough Cost Estimate: Rs. 6.90 Millions

Completion Period: Three (03) Months

BSWC I-2: Access to IPS at Bukkur Island (Road & Pedestrian Bridge):

Rough Cost Estimate: Rs. 8.51 Millions

Completion Period: Three (03) Months

POSSIBLE SOLUTIONS FOR PROJECT SELECTION

IN THIS SECTION FOLLOWING SOLUTIONS ARE PROPOSED;

5.1 INTAKE WORKS ON FAR SIDE OF BUKKUR ISLAND

5.2 INTAKE WORKS ON DOWNSTREAM SIDE OF EXISTING IPS

5.3 INTAKE WORKS ON UPSTREAM SIDE OF LANSDOWNE BRIDGE ON BUKKUR ISLAND

5.4 CONSTRUCTION OF 270 MG STORAGE LAGOONS AND INTAKE WORKS WITH REHABILITATION OF EXISTING IPS

5.5 CONSTRUCTION OF INFILTRATION GALLERIES AND ALLIED WORKS

SECTION 05

5. POSSIBLE SOLUTIONS FOR PROJECT SELECTION

This section is the culmination of all the preceding sections of this report as well as of previously submitted four reports namely:

- HYDROLOGICAL & HYDEROGEOLOGICAL INVESTIGATION REPORT
- RIVER BED & WATER QUALITY STUDY REPORT

The sub-works as outlined in Section 4.2 of the report are now the basic building blocks for the several Alternative Technical Solution, being presented below. The lowest cost Basic Sub-work Components are initially assembled to form an option. However during final selections of viable option other components can be considered.

5.1 INTAKE WORKS ON FAR SIDE OF BUKKUR ISLAND

This alternative entails construction of Intake works, a new pump house on far side of Bukkur Island. The delivery pipes will be laid across the Sukkur Channel river part either on piles or buried under bed. This alternative will have following basic components

5.1.1 BASIC SUB-WORK COMPONENT (BSWC) IN THIS ALTERNATIVE

BSWC A-1: Jacked Pipe Intake.

BSWC C-1: Construction of new Intake Pump House on Shore (Over River Bank/ Island).

BSWC D-1: Substation on Piles (Near River Indus).

BSWC E-1: Construction of delivering force mains from Pump House on Island to WTPs buried in River Bed.

BSWC H: Electrical Mechanical works at IPS

BSWC I-2: Access to IPS at Bukkur Island (Road & Pedestrian Bridge)

5.1.2 ROUGH COSTS ESTIMATES

S no	BSWC no	Description	Rough Cost (Rs. Millions)
1	A-1	Jacked Pipe Intake	20.68
2	C-1	Construction of new Intake Pump House on Shore (Over River Bank/ Island)	19.41
3	D-1	Substation on Piles (Near River Indus)	15.58
4	E-1	Construction of delivering force mains from Pump House on Island to WTPs buried in River Bed	102.72
5	H	Electrical Mechanical works at IPS	144.04
6	I-2	Access to IPS at Bukkur Island (Road & Pedestrian Bridge)	8.51
		TOTAL COST OF THIS OPTION	310.94

NOTE: Pumping Machinery, DG sets and allied accessories need up-gradation by year 2020 and beyond. Refer Table 4.2 in Section 4.2 for subsequent rough costs

5.1.3 SCHEDULE OF COMPLETION (Option 5.1)

ID	Task Name	Nov – Dec; Half 1, 2012 (Jan – Jun); Half 2, 2012 (Jul – Dec)
1	INTAKE WORKS ON FAR SIDE OF BUKKUR ISLAND	6 MONTHS
2	Jacked Pipe Intake (BSWC A-1)	4 MONTHS
3	Construction of new Intake Pump House on Shore (Over River Bank/ Island) (BSWC C-1)	4 MONTHS
4	Access to IPS at Bukkur Island (Road & Pedestrian Bridge) (BSWC I-2)	3 MONTHS
5	Substation on Piles (Near River Indus) (BSWC D-1)	4 MONTHS
6	Delivering force mains from Pump House on Island to WTPs buried in River Bed (BSWC E-1)	6 MONTHS
7	Electrical Mechanical works of Substation (BSWC-H)	4 MONTHS

5.1.4 MERITS & DEMERITS

Merits:

- This alternative ensure un-interrupted water supply to Sukkur city even during closure periods.
- The depth at which Intake pipes are proposed will have contamination free water.

De-merits:

- Irrigation Authorities have to approve for location of pump house and Intake work at Island. The same Authority shall also approve for delivery pipe crossing either on piles or under bed through Sukkur side river channel.
- Electric connections are to be brought on the Island. HESCO to approve the scheme.
- During submersion of Island (Reference 3.4 Hydrological & Hydrogeological Investigation Report) only access to pump house shall be through pedestrian bridge. (Refer BSWC I-2)
- The access road will also get submerged for this reason concrete access road is proposed for this site. (Refer BSWC I-2)

5.2 INTAKE WORKS ON DOWNSTREAM SIDE OF EXISTING IPS

In this option concrete conduit/gravity pipes are proposed to be laid across the Sukkur Channel to transmit water from deep point in Rohri Channel. A new IPS is proposed to extract water from the sump where these gravity conduits will terminate on Right Bank.

For de-settling of concrete conduits, three access chambers are provided for manual removal of silt deposits. For option of pipes conduits high pressure jetting line is proposed. During laying of conduits under river bed a temporary construction path is proposed 20ft wide and 3ft high made from morrum soil to carry vehicles loads required during construction phase.

5.2.1 BASIC SUB WORK COMPONENT OF THIS ALTERNATIVE

BSWC A-1: Jacked Pipe Intake

BSWC B-1: Using Pre-Cast Concrete Conduit

BSWC C-1: Construction of new Intake Pump House on Shore (Over River Bank/ Island)

BSWC D-1: Substation on Piles (Near River Indus)

BSWC E-1: Construction of delivering force mains from Pump House on Island to WTPs buried in River Bed

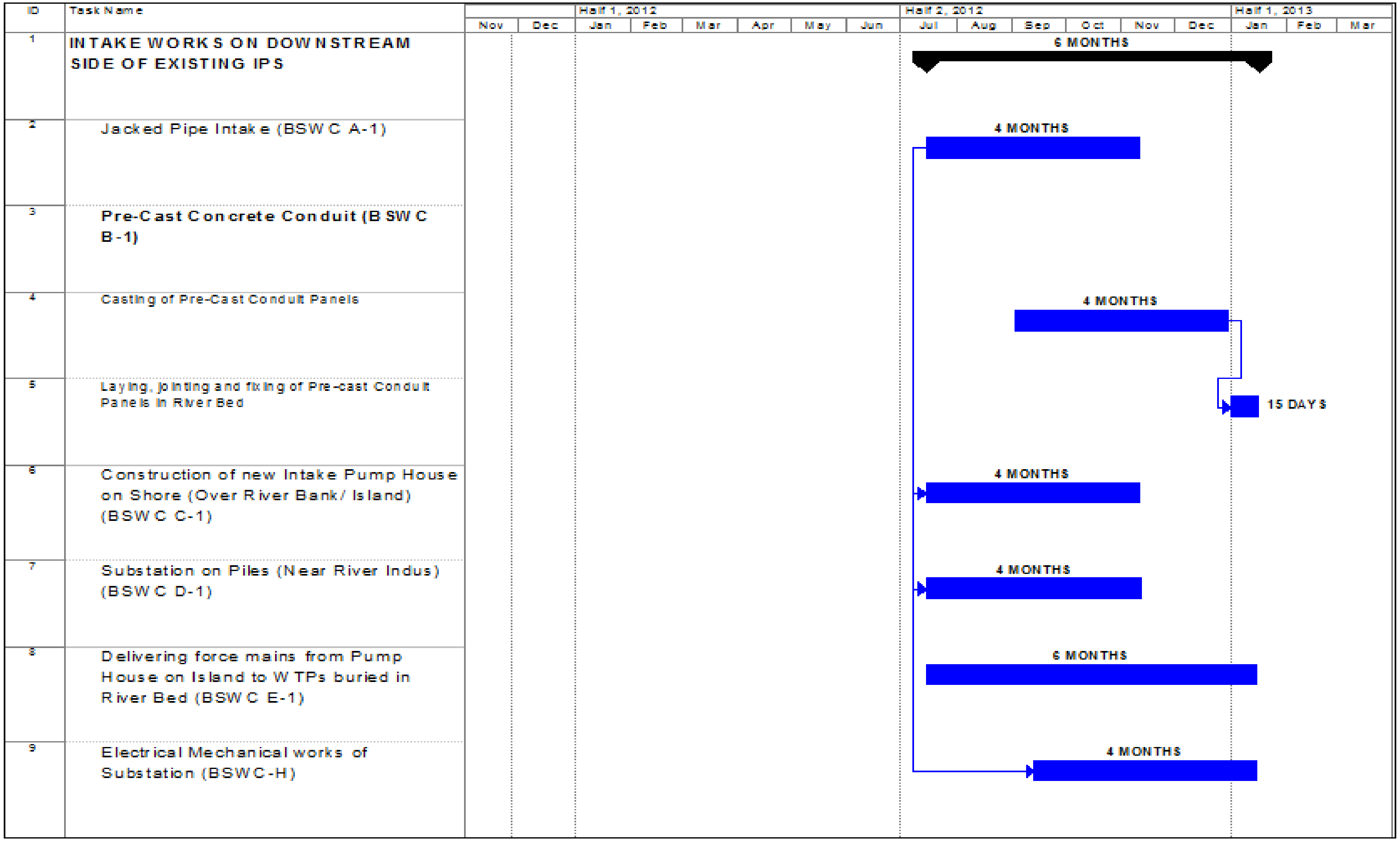
BSWC H: Electrical Mechanical works at IPS

5.2.2 ROUGH COSTS ESTIMATES

S no	BSWC no	Description	Rough Cost (Rs. Millions)
1	A-1	Jacked Pipe Intake	20.68
2	B-1	Using Pre-cast Concrete Conduit	50.97
3	C-1	Construction of new Intake Pump House on Shore (Over River Bank/ Island)	19.41
4	D-1	Substation on Piles (Near River Indus)	15.58
5	E-1	Construction of delivering force mains from Pump House on Island to WTPs buried in River Bed	102.72
6	H	Electrical Mechanical works at IPS	144.04
		TOTAL COST OF THIS OPTION	353.4

NOTE: Pumping Machinery, DG sets and allied accessories need up-gradation by year 2020 and beyond. Refer Table 4.2 in Section 4.2 for subsequent rough costs

5.2.3 SCHEDULE OF COMPLETION (Option 5.2)



5.2.4 MERITS & DEMERITS

Merits:

- The Alternative meets the requirement at lowest costs.
- Easy electric connection from HESCO.

De-merits:

- Requires permission of Irrigation Authorities for:
  - Intake Jacked pipes
  - Gravity conduits under river bed
  - New location of Intake pumping station
- Require de-silting of gravity conduits annually
- Laying and Jointing of gravity conduit across Sukkur side river part (500ft) in only 15 days (Closure period). For this reason pre-cast conduit are proposed.

5.3: INTAKE WORKS ON UPSTREAM SIDE OF LANSDOWNE BRIDGE ON BUKKUR ISLAND

This option requires construction of IPS on upstream side of Lansdowne Bridge. Intake option are jacked pipes or over head steel bridge, deliver pipes could be through space provided on Lansdowne bridge or could be on piles or under river bed. This option is however priced with most optimistic low cost sub-work components. Sub work components options are readily available with rough costs ensure the proposal if required.

5.3.1 BASIC SUB WORK COMPONENT OF THIS ALTERNATIVE

BSWC A-2: Steel Bridge Intake Arrangement

BSWC C-2: Construction of new Intake Pump House off Shore (inside at point of deepest water).

BSWC D-1: Substation on Piles (Near River Indus)

BSWC E-4: Delivering force mains from Pump House near Lansdowne Bridge. Pipes crossing buried under river bed.

BSWC H: Electrical Mechanical works at IPS

BSWC I-1: Access to IPS on Lansdowne Bridge (Lifting Equipment & Stair)

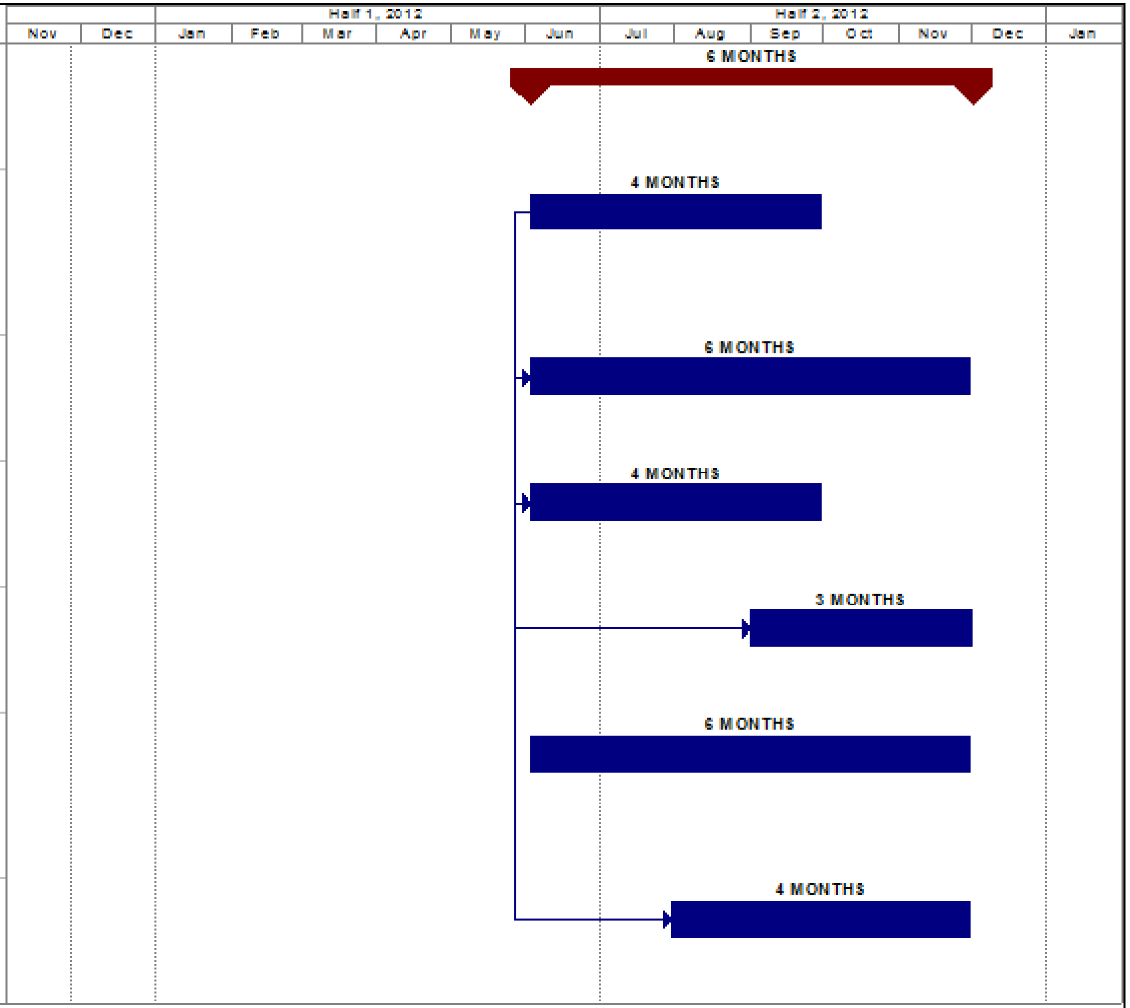
5.3.2 ROUGH COSTS ESTIMATES

S no	BSWC no	Description	Rough Cost (Rs. Millions)
1	A-2	Steel Bridge Intake Arrangement	34.97
2	C-2	Construction of new Intake Pump House off Shore (inside at point of deepest water)	20.08
3	I-1	Access to IPS on Lansdowne Bridge (Lifting Equipment & Stair)	6.9
4	D-1	Substation on Piles (Near River Indus)	15.58
5	E-4	Delivering force mains from Pump House near Lansdowne Bridge. Pipes crossing buried under river bed.	102.26
6	H	Electrical Mechanical works at IPS	144.04
		TOTAL COST OF THIS OPTION	323.83

NOTE: Pumping Machinery, DG sets and allied accessories need up-gradation by year 2020 and beyond. Refer Table 4.2 in Section 4.2 for subsequent rough costs

5.3.3 SCHEDULE OF COMPLETION (Option 5.3)

ID	Task Name
1	**INTAKE WORKS ON UPSTREAM SIDE OF LANSDOWNE BRIDGE ON SUKKUR ISLAND**
2	Construction of new Intake Pump House off Shore (inside at point of deepest water) (BSWC C-2)
3	Steel Bridge Intake Arrangement (BSWC A-2)
4	Substation on Piles (Near River Indus) (BSWC D-1)
5	Access to IPS on Lansdowne Bridge (Lifting Equipment & Stairs) (BSWC I-1)
6	Delivering force mains from Pump House near Lansdowne Bridge. Pipes crossing buried under river bed. (BSWC E-4)
7	Electrical Mechanical works of Substation (BSWC-H)



5.3.4 MERITS & DEMERITS

Merits:

- Trouble free option.
- No de-silting requires for any pipes.
- HESCO connection already available.

De-merits:

- Need approval from Railway authorities to use any of two pedestrian spaces to place pipes over bridge.
- Approval required from Irrigation Authorities to Construct. Access Bridge on piles, and Intake pump station on piles over point of deep water.

5.4. CONSTRUCTION OF 270 MG STORAGE LAGOONS AND INTAKE WORKS WITH REHABILITATION OF EXISTING IPS

In this option existing IPS will be re-habilitated and connected with 270 million gallon capacity Lagoons. From lagoons settled water will be pumped back to Water Treatment Plants.

5.4.1 BASIC SUB WORK COMPONENT OF THIS ALTERNATIVE

BSWC C-3: Construction of Pump house at side of proposed Lagoons

BSWC C-4: Rehabilitation of existing IPS

BSWC D-2: Substation on Strip Foundation (Near Lagoons)

BSWC E-5: Delivering pipes to Lagoons from existing pump house on Right Bank for Storage & Settling of Raw water

BSWC E-6: Delivery pipes from Lagoons pump house to WTPs

BSWC F: Construction of Lagoons

BSWC H: Electrical Mechanical works at IPS (2 Sets)

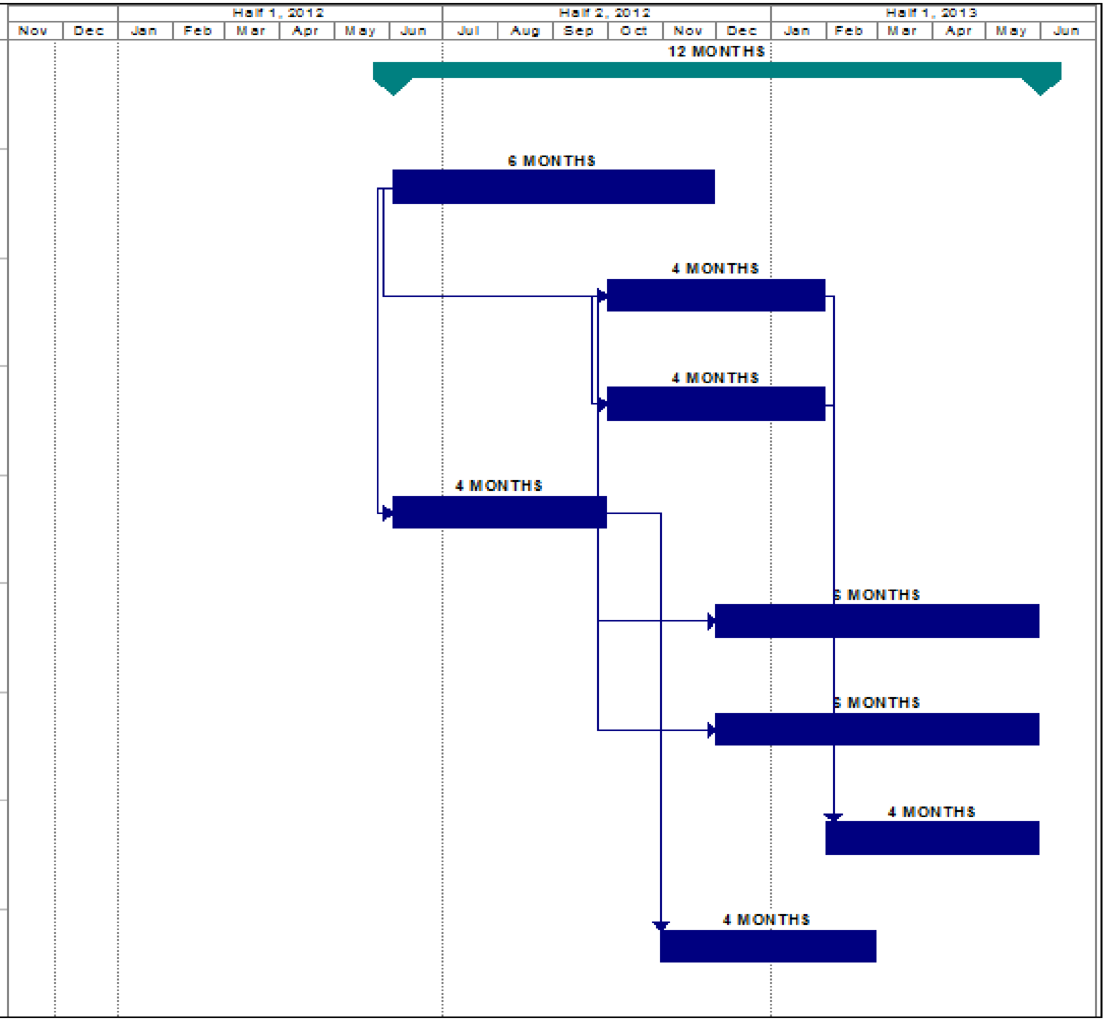
5.4.2 ROUGH COSTS ESTIMATES

S no	BSWC no	Description	Rough Cost (Rs. Millions)
1	C-3	Construction of Pump house at side of proposed Lagoons	16.84
2	C-4	Rehabilitation of existing IPS	26.41
3	D-2	Substation on Strip Foundation (Near Lagoons)	6.0
4	E-5	Delivering pipes to Lagoons from existing pump house on Right bank for Storage and Settling of raw water	555.7
5	E-6	Delivering pipes from Lagoons pump house to WTPs	533.01
6	F	Construction of Lagoons	625.28
7	H	Electrical Mechanical works at IPS (2 Sets)	144.04 x 2
		TOTAL COST OF THIS OPTION	2050.89

NOTE: Pumping Machinery, DG sets and allied accessories need up-gradation by year 2020 and beyond. Refer Table 4.2 in Section 4.2 for subsequent rough costs

5.4.3 SCHEDULE OF COMPLETION (Option 5.4)

ID	Task Name
1	CONSTRUCTION OF 270 MG STORAGE LAGOONS AND INTAKE WORKS WITH REHABILITATION OF EXISTING IPS
2	Construction of Lagoons
3	Construction of Pump house at side of proposed Lagoons) (BSWC C-3)
4	Substation on Strip Foundation (Near Lagoons) (BSWC D-2)
5	Rehabilitation of existing IPS (BSWC C-4)
6	Delivering pipes to Lagoons from existing pump house on Right bank for Storage and Settling of raw water) (BSWC D-5)
7	Delivering pipes from Lagoons pump house to WTPs (BSWC E-6)
8	Electrical Mechanical works of Substation at Lagoon IPS (BSWC-H)
9	Electrical Mechanical works of Substation at Existing IPS after Rehabilitation(BSWC-H)



5.4.4 MERITS & DEMERITS

Merits:

- This is a typical alternative, already in use with all other filtration units in Sindh Province.
- Substantial savings from low consumption of Alum, Chlorine and enhanced water production at filtration plants will occur.
- Water will be available during closure periods or during other emergencies.
- No approval of any sort is required for Irrigation Alternative.
- In winter settled water could be sent to city without filtration.
- Existing IPS can be used.

De-merits:

- High cost of investment.
- Relatively high cost of water production due to double pumping, but substantial offset through saving on reduced cost of less Alum and Chlorine consumption etc.
- 140 acre of private land is required. The location proposed is agricultural private land. Rs: 1.0 million/acre cost is included in rough cost estimates.

5.5. CONSTRUCTION OF INFILTRATION GALLERIES AND ALLIED WORKS

This option though rarely tried in Pakistan as source of water for drinking purposes, apparently carries lot of promise. Bed of River Indus contain coarse sand with fine silt content and is ideal medium to allow such a permeability that infiltration galleries constructed 5ft below river bed surface to get filtered quality sweet water.

M/s RCC Consultants Hydrogeologist who demised during course of this study had proposed an empirical formula to construct infiltration galleries under river bed. He was the expert who spent his life studying subsoil, water logging and salinity throughout 40 year of his professional career. He proposed on basis of Darcy's Law for groundwater flow,

$$L_g = W.Q_g / 8.k.D.h$$

Where

W = width of extraction area (m);
Q_g= pump flow from gallery (m^3/day);
k = permeability (m/day);
D = approximate mean thickness of freshwater zone (m);
h = allowable drawdown (m); and,

L_g = length of a gallery (in meter).

And formula:

$$Q_g = A.QS / AL = (L_g + W).\ W.\ Q_S / A_L$$

Where

A = extraction area (m^2) = W.L
Q_S = sustainable yield of entire freshwater lens (m^3/day or kL/day), and
A_L = area of lens (ha).

that an infiltration galleries of size and arrangement (shown in figure 5.1) if placed below surface of river Indus in areas containing saturated water zones could extract about 0.76 gallons per minute per ft length.

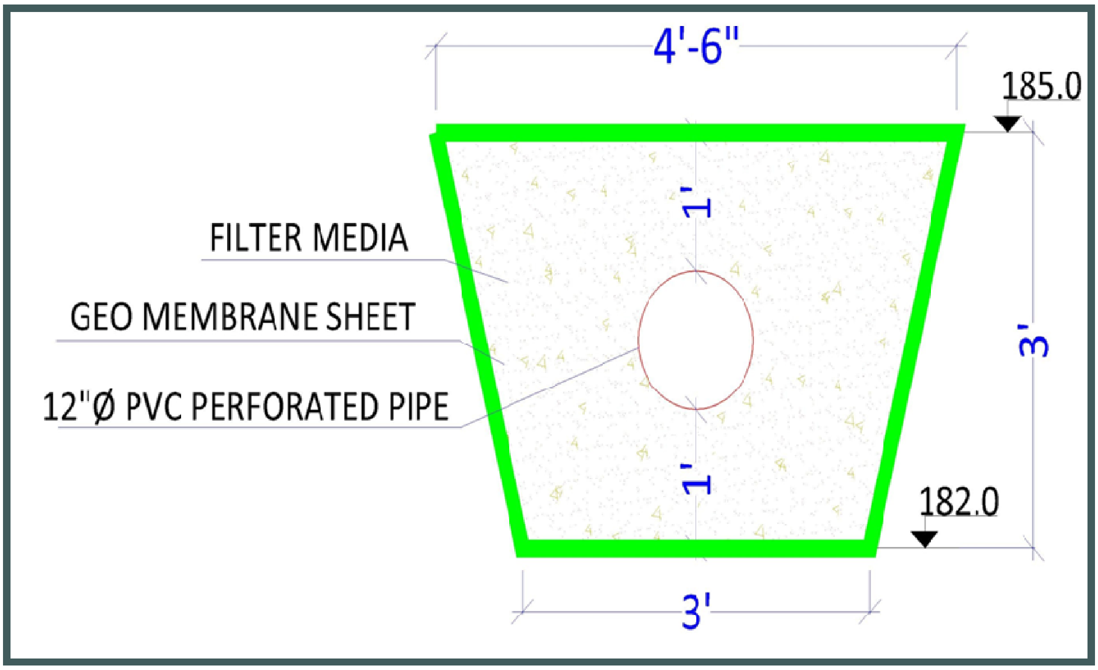


Figure 5.1: Typical Section of Proposed Infiltration Gallery

Based on this empirical approach a full scale project is proposed to extract 36 Million Gallons of sweet water. For this about 32,000 ft of galleries spread on 40 acre of land are proposed inside of river Indus bed area over an agricultural land opposite to Numaish WTP.

However it has been proposed at several sections in this report that before going for full scale project, a pilot project is recommended to produce about 50,000 gallons/day. This is essential to confirm empirical design and for other reasons as spelled out at Section 4.2 BSWC-G of this report.

5.5.1 BASIC SUB WORK COMPONENT OF THIS ALTERNATIVE

BSWC C-1: Construction of new Intake Pump House on bank of river.

BSWC D-1: Substation on Piles (Near River Indus).

BSWC E-7: Delivery pipes from Infiltration Galleries pump house to WTPs.

BSWC G: Construction of Infiltration Galleries.

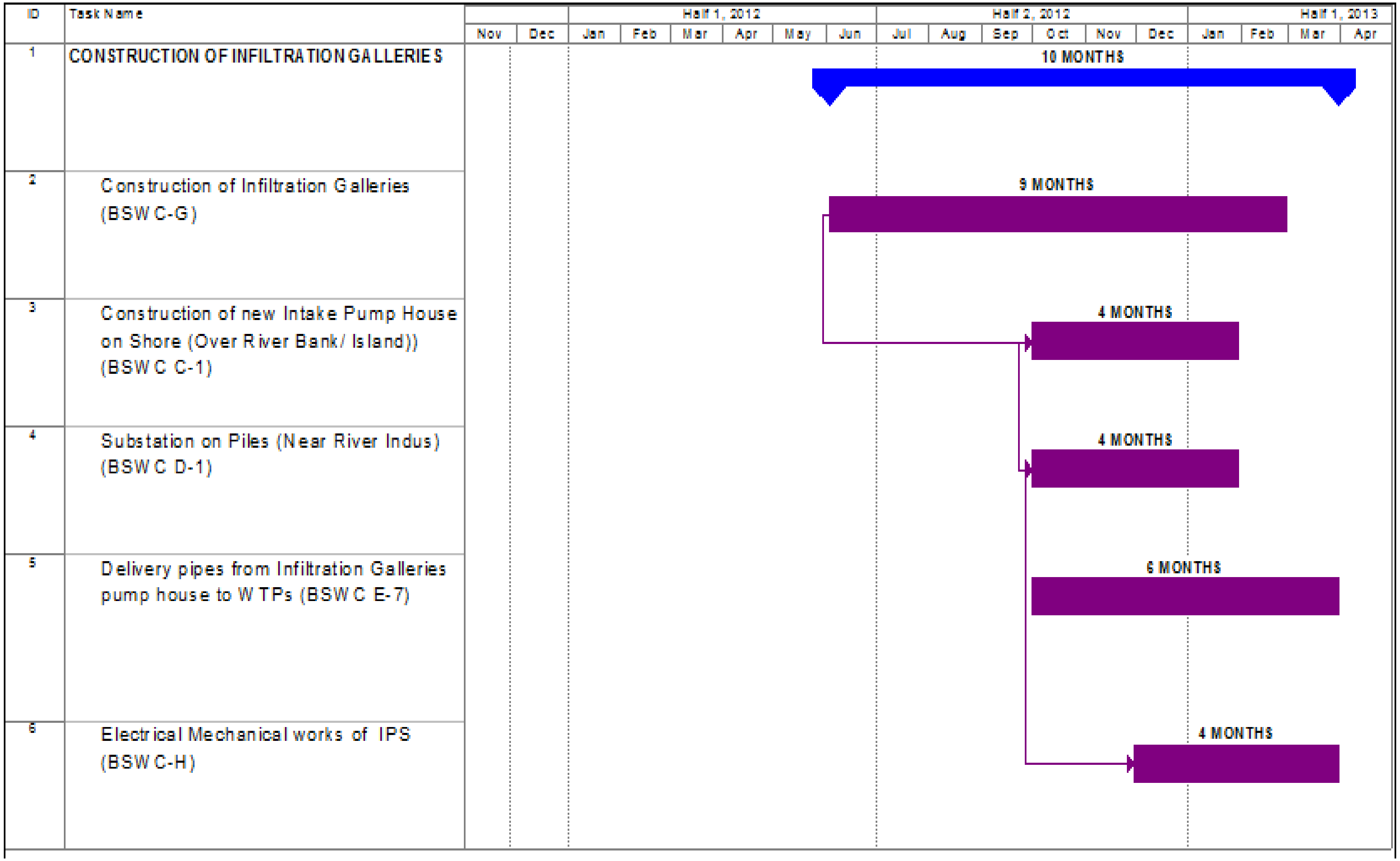
BSWC H: Electrical Mechanical works at IPS.

5.5.2 ROUGH COSTS ESTIMATES

S no	BSWC no	Description	Rough Cost (Rs. Millions)
1	C-1	Construction of new Intake Pump House on Shore (Over River Bank/ Island)	19.41
2	D-1	Substation on Piles (Near River Indus)	15.58
3	E-7	Delivery pipes from Infiltration Galleries pump house to WTPs	137.02
4	G	Construction of Infiltration Galleries	215.33
5	H	Electrical Mechanical works at IPS	144.04
		TOTAL COST OF THIS OPTION	531.38

NOTE: Pumping Machinery, DG sets and allied accessories need up-gradation by year 2020 and beyond. Refer Table 4.2 in Section 4.2 for subsequent rough costs

5.5.3 SCHEDULE OF COMPLETION (Option 5.5)



5.5.4 MERITS & DEMERITS

Merits:

- Water produced through infiltration galleries may not require further treatment at Water Treatment Plants. Only disinfection may be required.
- This is most economical option O&M costs past WTPs will be lowest among all the option proposed.

De-merits:

- Permission for Irrigation Authorities may be necessary.

5.6 SUMMARY OF ALTERNATIVE TECHNICAL ANALYSIS OF POSSIBLE SOLUTIONS FOR PROJECT SELECTION

ANALYSIS OF DIFFERENT OPTIONS											
S No	OPTION	DESCRIPTION	COMPLETION TIME (Months)	PROJECT COST (Rs. In Millions)	O&M COST (Rs/1000 GALLONS) UPTO BETTERY LIMIT OF WTPs	RANKING COST-WISE	RANKING COMPLETION TIME-WISE	RANKING (IRRIGATION DEPT FOR SMOOTH SAIL WITH IRRIGATION & POWER DEPT	RANKING EASE OF PROJECT OPERATION	RANKING ENVIRONMENTAL FRIENDLY PROJECT
1	5.1	INTAKE WORKS ON FAR SIDE OF BUKKUR ISLAND	6	310.94	29.91	1	1	3	2	2
2	5.2	INTAKE WORKS ON DOWNSTREAM SIDE OF EXISTING IPS	6	353.4	29.91	3	1	3	3	2
3	5.3	INTAKE WORKS ON UPSTREAM SIDE OF LANSDOWNE BRIDGE ON BUKKUR ISLAND	6	323.83	29.91	2	1	3	1	3
4	5.4	CONSTRUCTION OF 270 MG STORAGE LAGOONS AND INTAKE WORKS WITH REHABILITATION OF EXISTING IPS	12	2050.89	60.96	5	3	1	1	1
5	5.5	CONSTRUCTION OF INFILTRATION GALLERIES AND ALLIED WORKS	10	531.8	30.32	4	2	2	1	1
6		PILOT PROJECT INFILTRATION GALLERIES TO PRODUCE 50,000 GALLONS/DAY	3	6.94						

ALTERNATIVE COST ANALYSIS

IN THIS SECTION:

6.1 BASICS OF ROUGH COST ESTIMATES

6.2 SUB WORK ROUGH COST ESTIMATES

6.3 OPERATION & MAINTENANCE (O&M) COSTS

SECTION 06

6. ALTERNATIVE COST ANALYSIS

6.1 BASICS OF ROUGH COST ESTIMATES

The Cost Estimates are based on following basis.

- All Cost Estimates are in Pakistan Rupees.
- Costs are based on market rates for materials and labor as prevailing in November 2011.
- Present exchange rate is Rs: 86.5 = 1.0 US$
- Pumping machinery, DG set and allied accessories are priced to meet water demand till 2020. Beyond 2020 upto 2050, additional machinery required is costed at price that include official inflation rate of 6.5% per annum. Reference table xxx to get such price details and machinery requirement, during period beyond 2020.
- Each proposed Alternative solution contains such sub-work components that result into least overall cost. However there could be cases that lowest cost sub-work options may not be preferred for variety of reasons. For such situation several additional alternate sub-work options are provided in this report.
- For first year 10% price contingency and 3% physical contingencies are proposed. For subsequent years additional 6.5% escalation per annum is added to price contingency, as per Government of Sindh rules.
- Contractor over heads are proposed at 20% of work cost and 3% are proposed as construction supervision costs.

6.2 ROUGH COST ESTIMATES OF BASIC SUB-WORK COMPONENTS

BSWC A-1: JACKED PIPE INTAKE

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Excavation for tanks and reservoirs in all kind of soils upto 30ft deep	P-Cft	30000.0	20.00	600,000.00
2	Lowering of subsoil water table, by installation well point system, for excavation below subsoil water level, concreting, curing, laying and jointing of pipe, filling haunches etc till the completion of chamber. Contractor is responsible for disposal of pumped out water and removal of silt if it is to be discharged to a chamber/conduit.	P-Rft	300.0	7,500.0	2,250,000.00
3	P/F driving close timbering to trenches for depth upto 30ft	P-Sft	1600.0	100.0	160,000.00
4	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	419.25	150.0	62,887.50
5	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	5888.0	400.0	2,355,200.00
6	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	17.66	120,000.0	2,119,680.00
7	Jacking of 36" dia black steel M.S pipe of API 5L of X-42 grade (790 psi) pipe tested at factory made out of M.S sheet of 10 mm thick of approved manufacturer i/c jointing, welding etc complete	P-Rft	600.0	9,840.0	5,904,000.00
8	Providing and fixing 1" dia C.I Foot Steps @ 12" C/C in Chamber	Each	30.0	1,000.0	30,000.00
9	Supply and fixing 36"dia C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported)	Each	3	350,000.0	1,050,000.00

	Approved by Consultant.				
10	10" dia MS Pipe line for flushing of 36"dia MS Pipes	P-Rft	100.0	3,500.0	350,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**14,881,767.50**
	IN MILLIONS				**14.88**
	3% Physical Contingency				**0.45**
	10% Price Contingency				**1.49**
	TOTAL				**16.82**
	20% Contractor Overheads				**3.36**
	3% Construction Supervision				**0.50**
	Grand Total Rs.				**20.68**

BSWC A-2: STEEL BRIDGE INTAKE ARRANGEMENT					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Piles 22" dia in 1-1-1/2:3 concrete	P-Rft	400.00	10,000.00	4,000,000.0
2	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	690.00	400.00	276,000.0
3	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	2.76	120,000.00	331,200.0
4	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	1200.00	200.00	240,000.0
5	Providing and fixing supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	67718.00	300.00	20,315,400.0
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**25,162,600.0**
	IN MILLIONS				**25.16**
	3% Physical Contingency				**0.75**
	10% Price Contingency				**2.52**
	TOTAL				**28.43**
	20% Contractor Overheads				**5.69**
	3% Construction Supervision				**0.85**
	Grand Total				**34.97**

BSWC B-1 USING PRE-CAST CONCRETE CONDUIT					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	247500.00	20.00	4,950,000.0
2	Pre-cast Beams, Slab, Foundations in RCC Ratio 1:1-1/2:3 (having compressive strength 5000 psi after 28 days) including placing compacting finishing , curing complete including cost of all labour. The rate also includes all kind of Lifting Fixing in position, Jointing of all Pre-cast members etc complete in all respects as per drawings and specifications and as per directions of Engineer incharge.	P-Cft	40500.00	400.00	16,200,000.0
3	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete including cutting, bending, laying in position, making joints and fastenings including cost of binding wire M.S, chairs, labour and also includes removal of rust from bars etc complete in all respects as per drawings and specifications.	P-Ton	101.25	120,000.00	12,150,000.0
4	Construction of Temporary Path	P-Cft	67500	50.00	3,375,000.0
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**36,675,000.0**
	IN MILLIONS				**36.68**
	3% Physical Contingency				**1.10**
	10% Price Contingency				**3.67**
	TOTAL				**41.44**
	20% Contractor Overheads				**8.29**
	3% Construction Supervision				**1.24**
	Grand Total Rs.				**50.97**

BSWC B-2: USING 3x36" DIA MS PIPE AS GRAVITY CONDUIT

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	270000.00	20.00	5,400,000.00
2	Manufacturing supplying & fixing black steel M.S pipe of API 5L of X-42 grade (790 psi minimum test pressure for pipe tested at factory made out of M.S sheet thick of approved manufacturer i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all specials required etc complete in all respects as per directions of engineer incharge and specifications.				
	36"Dia Rising Main 10mm wall thickness	P-Rft	3150.00	9,750.00	30,712,500.00
3	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.				
	36"Dia Rising Main	P-Rft	3150.00	500.00	1,575,000.00
4	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc complete				
	36"Dia Rising Main	P-Rft	3150.00	1,000.00	3,150,000.00

5	Supply and fixing C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported) Approved by Consultant.				
	For 36"Dia Rising Main	Each	3	3,500,000.00	10,500,000.00
6	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete	P-Cft	8970.75	200.00	1,794,150.00
7	Providing and fixing Stainless Steel Clips including SS nut bolts etc complete all respects	Each	360	10,000.00	3,600,000.00

TOTAL AMOUNT OF CIVIL WORK IN Rs.	**56,731,650.00**
IN MILLIONS	**56.73**
3% Physical Contingency	**1.70**
10% Price Contingency	**5.67**
TOTAL	**64.11**
20% Contractor Overheads	**12.82**
3% Construction Supervision	**1.92**
Grand Total Rs.	**78.85**

BSWC C-1: CONSTRUCTION OF PUMP HOUSE ON PILES AT SHORE (OVER RIVER BANK/ISLAND)					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Excavation for tanks and reservoirs in all kind of soils +Cartage etc	P-Cft	90.00	10.00	900.00
2	Piles 22" dia in 1-1-1/2:3 concrete	P-Rft	900.00	7,500.00	6,750,000.00
3	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	12.50	150.00	1,875.00
4	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	6525.68	400.00	2,610,270.00
5	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	19.58	120,000.00	2,349,243.00
6	Providing & laying of best quality burnt bricks masonry in foundation & super structure set in cement sand mortar 1:4	P-Cft	2251.13	150.00	337,668.75
7	Cement Plaster 1:4 upto 20' height 1/2" thick	P-Sft	12643.20	20.00	252,864.00
8	Cement Plaster 1:4 upto 20' height 3/8" thick	P-Sft	12643.20	18.00	227,577.60
9	Distempering over new surfaces three coats ICI or equivalent etc complete in all respects as per directions of engineer incharge and specifications.	P-Sft	2203.20	15.00	33,048.00
10	Preparing the surface & painting with matt finish Three Coats	P-Sft	6321.60	25.00	158,040.00
11	Preparing the surface and painting with weather three coats	P-Sft	6321.60	30.00	189,648.00
12	Providing and laying 2" thick cement concrete toping (1:2:4) including surface finishing and dividing into panels	P-Sft	2203.20	40.00	88,128.00
13	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	300.00	200.00	60,000.00

14	Providing and laying single layer of polythene sheet 150 micron , Two coats of hot bitumen 34lbs for % sft over roof & 2" thick C.C 1:2:4 with slope for roof topping etc complete in all respects and as per directions of engineer incharge and specifications.	P-Sft	2203.20	100.00	220,320.00
15	Making & fixing steel grated doors with sheeting including angle iron frame including locking arrangement & 3 coats ICI paint	P-Kg	1284.00	200.00	256,800.00
16	Providing and fixing 5 Tons capacity manual crane of supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	2160.00	200.00	432,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**13,968,382.35**
	IN MILLION RS.				**13.97**
	3% Physical Contingency				**0.42**
	10% Price Contingency				**1.40**
	TOTAL				**15.78**
	20% Contractor Overheads				**3.16**
	3% Construction Supervision				**0.47**
	Grand Total Rs.				**19.41**

BSWC C-2: CONSTRUCTION OF PUMP HOUSE ON PILES OFF SHORE (INSIDE AT POINT OF DEEPEST WATER)

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Piles 22" dia in 1-1-1/2:3 concrete	P-Rft	600.00	10,000.00	6,000,000.00
2	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	3070.50	400.00	1,228,200.00
3	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	9.21	120,000.00	1,105,380.00
4	Providing and laying 2" thick cement concrete toping (1:2:4) including surface finishing and dividing into panels	P-Sft	1200.00	40.00	48,000.00
5	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	420.00	200.00	84,000.00
6	Providing and fixing supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	6604.00	300.00	1,981,200.00
7	Over Head Crane over pumps including assembly electrical operation.	Job	1	4,000,000.00	4,000,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**14,446,780.00**
	IN MILLIONS				**14.45**
	3% Physical Contingency				**0.43**
	10% Price Contingency				**1.44**
	TOTAL				**16.32**
	20% Contractor Overheads				**3.26**
	3% Construction Supervision				**0.49**
	Grand Total Rs.				**20.08**

BSWC C-3: CONSTRUCTION OF PUMP HOUSE NEAR LAGOONS

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Excavation for tanks and reservoirs in all kind of soils +Cartage etc	P-Cft	16107.00	5.00	80,535.00
2	Bailing out sub soil water during excavation, concreting cast in situ concrete or masonry work in foundation				
	10 BHP Pump	P-Hour	500.00	1,000.00	500,000.00
3	P/F driving close timbering to trenches for depth upto 20ft	P-Sft	1600.00	50.00	80,000.00
4	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	1150.50	150.00	172,575.00
5	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	12172.97	400.00	4,869,189.60
6	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	36.52	120,000.00	4,382,270.64
7	Providing & laying of best quality burnt bricks masonry in foundation & super structure set in cement sand mortar 1:4	P-Cft	2070.00	150.00	310,500.00
8	Cement Plaster 1:4 upto 20' height 1/2" thick	P-Sft	7740.00	20.00	154,800.00
9	Cement Plaster 1:4 upto 20' height 3/8" thick	P-Sft	7740.00	18.00	139,320.00
10	Distempering over new surfaces three coats ICI or equivalent etc complete in all respects as per directions of engineer incharge and specifications.	P-Sft	1800.00	15.00	27,000.00
11	Preparing the surface & painting with matt finish Three Coats	P-Sft	3870.00	25.00	96,750.00
12	Preparing the surface and painting with weather three coats	P-Sft	3870.00	30.00	116,100.00
13	Providing and laying 4" thick cement concrete toping (1:2:4) including surface finishing and dividing into panels	P-Sft	1800.00	40.00	72,000.00

14	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	600.00	200.00	120,000.00
15	Providing and laying single layer of polythene sheet 150 micron , Two coats of hot bitumen 34lbs for % sft over roof & 2" thick C.C 1:2:4 with slope for roof topping etc complete in all respects and as per directions of engineer incharge and specifications.	P-Sft	1800.00	100.00	180,000.00
16	Making & fixing steel grated doors with sheeting including angle iron frame including locking arrangement & 3 coats ICI paint	P-Kg	1184.00	200.00	236,800.00
17	Providing and fixing 5 Tons capacity manual crane of supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	2908.00	200.00	581,600.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**12,119,440.24**
	IN MILLIONS				**12.12**
	3% Physical Contingency				**0.36**
	10% Price Contingency				**1.21**
	TOTAL				**13.69**
	20% Contractor Overheads				**2.74**
	3% Construction Supervision				**0.41**
	Grand Total Rs.				**16.84**

BSWC C-4 REHABILITATION OF EXISTING IPS

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Excavation for tanks and reservoirs in all kind of soils +Cartage etc	P-Cft	7100.00	10.00	71,000.00
2	Piles 22" dia in 1-1-1/2:3 concrete	P-Rft	900.00	7,500.00	6,750,000.00
3	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	2375.00	150.00	356,250.00
4	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	10076.30	400.00	4,030,520.00
5	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	30.23	120,000.00	3,627,468.00
6	Providing & laying of best quality burnt bricks masonry in foundation & super structure set in cement sand mortar 1:4	P-Cft	8415.00	150.00	1,262,250.00
7	Cement Plaster 1:4 upto 20' height 1/2" thick	P-Sft	18403.20	20.00	368,064.00
8	Cement Plaster 1:4 upto 20' height 3/8" thick	P-Sft	18403.20	18.00	331,257.60
9	Distempering over new surfaces three coats ICI or equivalent etc complete in all respects as per directions of engineer incharge and specifications.	P-Sft	2203.20	15.00	33,048.00
10	Preparing the surface & painting with matt finish Three Coats	P-Sft	9201.60	25.00	230,040.00
11	Preparing the surface and painting with weather three coats	P-Sft	9201.60	30.00	276,048.00
12	Providing and laying 2" thick cement concrete toping (1:2:4) including surface finishing and dividing into panels	P-Sft	2203.20	40.00	88,128.00
13	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	300.00	200.00	60,000.00
14	Providing and laying single layer of polythene sheet 150 micron , Two coats of hot bitumen 34lbs for % sft over roof & 2" thick C.C 1:2:4 with slope for roof topping etc complete in all respects and	P-Sft	2203.20	100.00	220,320.00

	as per directions of engineer incharge and specifications.				
15	Making & fixing steel grated doors with sheeting including angle iron frame including locking arrangement & 3 coats ICI paint	P-Kg	2084.00	200.00	416,800.00
16	Providing and fixing 5 Tons capacity manual crane of supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	2160.00	200.00	432,000.00
17	Supplying & Filling clean screened River/Pit Sand from outside and laying in 6" layers, watering, ramming, compaction and lead upto 10 miles, lift upto 7.00 ft etc compete in all respects and specifications.	P-Cft	45000.00	10.00	450,000.00
	TOTAL AMOUNT IN Rs.				**19,003,193.60**
	In Millions				**19.00**
	3% Physical Contingency				**0.57**
	10% Price Contingency				**1.90**
	TOTAL				**21.47**
	20% Contractor Overheads				**4.29**
	3% Construction Supervision				**0.64**
	Grand Total				**26.41**

BSWC D-1: SUBSTATION ON PILES (NEAR RIVER INDUS)					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Excavation for tanks and reservoirs in all kind of soils +Cartage etc	P-Cft	75.00	5.00	375.00
2	Piles 22" dia in 1-1-1/2:3 concrete	P-Rft	600.00	7,500.00	4,500,000.00
3	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	7.50	150.00	1,125.00
4	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	4616.10	400.00	1,846,440.00
5	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	13.85	120,000.00	1,661,796.00
6	Providing & laying of best quality burnt bricks masonry in foundation & super structure set in cement sand mortar 1:4	P-Cft	3622.50	150.00	543,375.00
7	Cement Plaster 1:4 upto 20' height 1/2" thick	P-Sft	15000.00	20.00	300,000.00
8	Cement Plaster 1:4 upto 20' height 3/8" thick	P-Sft	15000.00	18.00	270,000.00
9	Distempering over new surfaces three coats ICI or equivalent etc complete in all respects as per directions of engineer incharge and specifications.	P-Sft	3408.00	15.00	51,120.00
10	Preparing the surface & painting with matt finish Three Coats	P-Sft	7500.00	25.00	187,500.00
11	Preparing the surface and painting with weather three coats	P-Sft	7500.00	30.00	225,000.00
12	Providing and laying 2" thick cement concrete toping (1:2:4) including surface finishing and dividing into panels	P-Sft	3408.00	40.00	136,320.00
13	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	2400.00	200.00	480,000.00

14	Providing and laying single layer of polythene sheet 150 micron , Two coats of hot bitumen 34lbs for % sft over roof & 2" thick C.C 1:2:4 with slope for roof topping etc complete in all respects and as per directions of engineer incharge and specifications.	P-Sft	3408.00	100.00	340,800.00
15	Making & fixing steel grated doors with sheeting including angle iron frame including locking arrangement & 3 coats ICI paint	P-Kg	3320.00	200.00	664,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**11,207,851.00**
	IN MILLIONS				**11.21**
	3% Physical Contingency				**0.34**
	10% Price Contingency				**1.12**
	TOTAL				**12.66**
	20% Contractor Overheads				**2.53**
	3% Construction Supervision				**0.38**
	Grand Total				**15.58**

BSWC D-2: SUBSTATION ON STRIP FOUNDATION (NEAR LAGOONS)					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Excavation for tanks and reservoirs in all kind of soils +Cartage etc	P-Cft	2940.00	5.00	14,700.00
2	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	519.00	150.00	77,850.00
3	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	2863.79	400.00	1,145,515.00
4	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	8.59	120,000.00	1,030,963.50
5	Providing & laying of best quality burnt bricks masonry in foundation & super structure set in cement sand mortar 1:4	P-Cft	3286.13	150.00	492,918.75
6	Cement Plaster 1:4 upto 20' height 1/2" thick	P-Sft	11430.00	20.00	228,600.00
7	Cement Plaster 1:4 upto 20' height 3/8" thick	P-Sft	11430.00	18.00	205,740.00
8	Distempering over new surfaces three coats ICI or equivalent etc complete in all respects as per directions of engineer incharge and specifications.	P-Sft	1608.00	15.00	24,120.00
9	Preparing the surface & painting with matt finish Three Coats	P-Sft	5715.00	25.00	142,875.00
10	Preparing the surface and painting with weather three coats	P-Sft	5715.00	30.00	171,450.00
11	Providing and laying 4" thick cement concrete toping (1:2:4) including surface finishing and dividing into panels	P-Sft	1608.00	80.00	128,640.00

12	Providing and laying single layer of polythene sheet 150 micron , Two coats of hot bitumen 34lbs for % sft over roof & 2" thick C.C 1:2:4 with slope for roof topping etc complete in all respects and as per directions of engineer incharge and specifications.	P-Sft	1608.00	100.00	160,800.00
13	Making & fixing steel grated doors with sheeting including angle iron frame including locking arrangement & 3 coats ICI paint	P-Kg	2470.00	200.00	494,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**4,318,172.25**
	IN MILLIONS				**4.32**
	3% Physical Contingency				**0.13**
	10% Price Contingency				**0.43**
	TOTAL				**4.88**
	20% Contractor Overheads				**0.98**
	3% Construction Supervision				**0.15**
	Grand Total Rs.				**6.00**

BSWC E-1: CONSTRUCTION OF DELIVERING FORCE MAINS FROM PUMP HOUSE ON ISLAND TO WTPs BURIED IN RIVER BED					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Dismantling all kinds of Roads, CC, RCC, brick masonry pads	P-Cft	73600.00	20.00	1,472,000.00
2	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	264400.00	10.00	2,644,000.00
3	Manufacturing supplying & fixing MS black steel made out of MS sheet of following dia and thicknesses confirming to API 5L grade X-42 spirally welded (790 psi minimum test pressure for pipe tested at factory i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all tees, bends and elbows if required etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main 10mm wall thickness	P-Rft	1800.00	6,500.00	11,700,000.00
	24"Dia Rising Main 8mm wall thickness	P-Rft	400.00	5,400.00	2,160,000.00
	22"Dia Rising Main 8mm wall thickness	P-Rft	8700.00	4,800.00	41,760,000.00
4	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main	P-Rft	1800.00	500.00	900,000.00
	24"Dia Rising Main	P-Rft	400.00	450.00	180,000.00
	22"Dia Rising Main	P-Rft	8700.00	300.00	2,610,000.00

5	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc complete				
	30"Dia Rising Main	P-Rft	1800.00	750.00	1,350,000.00
	24"Dia Rising Main	P-Rft	400.00	650.00	260,000.00
	22"Dia Rising Main	P-Rft	8700.00	600.00	5,220,000.00
6	Supply and fixing C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported) Approved by Consultant.				
	30"Dia Rising Main	Each	1	300,000.00	300,000.00
	24"Dia Rising Main	Each	1	250,000.00	250,000.00
	22"Dia Rising Main	Each	1	150,000.00	150,000.00
7	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete	P-Cft	2990.25	200.00	598,050.00
8	Providing and fixing Stainless Steel Clips including SS nut bolts etc complete all respects	Each	120	10,000.00	1,200,000.00
9	S/F Double acting air Valve heavy duty 6" dia by making hole from 42"dia M.S rising main I/c G.I pipe of 3" dia 8Rft including providing and fixing 6" dia sluice valve and also includes the rate of 12" cement concrete 1:2:4 around the pipe and as sleeve concrete foundation and filling the gaps with concrete etc complete				
	For 30"Dia	Each	3	30,000.00	90,000.00
	For 22"Dia	Each	9	20,000.00	180,000.00

10	Refilling the excavated stuff in trenches 6" thick layers I/c watering ramming to full compaction etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	264400.00	3.00	793,200.00
11	Construction of Sluice Valve chamber for the required inner size 5ft x 5ft and 8ft deep including excavation, back filling, 6" thick CC 1:4:8, 9" thick RCC base Ratio 1:2:4 , 12" thick RCC walls , 9" thick RCC top slab Ratio 1:2:4 (with 5lbs steel per cft) i/c 1/2" thick cement plaster inner and outer side of walls surface and top of slab including providing and fixing M.S foot rest at every 18" c/c including 30" dia Cast iron cover with frame (weight 5 cwt) etc complete	Each	3	30,000.00	90,000.00
	TOTAL AMOUNT IN Rs.				**73,907,250.00**
	In Millions				**73.91**
	3% Physical Contingency				**2.22**
	10% Price Contingency				**7.39**
	TOTAL				**83.52**
	20% Contractor Overheads				**16.70**
	3% Construction Supervision				**2.51**
	Grand Total T Rs.				**102.72**

BSWC E-2: DELIVERING FORCE MAINS FROM PUMP HOUSE NEAR LANSDOWNE BRIDGE. PIPES CROSSING SUKKUR SIDE RIVER CHANNEL THROUGH AND OVER PEDESTRIAN SPACE PROVIDED ON BOTH SIDES OF LANSDOWNE BRIDGE

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Dismantling all kinds of Roads, CC, RCC, brick masonry pads	P-Cft	85600.00	20.00	1,712,000.00
2	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	179200.00	10.00	1,792,000.00
3	Manufacturing supplying & fixing MS black steel made out of MS sheet of following dia and thicknesses confirming to API 5L grade X-42 spirally welded (790 psi minimum test pressure for pipe tested at factory i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all tees, bends and elbows if required etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main 10mm wall thickness	P-Rft	1800.00	6,500.00	11,700,000.00
	24"Dia Rising Main 8mm wall thickness	P-Rft	400.00	5,400.00	2,160,000.00
	22"Dia Rising Main 8mm wall thickness	P-Rft	8700.00	4,800.00	41,760,000.00
4	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main	P-Rft	1800.00	500.00	900,000.00
	24"Dia Rising Main	P-Rft	400.00	450.00	180,000.00
	22"Dia Rising Main	P-Rft	8700.00	300.00	2,610,000.00

5	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc complete				
	30"Dia Rising Main	P-Rft	1800.00	750.00	1,350,000.00
	24"Dia Rising Main	P-Rft	400.00	650.00	260,000.00
	22"Dia Rising Main	P-Rft	8700.00	600.00	5,220,000.00
6	Supply and fixing C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported) Approved by Consultant.				
	30"Dia Rising Main	Each	1	300,000.00	300,000.00
	24"Dia Rising Main	Each	1	250,000.00	250,000.00
	22"Dia Rising Main	Each	1	150,000.00	150,000.00
7	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete	P-Cft	1674.40	200.00	334,880.00
8	Providing and fixing supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	24000	200.00	4,800,000.00
9	S/F Double acting air Valve heavy duty 6" dia by making hole from 42"dia M.S rising main I/c G.I pipe of 3" dia 8Rft including providing and fixing 6" dia sluice valve and also includes the rate of 12" cement concrete 1:2:4 around the pipe and as sleeve concrete foundation and filling the gaps with concrete etc complete				
	For 30"Dia	Each	1	30,000.00	30,000.00

	For 22"Dia	Each	9	20,000.00	180,000.00
10	Refilling the excavated stuff in trenches 6" thick layers I/c watering ramming to full compaction etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	264800.00	3.00	794,400.00
11	Construction of Sluice Valve chamber for the required inner size 5ft x 5ft and 8ft deep including excavation, back filling, 6" thick CC 1:4:8, 9" thick RCC base Ratio 1:2:4 , 12" thick RCC walls , 9" thick RCC top slab Ratio 1:2:4 (with 5lbs steel per cft) i/c 1/2" thick cement plaster inner and outer side of walls surface and top of slab including providing and fixing M.S foot rest at every 18" c/c including 30" dia Cast iron cover with frame (weight 5 cwt) etc complete	Each	3	30,000.00	90,000.00
	TOTAL AMOUNT IN Rs.				**76,573,280.00**
	In Millions				**76.57**
	3% Physical Contingency				**2.30**
	10% Price Contingency				**7.66**
	TOTAL				**86.53**
	20% Contractor Overheads				**17.31**
	3% Construction Supervision				**2.60**
	Grand Total Rs.				**106.43**

BSWC E-3: DELIVERING FORCE MAIN FROM PUMP NEAR LANSDOWNE BRIDGE, PIPE CROSSING RIVER OVER PILES

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Dismantling all kinds of Roads, CC, RCC, brick masonry pads	P-Cft	85600.00	20.00	1,712,000.00
2	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	179200.00	10.00	1,792,000.00
3	Manufacturing supplying & fixing MS black steel made out of MS sheet of following dia and thicknesses confirming to API 5L grade X-42 spirally welded (790 psi minimum test pressure for pipe tested at factory i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all tees, bends and elbows if required etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main 10mm wall thickness	P-Rft	1800.00	6,500.00	11,700,000.00
	24"Dia Rising Main 8mm wall thickness	P-Rft	400.00	5,400.00	2,160,000.00
	22"Dia Rising Main 8mm wall thickness	P-Rft	8700.00	4,800.00	41,760,000.00
4	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main	P-Rft	1800.00	500.00	900,000.00
	24"Dia Rising Main	P-Rft	400.00	450.00	180,000.00
	22"Dia Rising Main	P-Rft	8700.00	300.00	2,610,000.00
5	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc.				

	30"Dia Rising Main	P-Rft	1800.00	750.00	1,350,000.00
	24"Dia Rising Main	P-Rft	400.00	650.00	260,000.00
	22"Dia Rising Main	P-Rft	8700.00	600.00	5,220,000.00
6	Supply and fixing C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported) Approved by Consultant.				
	30"Dia Rising Main	Each	1	300,000.00	300,000.00
	24"Dia Rising Main	Each	1	250,000.00	250,000.00
	22"Dia Rising Main	Each	1	150,000.00	150,000.00
7	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete	P-Cft	1721.50	200.00	344,300.00
8	S/F Double acting air Valve heavy duty 6" dia by making hole from 42"dia M.S rising main I/c G.I pipe of 3" dia 8Rft including providing and fixing 6" dia sluice valve and also includes the rate of 12" cement concrete 1:2:4 around the pipe and as sleeve concrete foundation and filling the gaps with concrete etc complete				
	For 30"Dia	Each	1	30,000.00	30,000.00
	For 22"Dia	Each	9	20,000.00	180,000.00
9	Refilling the excavated stuff in trenches 6" thick layers I/c watering ramming to full compaction etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	264800.00	3.00	794,400.00
10	Construction of Sluice Valve chamber for the required inner size 5ft x 5ft and 8ft deep including excavation, back filling, 6" thick CC 1:4:8, 9" thick RCC base Ratio 1:2:4 , 12" thick RCC walls , 9" thick RCC top slab Ratio 1:2:4 (with 5lbs steel per cft) i/c 1/2" thick cement plaster inner and outer side of walls surface and top of slab including providing and fixing M.S foot rest at every 18" c/c including 30" dia Cast iron cover with frame (weight 5 cwt) etc complete	Each	3	30,000.00	90,000.00

11	Piles 36" dia in 1-1-1/2:3 concrete including steel	P-Rft	1920.00	16,000.00	30,720,000.00
12	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	1766.40	400.00	706,560.00
13	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	7.07	120,000.00	847,872.00
14	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	1200.00	200.00	240,000.00
15	Providing and fixing supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	188634.00	300.00	56,590,200.00
	TOTAL AMOUNT IN Rs.				**160,887,332.00**
	In Millions				**160.89**
	3% Physical Contingency				**4.83**
	10% Price Contingency				**16.09**
	TOTAL				**181.80**
	20% Contractor Overheads				**36.36**
	3% Construction Supervision				**5.45**
	Grand Total Rs.				**223.62**

BSWC E-4: DELIVERING FORCE MAINS FROM PUMP HOUSE NEAR LANSDOWNE BRIDGE, PIPE CROSSING BURIED UNDER RIVER BED

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Dismantling all kinds of Roads, CC, RCC, brick masonry pads	P-Cft	85600.00	20.00	1,712,000.00
2	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	221200.00	10.00	2,212,000.00
3	Manufacturing supplying & fixing MS black steel made out of MS sheet of following dia and thicknesses confirming to API 5L grade X-42 spirally welded (790 psi minimum test pressure for pipe tested at factory i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all tees, bends and elbows if required etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main 10mm wall thickness	P-Rft	1800.00	6,500.00	11,700,000.00
	24"Dia Rising Main 8mm wall thickness	P-Rft	400.00	5,400.00	2,160,000.00
	22"Dia Rising Main 8mm wall thickness	P-Rft	8700.00	4,800.00	41,760,000.00
4	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main	P-Rft	1800.00	500.00	900,000.00
	24"Dia Rising Main	P-Rft	400.00	450.00	180,000.00
	22"Dia Rising Main	P-Rft	8700.00	300.00	2,610,000.00

5	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc complete				
	30"Dia Rising Main	P-Rft	1800.00	750.00	1,350,000.00
	24"Dia Rising Main	P-Rft	400.00	650.00	260,000.00
	22"Dia Rising Main	P-Rft	8700.00	600.00	5,220,000.00
6	Supply and fixing C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported) Approved by Consultant.				
	30"Dia Rising Main	Each	1	300,000.00	300,000.00
	24"Dia Rising Main	Each	1	250,000.00	250,000.00
	22"Dia Rising Main	Each	1	150,000.00	150,000.00
7	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete	P-Cft	1930.50	200.00	386,100.00
8	Providing and fixing Stainless Steel Clips including SS nut bolts etc complete all respects	Each	120	10,000.00	1,200,000.00
9	S/F Double acting air Valve heavy duty 6" dia by making hole from 42"dia M.S rising main I/c G.I pipe of 3" dia 8Rft including providing and fixing 6" dia sluice valve and also includes the rate of 12" cement concrete 1:2:4 around the pipe and as sleeve concrete foundation and filling the gaps with concrete etc complete				
	For 30"Dia	Each	1	30,000.00	30,000.00
	For 22"Dia	Each	9	20,000.00	180,000.00

10	Refilling the excavated stuff in trenches 6" thick layers I/c watering ramming to full compaction etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	306800.00	3.00	920,400.00
11	Construction of Sluice Valve chamber for the required inner size 5ft x 5ft and 8ft deep including excavation, back filling, 6" thick CC 1:4:8, 9" thick RCC base Ratio 1:2:4 , 12" thick RCC walls , 9" thick RCC top slab Ratio 1:2:4 (with 5lbs steel per cft) i/c 1/2" thick cement plaster inner and outer side of walls surface and top of slab including providing and fixing M.S foot rest at every 18" c/c including 30" dia Cast iron cover with frame (weight 5 cwt) etc complete	Each	3	30,000.00	90,000.00
	TOTAL AMOUNT IN Rs.				**73,570,500.00**
	In Millions				**73.57**
	3% Physical Contingency				**2.21**
	10% Price Contingency				**7.36**
	TOTAL				**83.13**
	20% Contractor Overheads				**16.63**
	3% Construction Supervision				**2.49**
	Grand Total Rs.				**102.26**

BSWC E-5: DELIVERING PIPES TO LAGOONS FROM EXISTING PUMP HOUSE ON RIGHT BANK FOR STORAGE AND SETTLING OF RAW WATER					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Dismantling all kinds of Roads, CC, RCC, brick masonry pads	P-Cft	40000.00	20.00	800,000.00
2	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	2264000.00	8.00	18,112,000.00
3	Manufacturing supplying & fixing MS black steel made out of MS sheet of following dia and thicknesses confirming to API 5L grade X-42 spirally welded (790 psi minimum test pressure for pipe tested at factory i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all tees, bends and elbows if required etc complete in all respects as per directions of engineer incharge and specifications.				
	42" dia & 10mm wall thickness	P-Rft	28300.00	11,400.00	322,620,000.00
4	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.	P-Rft	28300.00	650.00	18,395,000.00
5	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc complete in all respects as per directions of engineer incharge and specifications.	P-Rft	28300.00	1,100.00	31,130,000.00

6	S/F Double acting air Valve heavy duty 6" dia by making hole from 42"dia M.S rising main I/c G.I pipe of 3" dia 8Rft including providing and fixing 6" dia sluice valve and also includes the rate of 12" cement concrete 1:2:4 around the pipe and as sleeve concrete foundation and filling the gaps with concrete etc complete all respects as per directions of engineer incharge and specifications.	Job	30	50,000.00	1,500,000.00
7	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:4:8 including shuttering etc complete in all respects as per directions of engineer incharge and as per specifications.	P-Cft	2000.00	150.00	300,000.00
8	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	5400.00	200.00	1,080,000.00
9	Refilling the excavated stuff in trenches 6" thick layers I/c watering ramming to full compaction etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	1958400.00	3.00	5,875,200.00
				TOTAL AMOUNT IN Rs.	**399,812,200.00**
				In Millions	**399.81**
				3% Physical Contingency	**11.99**
				10% Price Contingency	**39.98**
				TOTAL	**451.79**
				20% Contractor Overheads	**90.36**
				3% Construction Supervision	**13.55**
				Grand Total Rs.	**555.70**

BSWC E-6 DELIVERING PIPES TO LAGOONS FROM EXISTING PUMP HOUSE ON RIGHT BANK FOR STORAGE AND SETTLING OF RAW WATER

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Dismantling all kinds of Roads, CC, RCC, brick masonry pads	P-Cft	70000.00	20.00	1,400,000.00
2	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	1939000.00	6.00	11,634,000.00
3	Manufacturing supplying & fixing MS black steel made out of MS sheet of following dia and thicknesses confirming to API 5L grade X-42 spirally welded (790 psi minimum test pressure for pipe tested at factory i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all tees, bends and elbows if required etc complete in all respects as per directions of engineer incharge and specifications.				
	42"Dia Rising Main 10mm wall thickness	P-Rft	19000.00	11,500.00	218,500,000.00
	36"Dia Rising Main 10mm wall thickness	P-Rft	9500.00	9,750.00	92,625,000.00
	18"Dia Rising Main 6.4mm wall thickness	P-Rft	1000.00	3,500.00	3,500,000.00
4	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.				
	42"Dia Rising Main	P-Rft	19000.00	650.00	12,350,000.00
	36"Dia Rising Main	P-Rft	9500.00	500.00	4,750,000.00
	18"Dia Rising Main	P-Rft	1000.00	250.00	250,000.00

5	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc complete				
	42"Dia Rising Main	P-Rft	19000.00	1,100.00	20,900,000.00
	36"Dia Rising Main	P-Rft	9500.00	1,000.00	9,500,000.00
	18"Dia Rising Main	P-Rft	1000.00	400.00	400,000.00
6	Supply and fixing C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported) Approved by Consultant.				
	For 42"Dia Rising Main	Each	1	500,000.00	500,000.00
	For 36"Dia Rising Main	Each	1	350,000.00	350,000.00
	For 18"Dia Rising Main	Each	1	150,000.00	150,000.00
7	S/F Double acting air Valve heavy duty 6" dia by making hole from 42"dia M.S rising main I/c G.I pipe of 3" dia 8Rft including providing and fixing 6" dia sluice valve and also includes the rate of 12" cement concrete 1:2:4 around the pipe and as sleeve concrete foundation and filling the gaps with concrete etc complete				
	For 42"Dia Rising Main	Each	20	50,000.00	1,000,000.00
	For 36"Dia Rising Main	Each	10	40,000.00	400,000.00
	For 18"Dia Rising Main	Each	1	25,000.00	25,000.00
8	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:4:8 including shuttering etc complete	P-Cft	2000.00	150.00	300,000.00

9	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete	P-Cft	24000.00	200.00	4,800,000.00
10	Refilling the excavated stuff in trenches 6" thick layers I/c watering ramming to full compaction etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	20400.00	3.00	61,200.00
11	Construction of Sluice Valve chamber for the required inner size 5ft x 5ft and 8ft deep including excavation, back filling, 6" thick CC 1:4:8, 9" thick RCC base Ratio 1:2:4 , 12" thick RCC walls , 9" thick RCC top slab Ratio 1:2:4 (with 5lbs steel per cft) i/c 1/2" thick cement plaster inner and outer side of walls surface and top of slab including providing and fixing M.S foot rest at every 18" c/c including 30" dia Cast iron cover with frame (weight 5 cwt) etc complete	Each	3	30,000.00	90,000.00

TOTAL AMOUNT IN Rs.	**383,485,200.00**
In Millions	**383.49**
3% Physical Contingency	**11.50**
10% Price Contingency	**38.35**
TOTAL	**433.34**
20% Contractor Overheads	**86.67**
3% Construction Supervision	**13.00**
Grand Total Rs.	**533.01**

BSWC E-7: DELIVERING PIPES FROM INFILTRATION GALLERIES PUMP HOUSE TO WTPs

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Dismantling all kinds of Roads, CC, RCC, brick masonry pads	P-Cft	56000.00	20.00	1,120,000.00
2	Excavation for pipe lines in trenches and pits in all kind of soils	P-Cft	488000.00	6.00	2,928,000.00
3	Manufacturing supplying & fixing MS black steel made out of MS sheet of following dia and thicknesses confirming to API 5L grade X-42 spirally welded (790 psi minimum test pressure for pipe tested at factory i/c jointing, welding and laying in trenches i/c testing with water minimum 300 psi pressure i/c cost of all tees, bends and elbows if required etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main 10mm wall thickness	P-Rft	10500.00	6,500.00	68,250,000.00
	18"Dia Rising Main 6.4mm wall thickness	P-Rft	2350.00	3,500.00	8,225,000.00
4	Providing, making cement lining (Ratio 1:1) of minimum 8mm thickness on inside surface of the pipes, i/c curing, cleaning of internal surface and workmanship as per AWW4 AC 602-83 Table -1 and pipe ends to be kept capped with PVC sheet to retain moisture etc complete in all respects as per directions of engineer incharge and specifications.				
	30"Dia Rising Main	P-Rft	10500.00	500.00	5,250,000.00
	18"Dia Rising Main	P-Rft	2350.00	250.00	587,500.00

5	Sand blasting of the steel pipe surface and providing / laying of protective coating on the outer surface of the steel pipe with approved fibre glass mat in two layers along with synthetic primer for bonding on bare pipe surface and 6 mm thick hot bitumen coating etc complete				
	30"Dia Rising Main	P-Rft	10500.00	750.00	7,875,000.00
	18"Dia Rising Main	P-Rft	2350.00	400.00	940,000.00
6	Supply and fixing C.I Sluice Valve heavy duty pattern test pressure 21.0 kg/c.m (imported) Approved by Consultant.				
	For 30"Dia Rising Main	Each	1	300,000.00	300,000.00
	For 18"Dia Rising Main	Each	1	150,000.00	150,000.00
7	S/F Double acting air Valve heavy duty 6" dia by making hole from 42"dia M.S rising main I/c G.I pipe of 3" dia 8Rft including providing and fixing 6" dia sluice valve and also includes the rate of 12" cement concrete 1:2:4 around the pipe and as sleeve concrete foundation and filling the gaps with concrete etc complete				
	For 30"Dia Rising Main	Each	11	40,000.00	440,000.00
	For 18"Dia Rising Main	Each	2	25,000.00	50,000.00
8	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:4:8 including shuttering etc complete	P-Cft	400.00	150.00	60,000.00
9	Cement concrete plain including placing compacting finishing and curing complete I/c washing of aggregates Ratio 1:2:4 including shuttering etc complete	P-Cft	4800.00	200.00	960,000.00

10	Refilling the excavated stuff in trenches 6" thick layers I/c watering ramming to full compaction etc complete in all respects as per directions of engineer incharge and specifications.	P-Cft	462400.00	3.00	1,387,200.00
11	Construction of Sluice Valve chamber for the required inner size 5ft x 5ft and 8ft deep including excavation, back filling, 6" thick CC 1:4:8, 9" thick RCC base Ratio 1:2:4 , 12" thick RCC walls , 9" thick RCC top slab Ratio 1:2:4 (with 5lbs steel per cft) i/c 1/2" thick cement plaster inner and outer side of walls surface and top of slab including providing and fixing M.S foot rest at every 18" c/c including 30" dia Cast iron cover with frame (weight 5 cwt) etc complete	Each	2	30,000.00	60,000.00
	TOTAL AMOUNT IN Rs.				**98,582,700.00**
	In Millions				**98.58**
	3% Physical Contingency				**2.96**
	10% Price Contingency				**9.86**
	TOTAL				**111.40**
	20% Contractor Overheads				**22.28**
	3% Construction Supervision				**3.34**
	Grand Total Rs.				**137.02**

BSWC-F: CONSTRUCTION OF LAGOONS					
S-NO	**DESCRIPTIONS**	**UNIT**	**QTY**	**RATE**	**AMOUNT**
1	Excavation for tanks and reservoirs in all kind of soils +Cartage etc	P-Cft	10266966.11	5.00	51,334,830.54
2	Filling excavated Earth on bunds and in Beds of lagoons etc complete	P-Cft	9755883.05	3.00	29,267,649.16
3	Earth work compaction by sheep Foot Roller and Power Roller with optimum moisture content (a) For 95-100% modified AASHO density	P-Cft	9755883.05	2.00	19,511,766.11
4	0.5mm Thick Geo Membrane sheet	P-Sft	5538300.05	25.00	138,457,501.35
5	Stone Pitching	P-Cft	547050.00	60.00	32,823,000.00
6	2" thick Fibber Reinforced Concrete over Stone pitching	P-Sft	547050.00	60.00	32,823,000.00
7	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	920.00	150.00	138,000.00
8	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	6187.50	400.00	2,475,000.00
9	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	12.38	120,000.00	1,485,000.00

10	Providing , Laying and Jointing 30" dia black steel M.S pipe of API 5L of X-42 grade (790 psi) pipe tested at factory made out of M.S sheet of 10 mm thick of approved manufacturer i/c jointing, welding etc complete in all respects as per directions of engineer incharge and specifications.	P-Rft	240.00	6,500.00	1,560,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs. (A)				**309,875,747.16**
11	Cost of Land (B)	P-Acre	140.00	1,000,000.00	**140,000,000.00**
	TOTAL AMOUNT IN Rs. (A+B)				**449,875,747.16**
	IN MILLIONS				**449.88**
	3% Physical Contingency				**13.50**
	10% Price Contingency				**44.99**
	TOTAL				**508.36**
	20% Contractor Overheads				**101.67**
	3% Construction Supervision				**15.25**
	Grand Total				**625.28**

BSWC-G: CONSTRUCTION OF INFILTRATION GALLERIES

S.No	ITEM	UNIT	QTY	RATE	AMOUNT
1	Excavation in all kinds of soils	Cft	1,080,000.00	10.00	10,800,000.00
2	Bailing out sub soil water during excavation	P-Hr	500.00	1,000.00	500,000.00
3	Providing, laying & jointing of perforated uPVC 12" dia pipe in trenches i/c all bends, specials, etc	Rft	32,000.00	1,000.00	32,000,000.00
4	Supplying & laying Filter Media (Gravel) Size 40mm to 60mm	Cft	360,000.00	10.00	3,600,000.00
5	Providing, laying & jointing Geo-membrane sheet in trenches	Sft	448,000.00	25.00	11,200,000.00
6	Providing and laying cast in-situ RCC cement concrete ration 1:1-1/2:3 in S.R cement	Cft	136,290.00	400.00	54,516,000.00
7	Fabrication of steel reinforcement of grade 60	Ton	272.58	120,000.00	32,709,600.00
8	Construction of construction path 20' wide 3' deep made of Morum material	Cft	240,000.00	40.00	9,600,000.00
	COST OF FULL SCALE PROJECT				**154,925,600.00**
	In Millions				**154.93**
	3% Physical Contingency				**4.65**
	10% Price Contingency				**15.49**
	TOTAL				**175.07**
	20% Contractor Overheads				**35.01**
	3% Construction Supervision				**5.25**
	Grand Total Rs.				**215.33**

PILOT PROJECT INFILTRATION GALLERIES TO PRODUCE 50,000 GALLONS PER DAY

COST OF PILOT PROJECT	**4.99**
3% Physical Contingency	**0.15**
10% Price Contingency	**0.50**
TOTAL	**5.64**
20% Contractor Overheads	**1.13**
3% Construction Supervision	**0.17**
Grand Total Rs.	**6.94**

BSWC-H: ELECTRICAL AND MECHANICAL WORK AT INTAKE PUMPING STATION P/S DEEP WELL TURBINE WITH ACCESSORIES (REQUIRED TILL 2012)

S-NO	DESCRIPTIONS	QTY	UNIT	RATE	AMOUNT
1	Supply & Install DWT vertical turbine KSB pump with electric motor (Siemens), 200ft head, Discharge 3150 IGPM, working depth 30 feet including motor control panel (starter) etc complete as per drawing or direction of engineer incharge.	3	No	5,000,000.0	15,000,000.0
2	Providing & fixing of 12" dia M.S pipe having 6.4mm wall thickness including bends etc complete as per drawing or direction by the engineer incharge.	60	P-Rft	7,000.0	420,000.0
3	Providing, welding and jointing of 12" dia M.S Flanges 6.4mm i/c providing rubber packing etc i/c nut bolts etc complete in all respects as per directions of engineer incharge.	180	P-Kg	500.0	90,000.0
4	Providing and fixing 12"dia Sluice valve (Foreign Made) approved by Engineer incharge.	3	No	500,000.0	1,500,000.0
5	Providing and fixing 12" dia Non-Return valve (Foreign Made) approved by Engineer incharge.	3	No	350,000.0	1,050,000.0
6	Supply & Install 42" dia M.S pipe 6.4mm Manifold with dead end plate, bends, Air valve, pressure meter and connection with delivery pipes etc complete in all respects as per directions of engineer incharge.	500	Rft	15,000.0	7,500,000.0
7	Supply and install digital flow meter 50 MGD as per approval of consultants	2	No	1,500,000.0	3,000,000.0
8	Supply, Installation, Testing of 1500 KVA transformer (Seimens or equivalent) 11 KVA/415 volts 3phase 4 wire system 50 Hz, oil immersed and naturally air cooled as per WAPDA requirement or approval/NOC . (from pole to building cost of cable is not included)	1	Job	4,500,000.0	4,500,000.0

9	Connection of 11 KV from nearest 11 KV line including all expenses Of WAPDA pay for demand notes and security etc complete as per WAPDA specification or instruction of engineer incahrge.	1	Job	5,000,000.0	5,000,000.0
10	Supply, Installation, testing and commissioning of 1500 KVA Diesel Generator (Siemens or Equivalent) . The Generator 415/220 volts, 50Hz, 1500 RPM, 0.8 power factor, 3-phase four wire system, including manual change over panel complete with all control wiring between DG set and change over panel, civil works for foundation etc i/c providing & fixing extra 2000 gallon capacity fuel tank including electric fuel pump, fuel lines etc complete as per direction of engineer incharge.	1	Job	36,000,000.0	36,000,000.0
11	Supply, installation and testing of the VCB panel 11 kv approved by the HESCO or as per direction of engineer incharge.	1	Job	2,000,000.0	2,000,000.0
12	Supply, installation and testing of the main Distribution panel. The Panel is to be installed in sub-station room. The main panel comprises of bus bar, incoming voltage meter, Ammeter, phase indicator bulbs (red, yellow and blue).Panel's earth bus bar solidly grounded. The sheet metal work of panel shall be minimum 2mm thickness powder coated. etc complete as per drawing and direction of Engineer incharge.The distribution panels to contain following accessories.				
	1- Main circuit Breaker 2500 Amp (three phase) 415 Volt 1 No (adjustable Type)				
	2- Molded case circuit Breaker 800 Amp (Three Phase) 415 Volt 6 No (adjustable Type)				
	3- Molded case circuit Breaker 400 Amp (Three Phase) 415 Volt 1 No (adjustable Type)				
	4- Molded case circuit Breaker 100 Amp (Three Phase) 415 Volt 1 No (adjustable Type)				
	5- Molded case circuit Breaker 60 Amp (Three Phase) 415 Volt 1 No (adjustable Type)				
	6- Molded case circuit Breaker 50 Amp (Three				

	Phase) 415 Volt 1 No (adjustable Type)				
	7- Power factor improvement plant	1	Job	2,000,000.0	2,000,000.0
13	Supply, laying, testing and commissioning of following sizes of single core / multi core PVC insulated and PVC sheathed, armored / unarmored / XLPE copper conductor cables in concealed PVC conduit or ground PVC pipe or on cable tray for power and miscellaneous wiring including cost of PVC pipe ,tee, elbow etc, as per direction of Engineer incharge. (Excluding cable tray cost)				
a	*3 core 95 sq.mm PVC/XLPE/PVC/*	50	Meter	15,000.0	750,000.0
b	*Single core 240 sq.mm CU/PVC/PVC*	2500	Meter	6,000.0	15,000,000.0
c	*1 core 630 sq.mm CU/PVC/PVC*	350	Meter	15,000.0	5,250,000.0
d	*3.5 core 150 sq.mm CU/PVC/PVC*	15	Meter	8,000.0	120,000.0
e	*3.5 core 70 sq.mm CU/PVC/PVC*	15	Meter	7,000.0	105,000.0
f	*3.5 core 25sq.mm CU/PVC/PVC*	15	Meter	2,600.0	39,000.0
g	*3.5 core 50 sq.mm CU/PVC/PVC*	30	Meter	5,000.0	150,000.0
h	*3.5 core 35 sq.mm CU/PVC/PVC*	20	Meter	4,000.0	80,000.0
i	*4 core 4 sq.mm CU/PVC/PVC*	500	Meter	150.0	75,000.0
j	*1 core 70 sq.mm CU/PVC/PVC*	300	Meter	1,500.0	450,000.0
14	Provide and fixing local control switch made of stainless steel with pleasing look water proof and dust proof with ON, OFF, TRIP switches, volt meter, ampere meter , including indication lamps etc complete as per direction of engineer incharge.	3	Job	200,000.0	600,000.0
15	Supply & Installation of lighting D.B, complete with 100A 3-Phase circuit breaker,10 to 32A miniature circuit breakers, 15 Nos., complete with incoming phase indicator bulbs (red, yellow, blue).etc complete in all respects as per drawing and direction by the engineer incharge.	1	Job	200,000.0	200,000.0

16	Supply and installation of earth electrode consisting of 24" x 24" x 6mm thick copper plate buried 20 ft deep under ground or to the depth of water level which ever is less and surrounded by mixture of charcoal and salt in 3:1 ratio, minimum 36" x 36" area. The job shall be completed in all respect including digging of earth pit and refilling with sand & complete with fixing all accessories like stainless steel nut-bolts, washer etc & making inspection chamber 12 x 12 inch with C.I cover etc i/c 2x70mm^2 copper earthing leads laid in 50mm PVC conduit etc complete as per direction of engineer incharge.	8	Job	75,000.0	600,000.0
17	Supply & Installation of Wiring for light / fan point with 3 x 1 x 1.5 sqmm PVC insulated wire in 20mm PVC conduit/channel on surface as required etc complete as per direction of engineer incharge	60	Each	1,500.0	90,000.0
18	Supply & Installation of Wiring for main with 3 x 1 x 2.5 sqmm Pvc insulated wire 20mm Pvc conduit / channel as required as etc complete fittings as per direction of engineer incharge.	500	Meter	100.0	50,000.0
19	Supply & Installation Wiring for main power plug with 3 x 1 x 4 sqmm Pvc insulated wire in 38mm Pvc conduit / channel .as required as etc complete fittings as per direction of engineer incharge.	300	Meter	150.0	45,000.0
20	Supplying & Installation TMS Tube light 1x40 watts with Iron frame complete with reflector, & all accessories made of Philips.	48	Nos	2,000.0	96,000.0
21	Supplying & Installation 24" dia sweep exhaust fan complete as required. (Pak Fan) with butterfly shutters .	8	Nos	5,000.0	40,000.0
22	Supply and installation of ceiling fans 56", complete with wiring, fixing hook and down rod etc complete as per direction of engineer incharge	4	Nos	5,000.0	20,000.0

23	Supply & Installation of Perforated type of cable tray Size 800 mm width & 100mm high with cover, made with galvanized iron 16 SWG complete with installation on brackets / suspension rods in all respects. Cost of tees, elbows, riser etc to be included in this item if any.	200	Meters	5,000.0	1,000,000.0
24	Supply & Installation of Perforated type of cable tray Size 600 mm width & 100mm high with cover, made with galvanized iron 16 SWG complete with installation on brackets / suspension rods in all respects. Cost of tees, elbows, riser etc to be included in this item if any.	200	Meters	4,000.0	800,000.0
	TOTAL AMOUNT OF Rs.				**103,620,000.0**
	IN MILLIONS				**103.62**
	3% Physical Contingency				**3.11**
	10% Price Contingency				**10.36**
	TOTAL				**117.09**
	20% Contractor Overheads				**23.42**
	3% Construction Supervision				**3.51**
	GRAND TOTAL Rs.				**144.02**

BSWC I-1: ACCESS TO IPS ON LANSDOWNE BRIDGE (LIFTING EQUIPMENT & STAIRS)					
S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Excavation in foundations	P-Cft	4900.00	10.00	49,000.00
2	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	490.00	150.00	73,500.00
3	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	3208.50	400.00	1,283,400.00
4	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	4.81	120,000.00	577,530.00
5	Providing and fixing supports steel structures i/c girders, channels, angles including cutting fabrication plates including fixing on concrete with bolts pulleys, lifting chains, round bars, channels etc complete three coats of ICI paint complete with all respects as per directions of engineer incharge	P-Kg	7260.00	300.00	2,178,000.00
6	Providing and fixing 5 ton capacity manual crane.	Job	1	500,000.00	500,000.00
7	Providing transport trolley rails fixed on concrete bed with Electric operative winching machine for heavy equipments from down side to upside	P-Rft	300	1,000.00	300,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**4,961,430.00**
	IN MILLIONS				**4.96**
	3% Physical Contingency				**0.15**
	10% Price Contingency				**0.50**
	TOTAL				**5.61**
	20% Contractor Overheads				**1.12**
	3% Construction Supervision				**0.17**
	Grand Total Rs.				**6.90**

BSWC I-2: ACCESS TO IPS AT BUKKUR ISLAND (ROAD AND PEDESTRIAN BRIDGE)

S-NO	DESCRIPTIONS	UNIT	QTY	RATE	AMOUNT
1	Excavation in foundations	P-Cft	1500.00	10.00	15,000.00
2	Cement concrete plain including placing compacting finishing 1:4:8	P-Cft	150.00	150.00	22,500.00
3	Providing and laying Cast-in-situ RCC cement concrete Ratio 1: 1-1/2:3 in sulphate resistant cement (having compressive strength 5000 psi after 28 days)	P-Cft	1186.80	400.00	474,720.00
4	Fabrication of steel reinforcement of Grade 60 having tensile strength of 60000 psi for cement concrete	P-Ton	3.56	120,000.00	427,248.00
5	Proving, fixing and welding 16 gauge MS steel pipe hand railing comprising 2" dia top rail 2" dia 2 nos middle rail and 2" dia balustrade & 3 coats ICI paint.	P-Kg	900.00	200.00	180,000.00
6	Cement concrete Road	P-Sft	20000.00	250.00	5,000,000.00
	TOTAL AMOUNT OF CIVIL WORK IN Rs.				**6,119,468.00**
	IN MILLIONS				**6.12**
	3% Physical Contingency				**0.18**
	10% Price Contingency				**0.61**
	TOTAL				**6.91**
	20% Contractor Overheads				**1.38**
	3% Construction Supervision				**0.21**
	Grand Total Rs.				**8.51**

6.3 OPERATION AND MAINTENANCE (O&M) COSTS

OPERATION AND MAINTENANCE COSTS FOR OPTION 5.1: INTAKE WORKS ON FAR SIDE OF BUKKUR ISLAND OPTION 5.2: INTAKE WORKS ON DOWNSTREAM SIDE OF EXISTING IPS OPTION 5.3: INTAKE WORKS ON UPSTREAM SIDE OF LANSDOWNE BRIDGE ON BUKKUR ISLAND		
MAIN SUMMARY		
S/No	**DESCRIPTION**	**TOTAL AMOUNT Per DAY in Rs.**
1	ENERGY/ELECTRICITY COST (12 WORKING HOURS)	319,049
2	DIESEL, OIL AND LUBRICANT (24 WORKING HOURS) FOR 8 NOS TURBINES	718,224
3	O/M COST OF TURBINES-ELECTRICAL EQUIPMENTS AND CIVIL WORKS PER DAY	22,660
4	MANPOWER COSTS PER DAY	16,701
	TOTAL AMOUNT Rs.	**1,076,635**
	TOTAL AMOUNT PER GALLON	**0.0299**
	TOTAL AMOUNT PER 1000 GALLON	**29.91**

NOTES:

1. *O&M costs are for supply of water upto Battery limit of Water Treatment Plants.*
2. *O&M costs are based on 12 hrs operation on Electricity and 12 hrs operation on DG sets.*
3. *O&M costs are based on Energy, Diesel, Civil works and Manpower costs as prevailing in month of Nov-2011*

OPERATION AND MAINTENANCE COSTS FOR
OPTION 5.1: INTAKE WORKS ON FAR SIDE OF BUKKUR ISLAND
OPTION 5.2: INTAKE WORKS ON DOWNSTREAM SIDE OF EXISTING IPS
OPTION 5.3: INTAKE WORKS ON UPSTREAM SIDE OF LANSDOWNE BRIDGE ON BUKKUR ISLAND

ENERGY/ELECTRICITY COST FOR 36 MGD(INTAKE P/STATION)

S.NO	DESCRIPTION	NO	HORSE POWER	WORKING HOURS	TOTAL HP
1	TURBINES	8	270	12	25920
2	LIGHTING AND MISCELENOUSE 10%				2592
			TOTAL HP		**28,512.00**

S.NO	DESCRIPRION	HP	CONVERSION FACTOR	WORKING DAYS	UNITS
1	ENERGY CHARGES	28512	0.746	1	21269.952
			RATE / UNIT		**15.00**
			TOTAL AMOUNT RS.		**319,049.28**

Annual Consumable Cost							
DIESEL, OIL AND LUBRICANT (12 WORKING HOURS) FOR 8 NOS TURBINES							
S.NO	**DESCRIPTION**	**UNIT**	**MONTH**	**QTY**	**T-QTY**	**RATE**	**AMOUNT**
1	Diesel consumption 297 liters per hour (12 hrs daily) (12 X 297 X 30 = 106920)	P liters	12	106920	1283040	100	128,304,000.00
2	Mobil Oil change @ 360 hours operation (12x30=360)	P liters	12	270	3240	300	972,000.00
3	Maintenance and service cost @ 5% of purchase cost of (36,000,000 each) per annum						1,800,000.00
			TOTAL AMOUNT PER YEAR				131,076,000
			2 NOS DG SET				262,152,000
			TOTAL COST PER DAY (12 HOURS)				718,225

O/M OF TURBINES-ELECTRICAL EQUIPMENTS AND CIVIL WORKS (PER ANUM)					
S.NO	**DESCRIPTION**	**%ge rate**	**AMOUNT**	**UNIT**	**AMOUNT**
1	R/M of machinery turbines and electrical equipments etc @ 5% of estimated cost	5	144,021,438.00	100	7,201,072
2	R/M of civil work of P/station and substation @ 3% of estimated cost	3	35,660,000.00	100	1,069,800
	Total Amount in Rs.				**8,270,872**
	TOTAL COST PER DAY				**22,660**

MANPOWER					
S.No	**OFFICIAL**	**NOS**	**SALARY/ MONTH**	**MONTHS**	**AMOUNT**
1	Electrical supervisor	4	20000	12	960,000
2	Mechanical Supervisor	4	20000	12	960,000
3	Operator (3 x 4)	12	12000	12	1,728,000
4	Shift incharge	4	35000	12	1,680,000
5	Helpers (2 X 4)	8	8000	12	768,000
	TOTAL AMOUNT PER YEAR				**6,096,000**
	TOTAL COST PER DAY				**16,701**

OPERATION AND MAINTENANCE COSTS FOR

OPTION 5.4: CONSTRUCTION OF 270 MG STORAGE LAGOONS AND INTAKE WORKS WITH REHABILITATION OF EXISTING IPS

S/No	DESCRIPTION	Total Amount per Day in Rs.
1	ENERGY/ELECTRICITY COST (12 WORKING HOURS)	638,098.560
2	DIESEL, OIL AND LUBRICANT (12 WORKING HOURS) FOR 8 NOS TURBINES	1,436,449.315
3	O/M COST OF TURBINES-ELECTRICAL EQUIPMENTS AND CIVIL WORKS PER DAY	83,391.901
4	MANPOWER COSTS PER DAY	36,558.904
	TOTAL AMOUNT PER DAY RS.	**2,194,498.68**
	TOTAL AMOUNT PER GALLON	**0.06**
	TOTAL AMOUNT PER 1000 GALLON	**60.96**

.

NOTES:

1. *O&M costs are for supply of water upto Battery limit of Water Treatment Plants.*
2. *O&M costs are based on 12 hrs operation on Electricity and 12 hrs operation on DG sets.*
3. *O&M costs are based on Energy, Diesel, Civil works and Manpower costs as prevailing in month of Nov-2011*

OPERATION AND MAINTENANCE COSTS FOR

OPTION 5.4: CONSTRUCTION OF 270 MG STORAGE LAGOONS AND INTAKE WORKS WITH REHABILITATION OF EXISTING IPS

ENERGY/ELECTRICITY COST FOR 36 MGD (INTAKE P/STATION)

S.NO	DESCRIPTION	NO	HORSE POWER	WORKING HOURS	TOTAL HP
1	TURBINES	8	270	12	25920
2	LIGHTING AND MISCELENOUSE 10%				2592
				TOTAL HP	**28,512.00**

S.NO	DESCRIPRION	HP	CONVERSION FACTOR	WORKING DAYS	UNITS
1	ENERGY CHARGES	28512	0.746	1	21269.952
				RATE / UNIT	**15.00**
				TOTAL AMOUNT RS.	**319,049.28**
				TOTAL COST OF 2 Nos PUMPING STATION	**638,092.56**

ANNUAL CONSUMABLE COST

DIESEL, OIL AND LUBRICANT (12 WORKING HOURS) FOR 8 NOS TURBINES

S.NO	DESCRIPTION	UNIT	MONTH	QTY	T-QTY	RATE	AMOUNT
1	Diesel consumption 297 liters per hour (12 hrs daily) (12 X 297 X 30 = 106920)	P liters	12	106920	1283040	100	128,304,000.00
2	Mobil Oil change @ 360 hours operation (12x30=360)	P liters	12	270	3240	300	972,000.00
3	Maintenance cost and service cost @ 5% of purchase cost of DG set (3,600,000 each) per annum						1,800,000.00
			TOTAL AMOUNT PER YEAR				131,076,000
			TOTAL AMOUNT PER YEAR (4 NOS DG SET)				425,304,000
			TOTAL COST PER DAY (12 HOURS)				1,436,449

O/M COST OF TURBINES-ELECTRICAL EQUIPMENTS AND CIVIL WORKS (PER ANUM)

S.NO	DESCRIPTION	%ge rate	AMOUNT	UNIT	AMOUNT
1	R/M of machinery turbines and electrical equipments etc @ 5% of estimated cost (2 sets)	5	288,042,876.00	100	14,402,144
2	R/M of civil work of lagoon @ 3% of estimated cost	3	485,280,000.00	100	14,558,400
3	R/M of civil work of P/station and substation @ 3% of estimated cost	3	22,840,000.00	100	685,200
4	R/M of civil work of existing P/station @ 3% of estimated cost	3	26,410,000.00	100	792,300
	Total Amount in Rs.				**30,438,044**
	TOTAL COST PER DAY				**83,392**

MANPOWER COSTS

S.No	OFFICIAL	NOS	SALARY/ MONTH	MONTHS	AMOUNT
1	Electrical supervisor	4	20000	12	960,000
2	Mechanical Supervisor	4	20000	12	960,000
3	Operator (3 x 4)	12	12000	12	1,728,000
4	Shift incharge	4	35000	12	1,680,000
5	Helpers (2 X 4)	8	8000	12	768,000
6	Labour (1 X 8)	8	6000	12	576,000
	TOTAL AMOUNT PER YEAR				**6,672,000**
	TOTAL COST PER DAY				**18,279**
	TOTAL COST OF 2 Nos PUMP STATIONS				**36,559**

OPERATION AND MAINTENANCE COSTS FOR OPTION 5.5: CONSTRUCTION OF INFILTRATION GALLERIES AND ALLIED WORKS		
S/No	**DESCRIPTION**	**TOTAL AMOUNT PER (Thousand Gallon) in Rs.**
1	ENERGY/ELECTRICITY COST (12 WORKING HOURS)	319,049
2	DIESEL, OIL AND LUBRICANT (12 WORKING HOURS) FOR 8 NOS TURBINES	718,224
3	O/M COST OF TURBINES-ELECTRICAL EQUIPMENTS AND CIVIL WORKS PER DAY	37,427
4	MANPOWER COSTS PER DAY	16,701
	TOTAL AMOUNT RS.	**1,091,402**
	TOTAL AMOUNT PER GALLON	**0.03**
	TOTAL AMOUNT PER 1000 GALLON	**30.32**

NOTES:

1. *O&M costs are for supply of water upto Battery limit of Water Treatment Plants.*
2. *O&M costs are based on 12 hrs operation on Electricity and 12 hrs operation on DG sets.*
3. *O&M costs are based on Energy, Diesel, Civil works and Manpower costs as prevailing in month of Nov-2011*

ENERGY/ELECTRICITY COST FOR 36 MGD(INTAKE P/STATION)

S.NO	DESCRIPTION	NO	HORSE POWER	WORKING HOURS	TOTAL HP
1	TURBINES	8	270	12	25920
2	LIGHTING AND MISCELENOUSE 10%				2592
			TOTAL HP		**28,512.00**

S.NO	DESCRIPRION	HP	CONVERSION FACTOR	WORKING DAYS	UNITS
1	ENERGY CHARGES	28512	0.746	1	21269.952
			RATE / UNIT		**15.00**
			TOTAL AMOUNT RS.		**319,049.28**

ANNUAL CONSUMABLE COST

DIESEL, OIL AND LUBRICANT (12 WORKING HOURS) FOR 8 NOS TURBINES

S.NO	DESCRIPTION	UNIT	MONTH	QTY	T-QTY	RATE	AMOUNT
1	Diesel consumption 297 liters per hour (12 hrs daily) (12 X 297 X 30 = 106920)	P liters	12	106920	1283040	100	128,304,000.00
2	Mobil Oil change @ 360 hours operation (12x30=360)	P liters	12	270	3240	300	972,000.00
3	Maintenance and service cost @ 5% of purchase cost of DG set (36,000,000 each) per annum						1,800,000.00
			TOTAL AMOUNT PER YEAR				131,076,000
			2 NOS DG SET				262,152,000
			TOTAL COST PER DAY (12 HOURS)				718,225

O/M OF TURBINES-ELECTRICAL EQUIPMENTS AND CIVIL WORKS (PER ANUM)

S.NO	DESCRIPTION	%ge rate	AMOUNT	UNIT	AMOUNT
1	R/M of machinery turbines and electrical equipments etc @ 5% of estimated cost	5	144,021,438.00	100	7,201,072
2	R/M of civil work @ 3% of estimated cost	3	215,330,000.00	100	6,459,900
3	R/M of civil work of P/station and substation @ 3% of estimated cost	3	34,990,000.00	100	1,049,700
	Total Amount in Rs.				**13,660,972**
	TOTAL COST PER DAY				**37,427**

MANPOWER

S.No	OFFICIAL	NOS	SALARY/ MONTH	MONTHS	AMOUNT
1	Electrical supervisor	4	20000	12	960,000
2	Mechanical Supervisor	4	20000	12	960,000
3	Operator (3 x 4)	12	12000	12	1,728,000
4	Shift incharge	4	35000	12	1,680,000
5	Helpers (2 X 4)	8	8000	12	768,000
	TOTAL AMOUNT PER YEAR				**6,096,000**
	TOTAL COST PER DAY				**16,701**

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HYDROLOGICAL & HYDROGEOLOGICAL INVESTIGATION REPORT

1. INTRODUCTION

1.1 OBJECTIVES OF THE REPORT

Following are objectives of this report;

i. Gather existing maps, charts and information about the River Indus water levels and flows (at least 50 Years). Conduct field studies to gather additional information where existing information is inadequate or unavailable.
ii. Based on historic river flow data of last 50 years, carry out analysis of low flow data suitable for reliable urban water supply for 1.8 million population for 2050.
iii. Provide estimates of projected low flows for 1 year, 2 year, 5 year, 10 year and 20 year return periods. Estimates should be provided for monthly, weekly and daily low flows.
iv. Provide estimates of projected high flows for 1 year, 2 year, 5 year, 10 year, 20 year, 50 year and 100 year return periods. Estimates should be provided for monthly, weekly, and daily high flows to plan in case intake structure is submerged and inaccessible.
v. Provide estimated daily flow duration curves from monthly stream flow data at the proposed intake side and at Sukkur barrage.
vi. Examine and report of the effects of Sukkur barrage gate opening and diversions on the available low water level for water supply.
vii. Examine and report on the long term aspects of River Indus low flows particularly due to global warming.
viii. Prepare and submit combined hydrological report on the above issues.
ix. Based on on-going test wells and ERS in Rohri, etc make estimate for available capacity for water supply to Sukkur, taking account of the fact that Rohri town will intend to exploit ground water to supply its population of above 75,000 persons in the present Trenche-I works and that there is

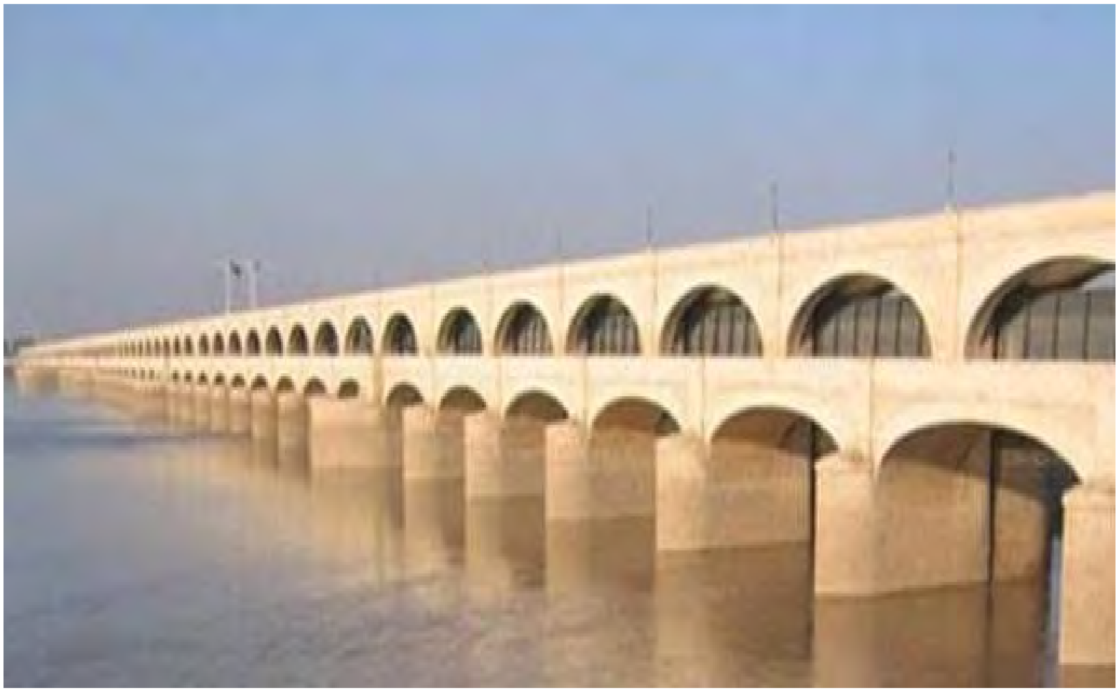


Figure: 1.3 The view of Sukkur Barrage

The barrage is named after the city of Sukkur, which was initially called Llyod Barrage. It was built from 1923 to 1932, following very long deliberations by the Government of Bombay. The barrage was formally inaugurated in January 1932 and was the largest irrigation project ever undertaken at that time. It brought nearly 7 million acres under cultivation. Some of the project's individual canals are even larger than that of the Suez Canal. The Rohri Canal, which off-takes from the left side of the Sukkur Barrage, is the largest canal in the world and flows upto Hyderabad. The Sukkur Barrage was instrumental in bringing agricultural activity in an economically depressed Sindh.

In the year 2005, Sukkur Barrage had developed serious cracks and was in the danger of giving away itself to the Indus for-ever. Therefore, emergent works were carried out to restore the barrage. New sheet piles were erected to replace the old sheet piles that had been placed at the time of its construction. The rehabilitation works were completed in time. The barrage was able to safely pass through 12 lacs cusecs of water in the flood season of 2010 without affecting the provincial irrigation system. It is estimated that the rehabilitation & repairing works of the barrage has enhanced its affectivity for another 60 to 70 years.

As for Sukkur city, it is one of the thriving cities of the Sindh province, located on the western bank of river Indus. It is an old city and has been an important commercial and industrial city and a centre for trade with other provinces. The modern Sukkur was built by the British Army General Sir Charles Napier in the 1840s. Sukkur has cotton and silk textile industries beside producing cement, lime and cigarettes. Being located on the river, boat building is the thriving business since most of the dwellers rely on their cache of fish which provide them handsome earnings. Besides handloom weaving is also important.

Today the Sukkur Barrage, while critical to the lower Indus basin economy, is also responsible for enormous water-logging and salinity problems in its command area. The drainage component was not provided at the time of its construction due to financial constraints. Besides, water table at that time was almost 50 ft deep, therefore, it was not immediately felt necessary. However, the water table started rising over the period of time and assumed the serious problem of water-logging & salinity, which was declared as Pakistan’s enemy No. 1 in 1960. Due to this twin problem, the ancient city of Mohen-jo-Daro is also threatened and cannot be further excavated. In order to control water-logging & salinity in the districts of Nawabshah, Sanghar & Mirpurkhas, which were the worst affected areas, a typical drain called LBOD (Left Bank Outfall Drain) was constructed which carried saline effluent from the affected areas of Nawabshah, Sanghar & Mirpurkhas districts for its final disposal into Arabian Sea. The right side of River Indus also started with the problem of water-logging & salinity.

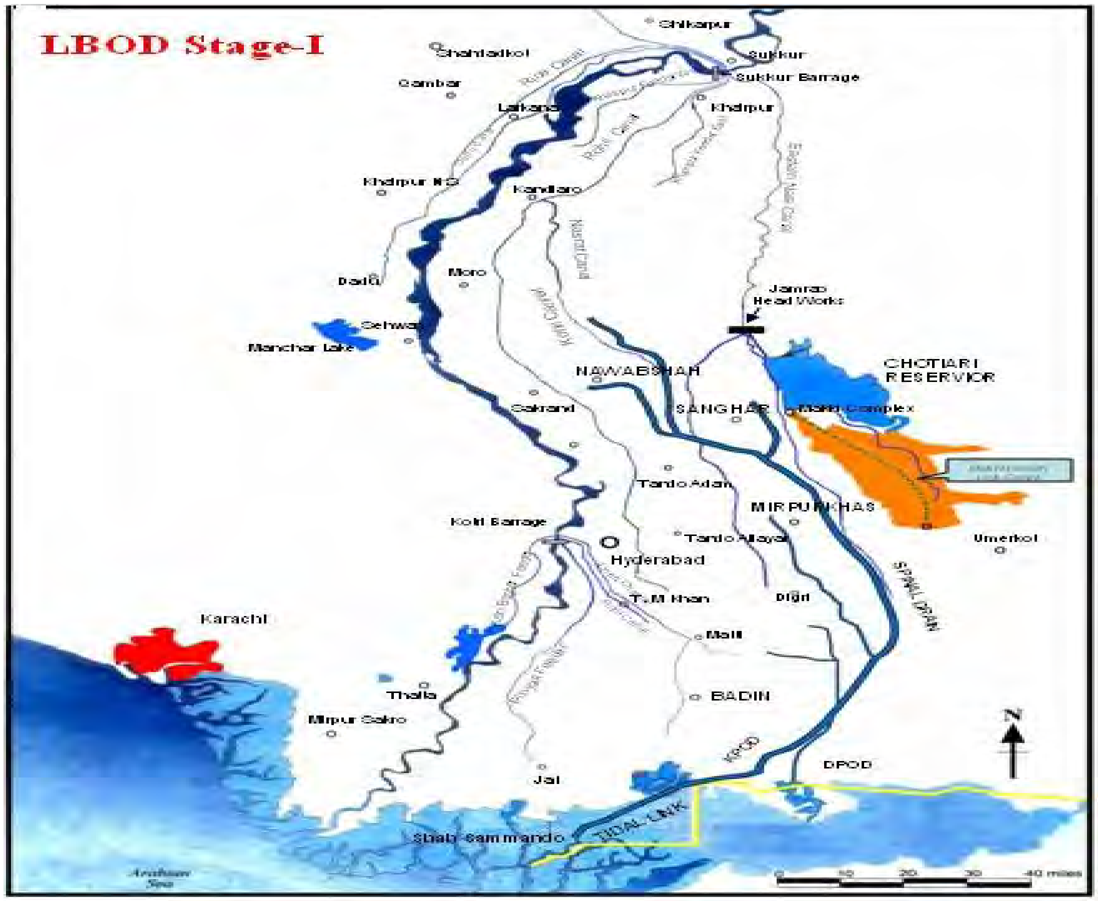


Figure: 1.4. LBOD System is laid out to cater drainage in the left bank area

Therefore, a very long drain called RBOD (Right Bank Outfall Drain) is also being constructed in the pattern of LBOD to tackle the problem of water-logging & salinity in the right bank areas of River Indus. The work on RBOD is underway where the saline effluent will be finally disposed-off into Arabian Sea through Gharo Creek. These two huge drainage projects are crucial for controlling water-logging & salinity problem in the command areas of Sukkur Barrage.

2. GATHERING OF EXISTING INFORMATION ANOUT RIVER INDUS

2.1 GATHERING OF EXISTING MAPS, CHARTS, RIVER INDUS WATER FLOWS FOR LAST 50 YEARS (1961-2011)

The collection of existing maps & charts besides historical data of River Indus including water levels and flows was the most exhausting part. The collection of water resources data is a cumbersome exercise and involves different organizations. It was discovered that no single authority is maintaining the river historical data. Before creation of provinces the data was maintained by Federal Government and then after the break down of One Unit in 1970, the data storage became fragmented and within the provinces several offices were involved at different times. Therefore, serious efforts were needed and offices as far as Karachi, Islamabad and Lahore were combed for data which eventually helped in getting the historical river discharge data that were then patched together to get the required volume of the data of the last fifty (50) years. The major chunk of the data was obtained from the following offices;

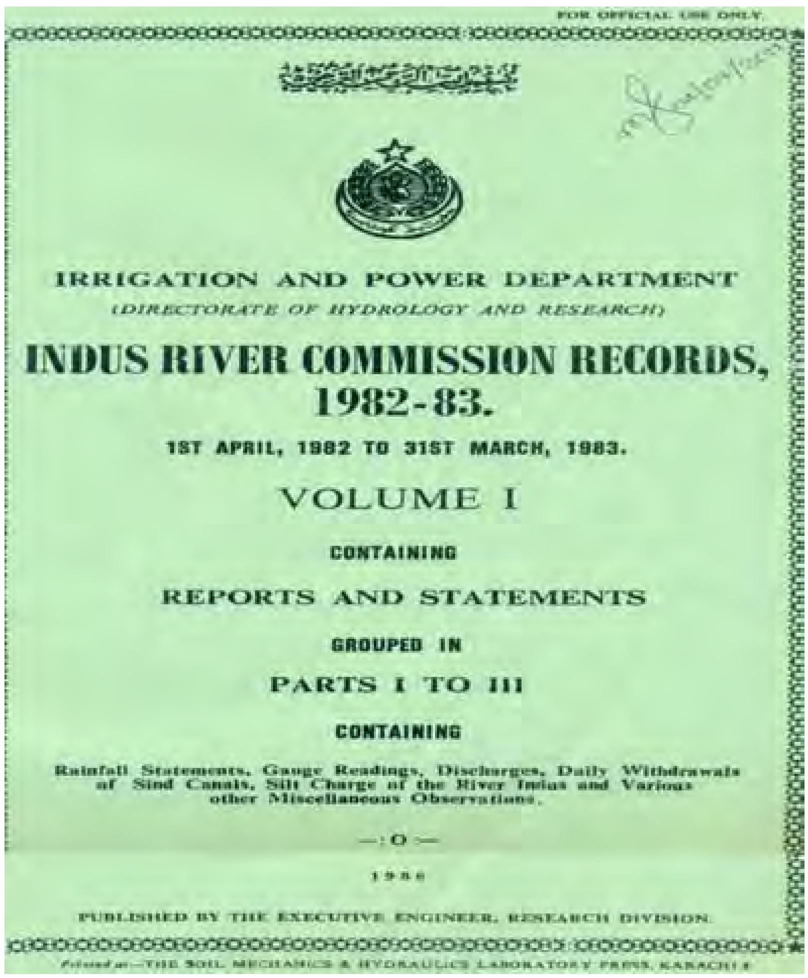
1. *Office of the Directorate of Regulation, Provincial Irrigation & Power Department (Obtained Data from Year-1976 to June-2011)*

2. *Pakistan Commissioner for Indus Water, Ministry of Water & Power, Government of Pakistan (Obtained Data from Year-1960 to December-1975)*

The collected data from above sources include Water levels at Sukkur Barrage, River Flow discharges on the upstream and downstream sides of the Sukkur Barrage, Withdrawals by the off-taking canals of the Sukkur Barrage. Furthermore, water levels at pertinent sites of River Indus are also included in the collected historical River Indus data.

M/s RCC Consultants went a step ahead and obtained another valuable historical data contained in a set of four thick volumes of "INDUS RIVER COMMISION RECORDS

(1931-1983)" from the Directorate of Hydrology & Research in Sindh, Irrigation & Power Department. It is imperative to mention the fact that the collected historical data which includes discharge of the off-taking canals from Sukkur Barrage and Kotri Barrage for over 50 years, pH values, Soluble Salt, Silt Load, River Bed Gradients, Gauge Readings, Daily Withdrawals and sediment load of River Indus at various location. It is imperative to mention the fact that this information is in addition to the requirements of TOR. This would further help in the better and proper understanding of the issue. It may be added that the publication of such valuable information books is not carried out anymore.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IRRIGATION AND POWER DEPARTMENT
(DIRECTORATE OF HYDROLOGY AND RESEARCH)

INDUS RIVER COMMISSION RECORDS, 1982-83.

1ST APRIL, 1982 TO 31ST MARCH, 1983.

VOLUME I

CONTAINING

REPORTS AND STATEMENTS

GROUPED IN

PARTS I TO III

CONTAINING

Rainfall Statements, Gauge Readings, Discharges, Daily Withdrawals of Sind Canals, Silt Charge of the River Indus and Various other Miscellaneous Observations.

—:O:—

PUBLISHED BY THE EXECUTIVE ENGINEER, RESEARCH DIVISION.

Printed at—THE SOIL MECHANICS & HYDRAULICS LABORATORY PRESS, KARACHI

Figure: 2.1. The scanned cover of the IRC Data, containing some valuable Historical information about River Indus.

M/s RCC Consultants collected historical data in several thick volumes from various sources. In this regard, various officials were coordinated and meetings held. It is worth to note here that the collected historical data was not in the digitalized format.

Table: 2.1. The digitalized form of the collected data

SUKKUR BARRAGE

Date	RIVER LEVELS		RIVER LEVELS		DISCHARGE		With Drawls	Sadhu Belo R.L
	Right Bank		Left Bank					
	U/S	D/S	U/S	D/S	U/S	D/S		
01-04-1977	196.3	180.8	195.9	180.6	31749	2598	29151	196.38
02-04-1977	196.3	180.8	195.9	180.6	31697	2636	29061	196.38
03-04-1977	196.3	180.7	195.9	180.5	30917	2372	28545	196.38
04-04-1977	196.3	180.8	195.9	180.6	31749	2598	29151	196.38
05-04-1977	196.3	180.2	195.9	180	30063	1318	28745	196.38
06-04-1977	196.3	180	195.9	179.8	29529	957	28572	196.38
07-04-1977	196.3	180	195.9	179.8	28492	510	27982	196.38
08-04-1977	196.3	180.3	195.9	179.8	28252	490	27762	196.38
09-04-1977	196.3	180.3	195.9	179.8	28217	508	27709	196.38
10-04-1977	196.3	180.8	195.9	179.8	28237	508	27729	196.38
11-04-1977	196.3	179.8	195.9	179.6	27527	-	27527	196.38
12-04-1977	196.3	179.8	195.9	179.6	27774	-	27774	196.38
13-04-1977	196.3	179.8	195.9	179.6	27933	-	27933	196.38
14-04-1977	196.1	180	195.7	179.8	28457	520	27937	196.18
15-04-1977	195.9	181	195.5	16.8	31590	3542	28048	195.98
16-04-1977	195.4	182.5	195.3	182.8	36538	8646	27892	195.78
17-04-1977	195.5	183	195.1	182.8	40609	12887	27722	195.58
18-04-1977	195.5	183	195.1	182.8	40609	12887	27722	195.58
19-04-1977	195.5	182.5	195.1	182.3	35006	7484	27522	195.58
20-04-1977	195.5	182.8	195.1	182.4	36384	11202	25182	195.58
21-04-1977	195.5	182.8	195.1	182.6	36384	11202	25182	195.58
22-04-1977	195.5	182.5	195.1	183.2	38622	14922	23700	195.58
23-04-1977	195.5	184.5	195.1	184.3	44575	20681	23894	195.58
24-04-1977	195.5	184.5	195.1	184.3	44593	20379	24214	195.58
25-04-1977	195.5	184.5	195.1	184.3	44250	20076	24174	195.58
26-04-1977	195.5	184.1	195.1	183.9	43435	18470	24965	195.58
27-04-1977	195.5	183.8	195.1	183.6	40208	14862	25346	195.58
28-04-1977	195.5	183.3	195.1	183.1	38792	12672	26120	195.58
29-04-1977	195.5	182.8	195.1	182.6	35952	9600	26352	195.58
30-04-1977	195.5	182.8	195.1	182.5	34940	8464	26476	195.58

Consultants thus made huge efforts to digitalize the collected data for subsequent modeling & analysis. The magnitude of data was so huge that several teams were constituted to manually convert this data in digitalize format. The digitalized data has been statistically analyzed to figure out the desired information as required per the TORs, for this study. A hard copy of digitized data with about 350 pages is submitted to NSUSC as part of this study as a separately bound volume. In addition this data is also provided in soft copy.

2.2 FIELD STUDIES TO GATHER ADDITIONAL INFORMATION

In pursuance with the study requirements, some additional in-situ data was required. The data requirements for the this goal are elaborated as under;

2.2.1 Measurement of water borne velocity and depth soundings at appropriately defined river cross sections with locations identified by GPS.

2.2.2 Collection of water samples at various depths and locations for comparison of turbidity and bacteriological pollution including chemical analysis for pH, BOD, nitrates, DO, etc.

2.2.3 Carry out Trial Hole investigations to examine depth and quality of siltation at selected location.

2.2.4 Measurement of river depth longitudinally along the right and left bank of River Indus involving an area of 5 km^2

The field data was collected in close cooperation with NSUSC for which regular meetings were held during the course of exercise. In connection with the collection of field data for sounding and depth measurement, two teams in separate boats were formed. They were equipped with all the necessary equipments including Global Positioning System (GPS) devices. Special measuring arrangements were made for the sounding of depths. During the field studies and survey expertise was also acquired from field staff Irrigation and Power Department.

2.2.1 MEASUREMENT OF WATER BORNE VELOCITY AND DEPTH SOUNDINGS AT APPROPRIATELY DEFINED RIVER CROSS SECTIONS WITH LOCATIONS IDENTIFIED BY GPS

The water borne velocities were measured at different depths at a location where entire River Indus Right Bank wing at Left Bank route of velocity measuring path. The paths location is shown below.

Figure 2.2: River Indus Right Bank wing at Left Bank route of velocity measuring path

The water borne velocity measurement and accordingly river discharge work was carried out at the potential points of interest. The velocity measurement exercise was carried out in a conventional manner as in vogue and practiced by the Irrigation & Power Department.

The water borne velocity was measured through a current meter, which has propeller fans and is lowered in a position and against the direction of flow. The current meter is standardized and verified in the local workshop of the Irrigation & Power Department to ensure that accurate velocity is measured. The number of revolutions at a unit time is measured through a head phone and recorded simultaneously. The number of revolutions is then converted into velocity through an empirical formula.

The velocity is measured at 1/6 of river depth at every section to get proper velocity since water currents have varying velocity along the depth at a particular section. The field staff coordinated with the staff of Irrigation & Power Department.

Figure 2.3 Operator is taking readings through the standard Current Meter

2.2.2 COLLECTION OF WATER SAMPLES AT VARIOUS DEPTHS AND LOCATIONS FOR COMPARISON OF TURBIDITY AND BACTERIOLOGICAL POLLUTION INCLUDING CHEMICAL ANALYSIS FOR PH, BOD, NITRATES, DO, ETC

The water samples were collected from different depths and at various locations on the Left and Right Bank side of the River Indus for the comparison of Turbidity and Bacteriological pollution including analysis for pH, BOD, nitrates, DO, etc. The samples were collected in a prescribed standard manner, properly conserved and immediately transported to the laboratory to obtain sound results. The results of all the water quality tests are being analyzed as part of the study.

Figure: 2.4 Water Samples were collected from strategic sites

2.2.3 CARRY-OUT TRIAL HOLE INVESTIGATIONS TO EXAMINE DEPTH AND QUALITY OF SILTATION AT SELECTED LOCATION

The information about soil lithology was to explore the possibility of using groundwater as a source of domestic water for Sukkur city if available in required volume or alternatively use the groundwater of the left bank side and transmit it to the right bank for Sukkur city. A table showing lithology of a test well is given as following;

Table: 2.4. The lithology of soil found in a test well

DEPTH (m)	FORMATION	DESCRITION
0-1.5	Clay	Silty Clay, Color light brown
1.5-3	Clay	Silty Clay, Color Light brown
3-4.5	Clay	Silty Clay, Color Light brown
4.5-6	Silt	Clayey sandy silt, color grey to light brown
6-7.5	Sand	Silty fine sand, color light brown to grey
7.5-9	Sand	Find sand, color grey
9-10.5	Sand	Find sand, color grey
10.5-12	Sand	Find sand, color grey
12-13.5	Sand	Find sand, color grey
13.5-15	Sand	Find sand, color grey
15-16.5	Sand	Fine to medium sand, color grey
16.5-18	Sand	Fine to medium sand, color grey
18-19.5	Sand	Fine to medium sand, color grey
19.5-21	Sand	Fine to medium sand, color grey
21-22.5	Sand	Fine to medium sand, color grey
22.5-24	Sand	Fine to medium sand, color grey
24-25.5	Sand	Fine to medium sand, color grey
25.5-27	Sand	Fine to medium sand, color grey
27-28.5	Sand	Fine to medium sand, color grey
28.5-30	Sand	Fine to medium sand, color grey
30-31.5	Sand	Fine to medium sand, color grey
31.5-33	Sand	Fine to medium sand, color grey
33-34.5	Clay	Sticky Clay, color brown
34.5-35.5	Clay	Sticky Clay, color brown

During the study of "TEST WELL DRILLING FOR ROHRI WATER SUPPLY" some wells near River Indus were drilled to collect information about the lithology and availability of groundwater. In this connection, hydro-geological information of River Indus including settling of different layers of sediment at central bars and along the banks was being collected through soil sampling at strategic location where GPS was also used to record respective satellite coordinates.

In this regard, expertise from the concerned wing of Water & Power Department Authority (WAPDA), Government of Pakistan, was requisitioned. The laboratory of SMO (Scarps Monitoring Organization) is the relevant wing of WAPDA, which deals with such soils investigations. The coordination with SMO largely helped in the collection of proper information.

Figure: 2.5. Collection of Soil Samples

The soil samples, collected at different layers was tested from the accredited laboratory to ascertain the quality and types of sediment in the river bed.

Figure: 2.6. Soil Samples collection through Augur Hole at another site

2.2.4 MEASUREMENT OF RIVER DEPTH LONGITUDINALLY ALONG THE RIGHT AND LEFT BANK OF RIVER INDUS INVOLVING AN AREA OF 3.5 Km^2

The bed depth readings were taken at more than 2000 specific points within the area of interest, measuring about 3.5 km^2, and are shown in the satellite image given below:

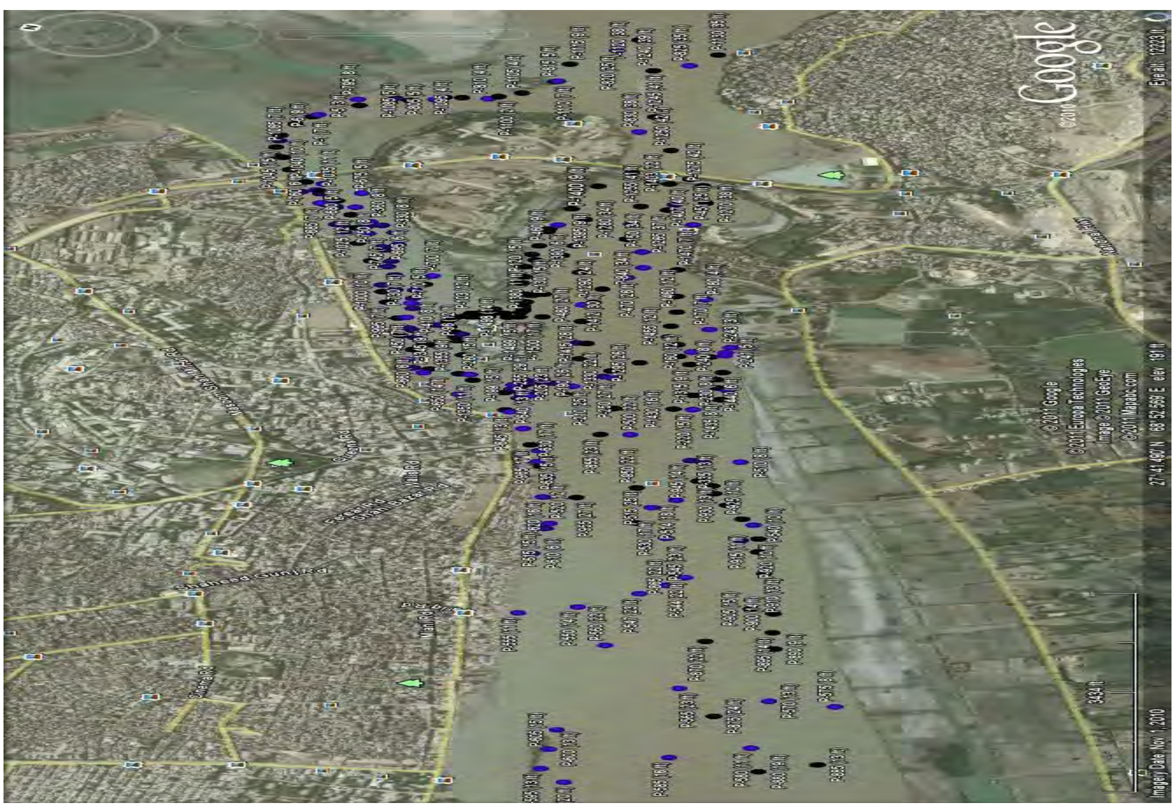


Figure: 2.7. River Bed Sounding Points Location

The data was recorded at specific points along the longitudinal direction of river as well as cross-sectional direction. Approximately 3.75 mile each way (longitudinal) strip was put under survey in which readings were recorded for depth of river bed and satellite coordinates through GPS. During bed survey, several readings were taken at upstream side as well as downstream of the Lansdowne Bridge as shown in the following plan;

Figure: 2.8. Sounding and Bed Measurement exercise was carried out in detail around Lansdowne Bridge

During this whole exercise due safety procedures were also followed for the protection of each field member.

Figure: 2.9 Field Staff is busy in the Measuring River Bed Depths

3. ESTIMATES OF PROJECTED LOW AND HIGH FLOWS FOR VARIOUS RETURN PERIODS AND CONSTRUCTION OF VARIOUS FLOW DURATION CURVES (FDC)

A return period also known as a recurrence interval is an estimate of the interval of time between events like an earthquake, flood or river discharge flow of certain intensity or size. It is a statistical measurement denoting recurrence interval over an extended period of time to dimension structures so that they are capable of withstanding an event of a certain return period (with its associated intensity).

The Daily flow duration curves (FDC) on the other hand are typically established at an un-gauged site where only a simulated or calculated monthly time series is available. In our case we are in possession of all gauged data, of daily flows for last 50 years. Thus we shall be using real monthly stream flow data to compute FDCs. FDC is a relationship between any given discharge value and the percentage of time that this discharge is equal or exceeded. It gives a summary of the flow variability at a site.

In this study the important parameter is water level (gauge level) rather than the discharge value. The Indus River even at its lowest flow (3500 cusecs) during last 50 years has 200 times the drinking water needs of Sukkur by 2050. T.O.Rs of this study though only require computation of various Return Periods and FDCs based only on flow discharge values, we additionally decided to compute these statistical parameters in terms of gauge levels as well. It is worth to mention that 50 years data reveals that the gauge levels in many events are not directly proportional to discharge values within Sukkur barrage pond area. The pond area is created by holding the water at Sukkur barrage gates to create water head up for diversion into seven irrigation canals four on left side and three on right side. Thus the gauge level is largely influenced by amount of the gates opening. It may be pointed out that our area of interest for any possible relocation of IPS is within this pond area. For instance at location of existing Intake Pumping Station (IPS) pumps will run dry when water level would fall below 191.0 ft

(River Bed level at that point is 190.0 ft). Similarly if we opt to shift IPS to some other perspective locations such as near Sadhu Bela (river bed level 186.0 ft), or on far side of island (river bed level 170.0 ft) or just upstream of Lansdowne Bridge (river bed level 160.0 ft), it will be immensely pertinent to know statistically the recurrence of water level falling there below the IPS extraction level rather than the discharge value which in all events is always higher than the water needs of the Sukkur city. Following sections describe the estimation of several Return Periods in terms of flow discharge as well as in terms of water levels. The FDCs are also constructed for discharge and gauges separately.

3.1 ESTIMATES FOR PROJECTED HIGH FLOW FOR 1 YEAR, 2 YEARS, 5 YEARS, 10 YEARS, 20 YEARS,50 YEARS, AND 100 YEARS RETURN PERIODS FOR MONTHLY, WEEKLY AND DAILY HIGH FLOWS TO PLAN IN CASE INTAKE STRUCTURE SUBMERGED AND INACCESSIBLE

Using the past hydrological records of river Indus at Sukkur Barrage, the data can be statistically modeled to predict future high floods or extreme low flows of a particular probability or Return Period. The same model can then be amended to produce Daily Flow Duration Curves (FDC).

Following steps were adopted to compute projected high flows for 1 year, 2 year, 5 year, 10 year, 20 year, and 50 year return period. For 100 year Return Period, separate procedure is proposed.

Step 1: From available 50 year data of daily discharges choose from each year maximum discharge that occurred in that year.

Table 3.1 Maximum Discharge in Cusecs in Respective Year

S.NO	Date	RIVER Left Bank gauge (ft)	Sadhu Bela gauge R.L (ft)	DISCHARGE in Cusecs
1	10-08-1961	200.00	200.48	828160
2	26-08-1962	197.85	198.33	439687
3	20-08-1963	198.10	198.58	522552
4	29-08-1964	200.70	201.18	710010
5	07-09-1965	198.40	198.88	989991
6	18-08-1966	200.00	200.48	665029
7	15-08-1967	198.60	199.08	656945
8	23-08-1968	198.40	198.88	585896
9	22-08-1969	199.90	200.38	652781
10	22-08-1970	198.60	199.08	329275
11	19-08-1971	198.70	199.18	581600
12	17-08-1972	200.40	200.88	374971
13	21-08-1973	202.90	203.38	1117246
14	11-06-1974	199.20	199.68	1177700
15	02-09-1975	202.50	202.98	1051316
16	17-08-1976	204.40	204.88	1200574
17	28-09-1977	199.55	200.03	1166336
18	20-08-1978	202.50	202.98	1116430
19	11-08-1979	199.10	199.58	501334
20	17-08-1980	198.10	198.58	615778
21	08-08-1981	199.15	199.63	631359
22	20-08-1982	198.50	198.98	465000
23	16-08-1983	201.30	201.78	763421
24	07-09-1984	199.00	199.48	607398
25	16-08-1985	198.80	199.28	390380
26	15-08-1986	199.30	199.78	1166574
27	04-09-1987	198.80	199.28	316245
28	31-07-1988	200.30	200.78	1118856
29	10-08-1989	198.80	199.28	910295
30	09-07-1990	199.30	199.78	551867
31	27-06-1991	199.30	199.78	567165
32	20-09-1992	199.30	199.78	1064200
33	25-07-1993	199.60	200.08	569160
34	02-08-1994	200.05	200.53	757350
35	07-08-1995	200.30	200.78	985929
36	24-08-1996	200.10	200.58	757190
37	08-09-1997	199.60	200.08	801170
38	24-07-1998	199.70	200.18	628755
39	01-10-1999	200.00	200.48	91818
40	09-08-2000	199.30	199.78	170775
41	01-08-2001	199.20	199.68	217848
42	23-08-2002	199.00	199.48	237549
43	07-08-2003	199.80	200.28	335933
44	24-07-2004	198.80	199.28	126130
45	26-07-2005	198.80	199.28	508837
46	16-08-2006	199.60	200.08	554088
47	24-08-2007	199.60	200.08	297840
48	15-08-2008	199.70	200.18	250085
49	26-08-2009	199.70	200.18	195717
50	10-08-2010	203.80	204.28	1130995

Table 3.1 is the list of 50 discharges that represent maximum discharge in

corresponding year.

Step 2: Arrange all discharge in descending order.

Step 3: Compute Return Periods for all years 1st to 50th using following formulas.

1) *California formula* : $T_r = n/m$
2) *Hazen's formula* : $T_r = n/m-0.5$
3) *Waybill's formula* : $T_r = n+1/m$
4) *Gum bell's formula:* $T_r = n/m+C-1$

Where, *n* is total discharge events (Years)

m = is serial number of the observation also called rank or order of observation

T_r = Return Period

C = Gum bell's correction factor. Its value depends on *m* and *n* and is given as follow

m/n	**1**	**0.9**	**0.8**	**0.7**	**0.6**	**0.5**	**0.4**	**0.3**	**0.2**	**0.1**
C	1.00	0.95	0.88	0.85	0.78	0.73	0.68	0.59	0.52	0.4

Table 3.2 shows data computation as per steps 2 and 3. This table provides flow estimates for all required Return Periods except 100 year return period.

Table 3.2 Computation Table for Return Period for High flow Yearly Discharge (part 1 of 2)

S.NO	Date	RIVER Left Bank gauge (ft)	Sadhu Bela gauge R.L (ft)	DISCHARGE in Cusecs	RETURN PERIOD			
					California formula	**Hazen's Formula**	**Weibull's formula**	**Gumbell's Formula**
1	17-08-1976	204.40	204.88	1200574	50.00	100.00	51.00	192.31
2	11-06-1974	199.20	199.68	1177700	25.00	33.33	25.50	39.06
3	15-08-1986	199.30	199.78	1166574	16.67	20.00	17.00	21.55
4	28-09-1977	199.55	200.03	1166336	12.50	14.29	12.75	14.97
5	10-08-2010	203.80	204.28	1130995	10.00	11.11	10.20	11.36
6	31-07-1988	200.30	200.78	1118856	8.33	9.09	8.50	9.23
7	21-08-1973	202.90	203.38	1117246	7.14	7.69	7.29	7.78
8	20-08-1978	202.50	202.98	1116430	6.25	6.67	6.38	6.72
9	20-09-1992	199.30	199.78	1064200	5.56	5.88	5.67	5.91
10	02-09-1975	202.50	202.98	1051316	5.00	5.26	5.10	5.25
11	07-09-1965	198.40	198.88	989991	4.55	4.76	4.64	4.75
12	07-08-1995	200.30	200.78	985929	4.17	4.35	4.25	4.33
13	10-08-1989	198.80	199.28	910295	3.85	4.00	3.92	3.99
14	10-08-1961	200.00	200.48	828160	3.57	3.70	3.64	3.69
15	08-09-1997	199.60	200.08	801170	3.33	3.45	3.40	3.43
16	16-08-1983	201.30	201.78	763421	3.13	3.23	3.19	3.20

Table 3.2 Computation Table for Return Period for High flow Yearly Discharge (part 2 of 2)

S.NO	Date	RIVER Left Bank gauge (ft)	Sadhu Bela gauge R.L (ft)	DISCHARGE in Cusecs	RETURN PERIOD			
					California formula	Hazen's Formula	Weibull's formula	Gumbell's Formula
17	02-08-1994	200.05	200.53	757350	2.94	3.03	3.00	3.01
18	24-08-1996	200.10	200.58	757190	2.78	2.86	2.83	2.84
19	29-08-1964	200.70	201.18	710010	2.63	2.70	2.68	2.68
20	18-08-1966	200.00	200.48	665029	2.50	2.56	2.55	2.54
21	15-08-1967	198.60	199.08	656945	2.38	2.44	2.43	2.42
22	22-08-1969	199.90	200.38	652781	2.27	2.33	2.32	2.31
23	08-08-1981	199.15	199.63	631359	2.17	2.22	2.22	2.20
24	24-07-1998	199.70	200.18	628755	2.08	2.13	2.13	2.11
25	17-08-1980	198.10	198.58	615778	2.00	2.04	2.04	2.02
26	07-09-1984	199.00	199.48	607398	1.92	1.96	1.96	1.94
27	23-08-1968	198.40	198.88	585896	1.85	1.89	1.89	1.87
28	19-08-1971	198.70	199.18	581600	1.79	1.82	1.82	1.80
29	25-07-1993	199.60	200.08	569160	1.72	1.75	1.76	1.74
30	27-06-1991	199.30	199.78	567165	1.67	1.69	1.70	1.68
31	16-08-2006	199.60	200.08	554088	1.61	1.64	1.65	1.62
32	09-07-1990	199.30	199.78	551867	1.56	1.59	1.59	1.57
33	20-08-1963	198.10	198.58	522552	1.52	1.54	1.55	1.52
34	26-07-2005	198.80	199.28	508837	1.47	1.49	1.50	1.48
35	11-08-1979	199.10	199.58	501334	1.43	1.45	1.46	1.43
36	20-08-1982	198.50	198.98	465000	1.39	1.41	1.42	1.39
37	26-08-1962	197.85	198.33	439687	1.35	1.37	1.38	1.36
38	16-08-1985	198.80	199.28	390380	1.32	1.33	1.34	1.32
39	17-08-1972	200.40	200.88	374971	1.28	1.30	1.31	1.29
40	07-08-2003	199.80	200.28	335933	1.25	1.27	1.28	1.25
41	22-08-1970	198.60	199.08	329275	1.22	1.23	1.24	1.22
42	04-09-1987	198.80	199.28	316245	1.19	1.20	1.21	1.19
43	24-08-2007	199.60	200.08	297840	1.16	1.18	1.19	1.17
44	15-08-2008	199.70	200.18	250085	1.14	1.15	1.16	1.14
45	23-08-2002	199.00	199.48	237549	1.11	1.12	1.13	1.11
46	01-08-2001	199.20	199.68	217848	1.09	1.10	1.11	1.09
47	26-08-2009	199.70	200.18	195717	1.06	1.08	1.09	1.06
48	09-08-2000	199.30	199.78	170775	1.04	1.05	1.06	1.04
49	24-07-2004	198.80	199.28	126130	1.02	1.03	1.04	1.02
50	01-10-1999	200.00	200.48	91818	1.00	1.01	1.02	1.00

In order to compute high flow value for Return Period of 100 years a trend curve (see Fig. 3.1) between T_r and respective discharges is required to be plotted. The discharge at 100 year return period is then interpolated from the curve.

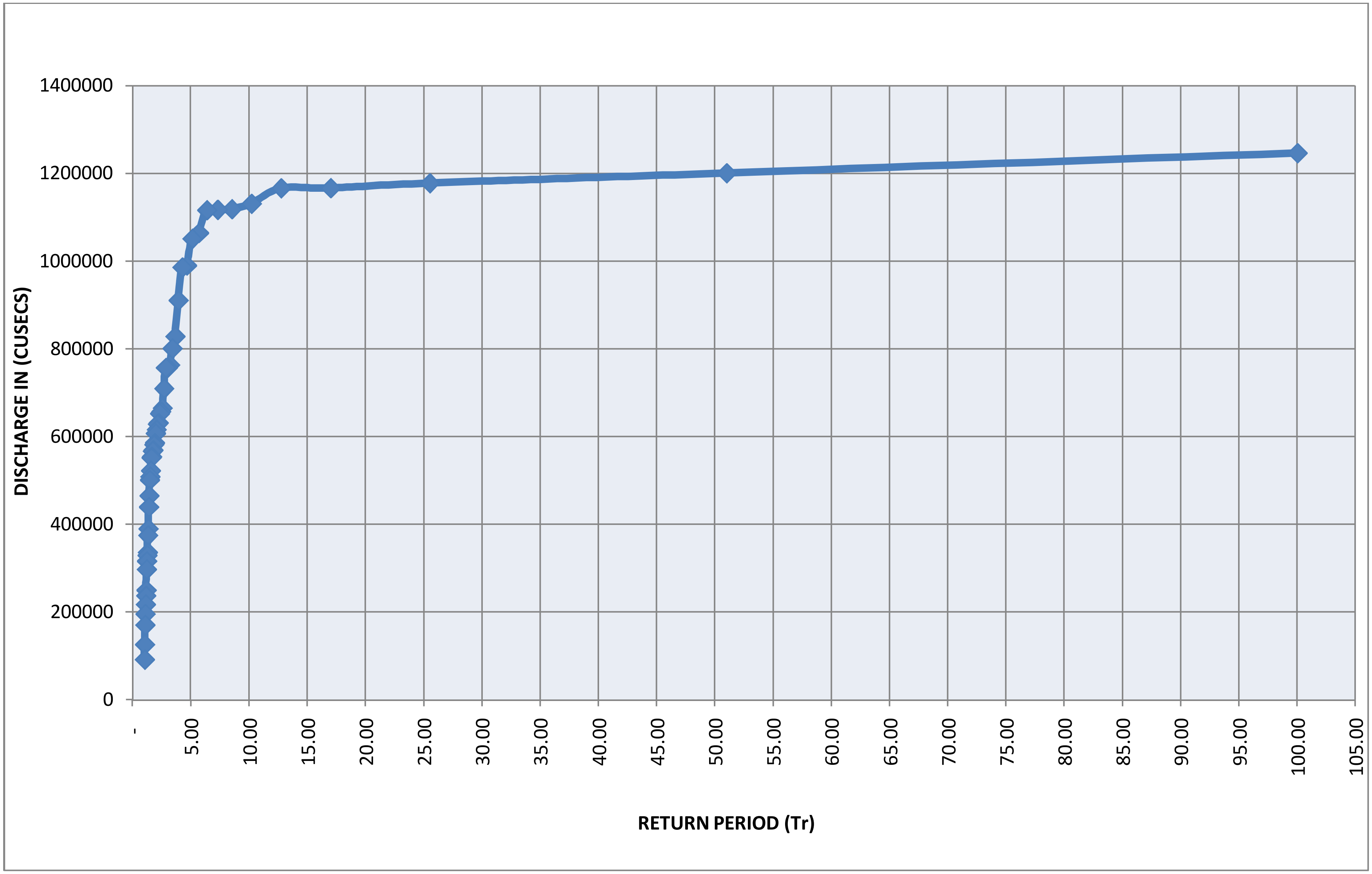


Figure: 3.1 Relation Between Return Period & Discharge in cusecs on Yearly Basis upto 100 years Return Period

The same procedure is adopted for return periods on monthly, weekly and daily basis. The results are discussed at section 3.4 and displayed in Tables 3.3 to 3.6. The data computation is provided in soft copy as otherwise more than 400 pages of A4 sizes are required to be printed in hard copy.

Table 3.3 Estimates of Yearly High Flow Return Periods

YEAR	RIVER LEVEL Left Bank (ft)	Sadhu Bela guage RL in (ft)	DISCHARGE in Cusecs			
			California formula	Hazen's Formula	Weibull's formula	Gumbell's formula
1 Year Return Period	200.00	200.48	91818	91818	91818	91818
2 Year Return Period	198.10	198.58	615778	615778	615778	615778
5 Year Return Period	202.50	202.98	1051316	1051316	1051316	1051316
10 Year Return Period	203.80	204.28	1130995	1118856	1130995	1118856
20 Year Return Period	199.25	199.73	1172137	1166574	833547	1166574
50 Year Return Period	204.40	204.88	1200574	1189137	1200574	1189137

Table 3.4 Estimates of Monthly High Flow Return Periods

RETURN PERIOD	Discharge in Cusecs	Sadhu Bela gauge RL in Ft (Weibull's Formula)
1 YEAR	568962.00	199.98
2 YEAR	757190.00	200.28
5 YEAR	1064200.00	201.58
10 YEAR	1130995.00	202.98
20 YEAR	1172137.00	203.92

Table 3.5 Estimates of Weekly High Flow Return periods

RETURN PERIOD	Discharge in Cusecs	Sadhu Bela gauge RL in Ft (Weibull's Formula)
1 YEAR	711123.00	200.28
2 YEAR	916614.00	201.08
5 YEAR	1106474.00	202.33
10 YEAR	1166336.00	202.98
20 YEAR	1187476.00	204.62

Table 3.6 Estimates of Daily High Flow Return Periods

RETURN PERIOD	Discharge in Cusecs	Sadhu Bela gauge RL in Ft (Weibull's Formula)
1 YEAR	1030786.00	201.93
2 YEAR	1109566.00	202.98
5 YEAR	1166336.00	204.23
10 YEAR	1190190.00	204.58
20 YEAR	1193769.00	204.68

3.2 ESTIMATES FOR PROJECTED LOW FLOWS FOR 1 YEAR, 2 YEARS, 5 YEARS, 10 YEARS AND 20 YEARS RETURN PERIODS FOR MONTHLY, WEEKLY AND DAILY LOW FLOWS TO PLAN FOR PROSPER LOCATION OF IPS WHERE WATER IS AVAILABLE THROUGHOUT THE YEAR

The procedure is identical to as in above described steps 1 to 3 except that in step 1 instead of each year's maximum flow, each month's (and each week's and then daily) lowest flow is selected and that in step 2 lowest selected discharges corresponding to each month (week and then daily) are sorted instead in ascending order. The tables 3.7 to 3.10 displays the results of estimation of Low Flows for 1 year, 2 year, 5 year, 10 year and 20 year Return Periods for monthly, weekly and daily Low Flows respectively. The computational table similar to table 3.2 above is provided in soft copy as printing the same would require about 500 pages of A4 size paper to display about 24000 lines of data.

Table 3.7 Estimates of Yearly Low Flow Return Period

YEAR	RIVER Left Bank gauge (ft)	Sadhu Bela gauge R.L (ft)	DISCHARGE in Cusecs			
			California formula	Hazen's Formula	Weibull's formula	Gumbells Formula
1 Year Return Period	182.40	182.88	30815	32600	32600	32600
2 Year Return Period	183.40	183.88	11849	11849	11849	11849
5 Year Return Period	183.80	184.28	6650	6650	6650	6650
10 Year Return Period	184.80	185.28	4639	4639	4639	4639
20 Year Return Period	181.90	182.38	3810	3810	3810	3810
50 Year Return Period	181.60	182.08	3490		3490	

Table 3.8 Estimates of Monthly Low Flow Return Period

RETURN PERIOD	Discharge in Cusecs	Sadhu Bela gauge RL in Ft (Weibull's Formula)
1 YEAR	13940.00	185.08
2 YEAR	10200.00	184.08
5 YEAR	4800.00	182.58
10 YEAR	4150.00	182.18
20 YEAR	3549.50	181.23

Table 3.9 Estimates of Weekly Low Flow Return Period

RETURN PERIOD	Discharge in Cusecs	Sadhu Bela gauge RL in Ft (Weibull's Formula)
1 YEAR	10353.00	184.28
2 YEAR	5810.00	182.98
5 YEAR	4320.00	182.18
10 YEAR	4010.00	181.18
20 YEAR	2965.00	180.98

Table 3.10 Estimates of Daily Low Flow Return Period

RETURN PERIOD	Discharge in Cusecs	Sadhu Bela gauge RL in Ft (Weibull's Formula)
1 YEAR	4850.00	182.38
2 YEAR	4300.00	181.48
5 YEAR	4010.00	181.18
10 YEAR	3490.00	180.98
20 YEAR	2965.00	180.78

3.3 DAILY FLOW DURATION CURVES FOR MONTHLY STREAM FLOW DATA AT THE PROPOSED INTAKE SITE AT SUKKUR BARRAGE

Daily flow duration curves (FDC) are typically established at an un-gauged site where only a simulated or calculated monthly time series is available. In our case we are in possession of all gauged data, of daily flows for last 50 years. FDC is a relationship between any given discharge value and the percentage of time that this discharge is equaled or exceeded. It gives a summary of the flow variability at a site. FDC may be constructed from either daily (1d FDC) or monthly (1m FDC) data.

Both 1d and 1m FDCs may be calculated on the basis of the whole available record period or on the basis of all similar calendar months from the whole period (e.g. all Januaries). The former curves are sometimes referred to in the literature as either "period of record FDC" or "long-term average annual FDCs" and the latter as either "long-term average monthly FDC" or FDC of a monthly "window". In this report, I d FDC for the whole year is referred to as 1d annual FDC, while 1d FDCs for each calendar month of the year are referred to as 1d monthly FDCs.

Previous studies attempted to approach the problem mostly on a conceptual back ground without much reference to the daily data. Consequently, the problems of monthly to daily data conversion remains largely unresolved.

For any site in a river, the variability of daily flows is higher than that of monthly flows. In high-flow months, maximum daily average discharges are higher than the monthly average. In low-flow month's minimum daily average discharges may be much lower than the monthly average. The implication for FDCs is that the 1d FDC generally has a larger slope than the 1m FDC. Consequently, daily discharges are higher than monthly discharges in the area of low probability of exceedance and lower than monthly discharges in the area of high probability.

For present study Monthly, Weekly and Daily FDCs are drawn using actual 50 year available data and adopting following methodology.

Step 1: *Daily discharges of 50 Years (1960 t0 2011) record are sorted from the largest value to the smallest value, involving a total of the 18,000 values.*

Step 2: *Each discharge value is assigned a rank (here it is S.No), starting with 1 for the largest daily discharge value, and the last sno. for the lowest value.*

Step 3: *The discharge value within certain class bounders are grouped together. For daily discharges 62 classes are formed each class step is about 20,000 cusecs.*

Step 4: *No of daily discharges in each class are counted as total of days that is number of discharge events according with the class.*

Step 5: The exceedance probability (P) is computed from formula

P= 100 x [M/ (n+1)]

P = The probability

M =The ranked position (class rank) on the listing

N =The number of events (days) for period of records

Based on above procedure following tables and corresponding daily, weekly and monthly Flow Discharge Curves are drawn.

Table 3.11 Computation Table for Daily Flow Duration Curve (part 1 of 2)

S.NO	CLASS BOUNDARIES		DISCHARGE in Cusecs	NO OF DAYS IN EACH CLASS	CUMULATIVE NO OF DAYS	PERCENT OF TIME FLOW IS NOT EXCEEDED	PERCENT OF TIME FLOW IS EXCEEDED
1	0	20000	20000	1083	1083	5.90	94.10
2	20001	40000	40000	6738	7821	42.63	57.37
3	40001	60000	60000	2516	10337	56.35	43.65
4	60001	80000	80000	1428	11765	64.13	35.87
5	80001	100000	100000	1206	12971	70.71	29.29
6	100001	120000	120000	840	13811	75.28	24.72
7	120001	140000	140000	616	14427	78.64	21.36
8	140001	160000	160000	452	14879	81.11	18.89
9	160001	180000	180000	412	15291	83.35	16.65
10	180001	200000	200000	322	15613	85.11	14.89
11	200001	220000	220000	276	15889	86.61	13.39
12	220001	240000	240000	235	16124	87.89	12.11
13	240001	260000	260000	166	16290	88.80	11.20
14	260001	280000	280000	163	16453	89.69	10.31
15	280001	300000	300000	157	16610	90.54	9.46
16	300001	320000	320000	164	16774	91.44	8.56
17	320001	340000	340000	164	16938	92.33	7.67
18	340001	360000	360000	134	17072	93.06	6.94
19	360001	380000	380000	116	17188	93.69	6.31
20	380001	400000	400000	98	17286	94.23	5.77
21	400001	420000	420000	81	17367	94.67	5.33
22	420001	440000	440000	83	17450	95.12	4.88
23	440001	460000	460000	87	17537	95.60	4.40
24	460001	480000	480000	83	17620	96.05	3.95
25	480001	500000	500000	75	17695	96.46	3.54
26	500001	520000	520000	67	17762	96.82	3.18

Table 3.11 Computation Table for Daily Flow Duration Curve (part 2 of 2)

S.NO	CLASS BOUNDARIES		DISCHARGE in cusecs	NO. OF DAYS IN EACH CLASS	CUMULATIVE NO OF DAYS	PERCENT OF TIME FLOW IS NOT EXCEEDED	PERCENT OF TIME FLOW IS EXCEEDED
27	520001	540000	540000	86	17848	97.29	2.71
28	540001	560000	560000	63	17911	97.63	2.37
29	560001	580000	580000	60	17971	97.96	2.04
30	580001	600000	600000	32	18003	98.14	1.86
31	600001	620000	620000	33	18036	98.32	1.68
32	620001	640000	640000	28	18064	98.47	1.53
33	640001	660000	660000	29	18093	98.63	1.37
34	660001	680000	680000	25	18118	98.76	1.24
35	680001	700000	700000	17	18135	98.86	1.14
36	700001	720000	720000	16	18151	98.94	1.06
37	720001	740000	740000	12	18163	99.01	0.99
38	740001	760000	760000	15	18178	99.09	0.91
39	760001	780000	780000	7	18185	99.13	0.87
40	780001	800000	800000	11	18196	99.19	0.81
41	800001	820000	820000	12	18208	99.25	0.75
42	820001	840000	840000	9	18217	99.30	0.70
43	840001	860000	860000	8	18225	99.35	0.65
44	860001	880000	880000	9	18234	99.39	0.61
45	880001	900000	900000	7	18241	99.43	0.57
46	900001	920000	920000	9	18250	99.48	0.52
47	920001	940000	940000	5	18255	99.51	0.49
48	940001	960000	960000	8	18263	99.55	0.45
49	960001	980000	980000	9	18272	99.60	0.40
50	980001	1000000	1000000	7	18279	99.64	0.36
51	1000001	1020000	1020000	10	18289	99.69	0.31
52	1020001	1040000	1040000	6	18295	99.73	0.27
53	1040001	1060000	1060000	9	18304	99.78	0.22
54	1060001	1080000	1080000	6	18310	99.81	0.19
55	1080001	1100000	1100000	7	18317	99.85	0.15
56	1100001	1120000	1120000	10	18327	99.90	0.10
57	1120001	1140000	1140000	5	18332	99.93	0.07
58	1140001	1160000	1160000	1	18333	99.93	0.07
59	1160001	1180000	1180000	6	18339	99.97	0.03
60	1180001	1200000	1200000	4	18343	99.99	0.01
61	1200001	1220000	1220000	1	18344	99.99	0.01

3.4 INTERPRETATIONS OF ESTIMATES OF RETURN PERIOD AND FLOW DURATION CURVES

The optimal approach review requires that Intake Pumping Station should be proposed at location where water levels do not fall below the intake pump suction pipe levels either during low flows in river Indus or during the period of Sukkur Barrage gate opening nor the proposed ITP gets submerged or become inaccessible during high flows.

In order to interpret results of the high and low flow return periods, in terms of water level at Sadhu Bela gauge station are graphically illustrated at perspective location of interest and these are for instance;

- On Near Side of Sadhu Belo (see figures 3.5 to 3.17)
- Opposite to existing IPS on far side of Bukkur island (figures 3.18 to 3.30) and
- On far side of Bukkur island upstream of Lansdowne Bridge (see figures 3.31 to 3.43)
- The figures 3.12, 3.25 and 3.38 show that every year (i-e 1 year Return Period) there will be no water at location of Present IPS nor there will be water at any location opposite the location of present IPS on near side of the island nor there will be any water on its downstream side along right bank upto Sadhu Belo. This probably coincides with Sukkur barrage gate openings every year. Therefore the estimates indicate that only viable locations are along far side of island either opposite to present IPS or just upstream Lansdowne Bridge on the same side where water is available for all return periods from 1 year to 50 years.

- The estimates of High Flow Return Period as shown in figures indicate that for 5 year return period and higher all area around outside of the Bukkur island Fort will be inundated. This means that even if IPS is located on far side of island where water will be available round the year the IPS will be likely inaccessible during every 5 years water level will rise above 200.0ft.

- Figures further show that existing IPS with present floor levels at 203.23ft will get submerged every 10 year when the water level is likely to exceed 204.28ft.
- The table 3.9 further shows that every 5 year Return Period the lowest flow in River Indus will be less than 7000 cusecs with water level of about 184.80ft. At this level River Indus bed between right bank and Bukkur Island from Lansdowne Bridge upto Sadhu Belo will dry up.
- The figure 3.17, figure 3.30 and figure 3.43 show that during the lowest flows for Return Period of 50 years and less sufficient water is available on far side of island with water level not dropping below 180.0ft. The river bed level on that side varies between 170ft along the island and upto to 160ft just upstream of Lansdowne Bridge. The lowest river flow for that return period is about 3500 cusecs but sufficient to provide project requirement of Sukkur city of 100.0 cusecs by the year 2054.
- The figures 3.11, 3.24 and 3.37 further show that water level can rise to 206.06 ft with return period of 100 years. This level is just short of 2 feet below the presently raised Bunder wall and just few inches below the Sadhu Belo protection wall. For these reasons the future IPS floor levels has to be fixed at around 210.0 ft
- Flow duration curves indicate that 96% of the time flow exceeds 20,000 cusecs for daily, weekly and monthly flows. The 50 year low flow return period was associated with an estimated discharge of 3490 cusecs which occurred on 17th January 2005. This period coincides with annual gate opening when all the canals are closed. Thus the only utility of this low flow during that period shall be extraction of about 100.0 cusecs for Sukkur drinking water needs.

Figure no. 3.5 1 Year Return Period Cross Section @ Chainage +2000

Figure no. 3.6 2 Year Return Period Cross Section @ Chainage +2000

ESTIMATES OF PROJECTED HIGH FLOW LEVELS AT IPS PROPOSED ON NEAR SIDE OF SADHU BELO

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2499-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

Figure no. 3.7 5 Year Return Period Cross Section @ Chainage +2000

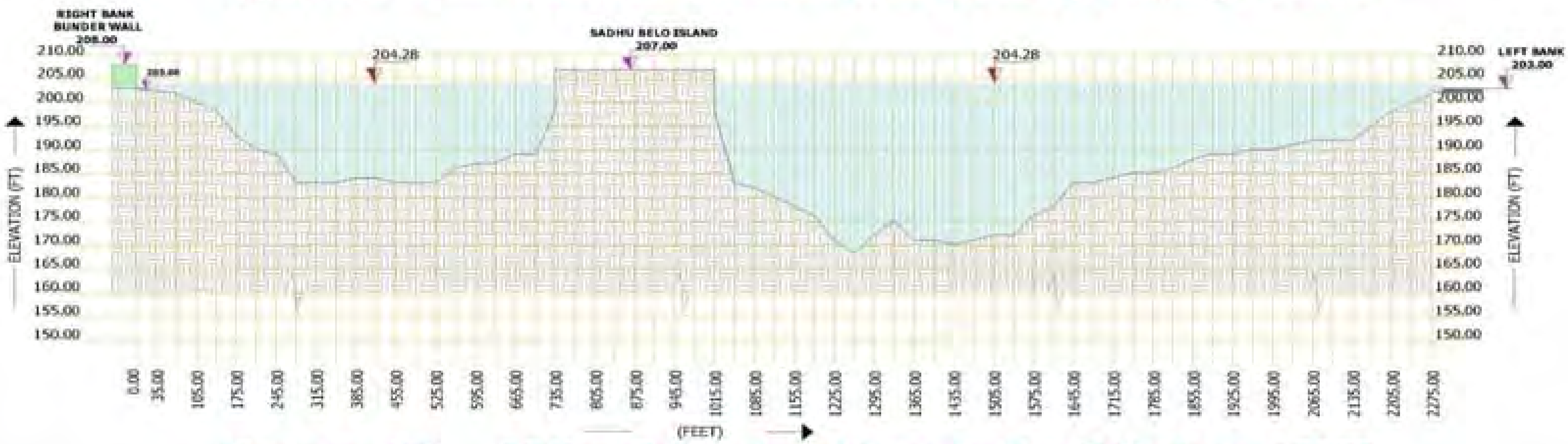


Figure no. 3.8 10 Year Return Period Cross Section @ Chainage +2000

ESTIMATES OF PROJECTED HIGH FLOW LEVELS AT IPS PROPOSED ON NEAR SIDE OF SADHU BELO

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2499-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

Figure no. 3.9 20 Year Return Period Cross Section @ Chainage +2000

Figure no. 3.10 50 Year Return Period Cross Section @ Chainage +2000

ESTIMATES OF PROJECTED HIGH FLOW LEVELS AT IPS PROPOSED ON NEAR SIDE OF SADHU BELO

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2499-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

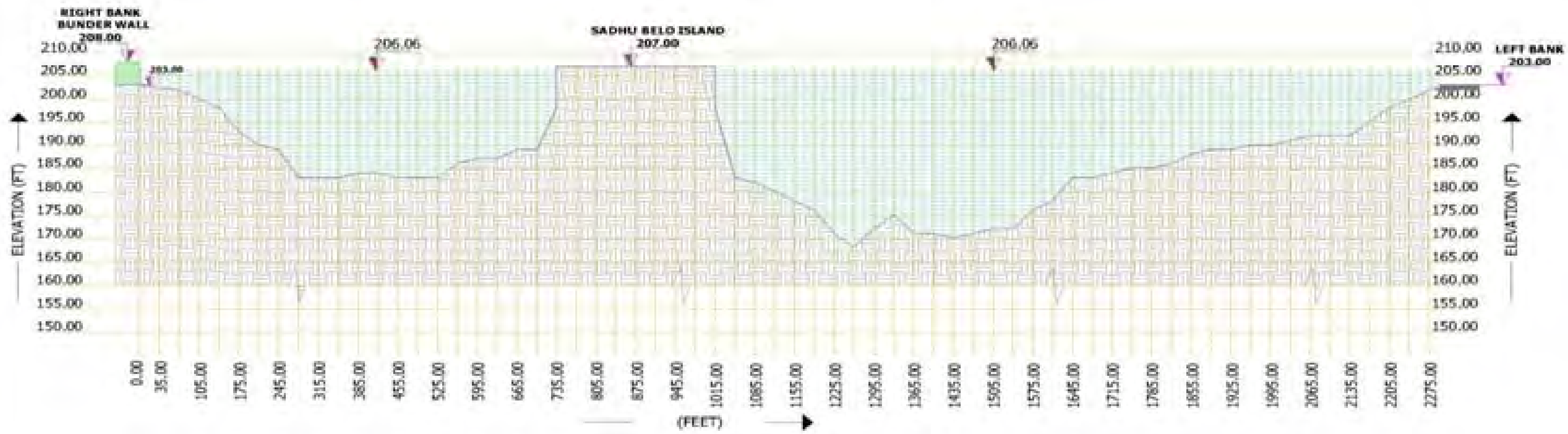


Figure no. 3.11 100 Year Return Period Cross Section @ Chainage +2000

ESTIMATES OF PROJECTED HIGH FLOW LEVELS AT IPS PROPOSED ON NEAR SIDE OF SADHU BELO

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2499-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

Figure no. 3.12 1 Year Return Period Cross Section @ Chainage +2000

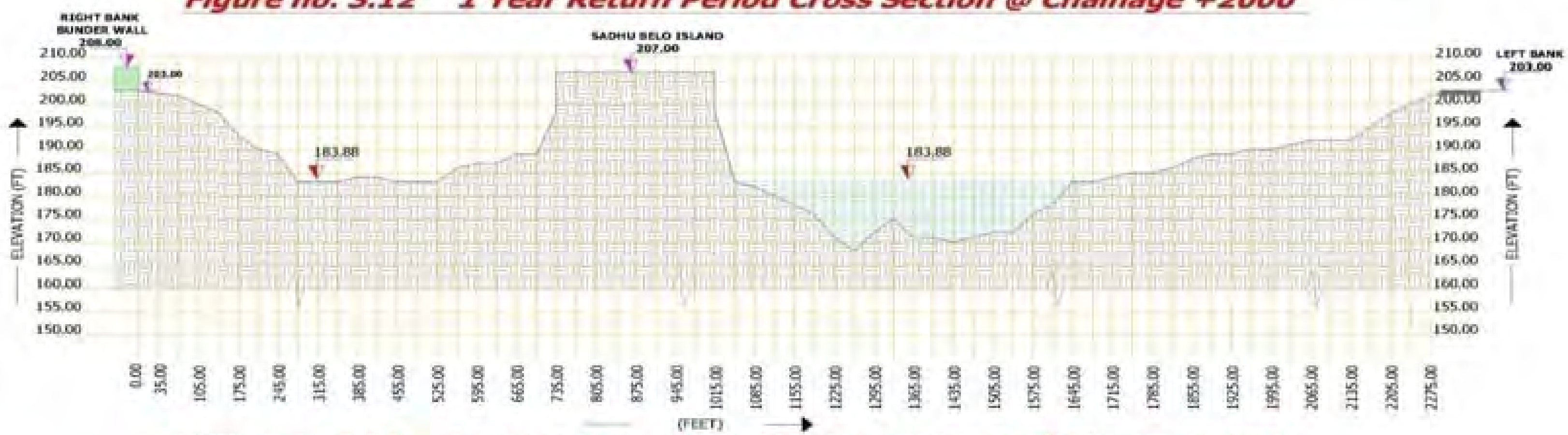


Figure no. 3.13 2 Year Return Period Cross Section @ Chainage +2000

ESTIMATES OF PROJECTED LOW FLOW LEVELS AT IPS PROPOSED ON NEAR SIDE OF SADHU BELO

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2499-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

Figure no. 3.14 5 Year Return Period Cross Section @ Chainage +2000

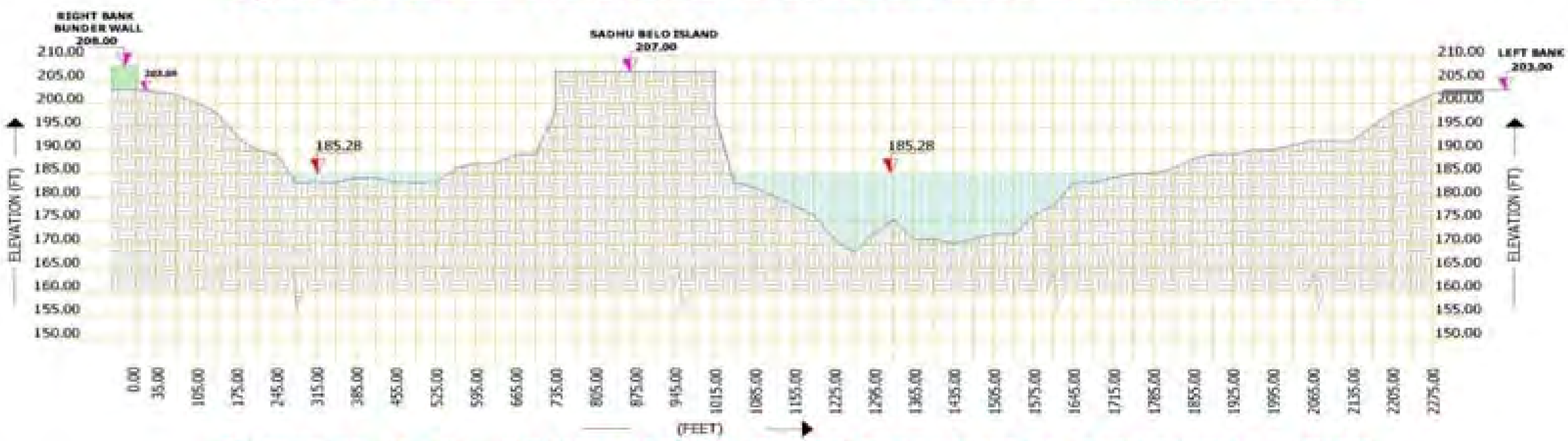


Figure no. 3.15 10 Year Return Period Cross Section @ Chainage +2000

ESTIMATES OF PROJECTED LOW FLOW LEVELS AT IPS PROPOSED ON NEAR SIDE OF SADHU BELO

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2499-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

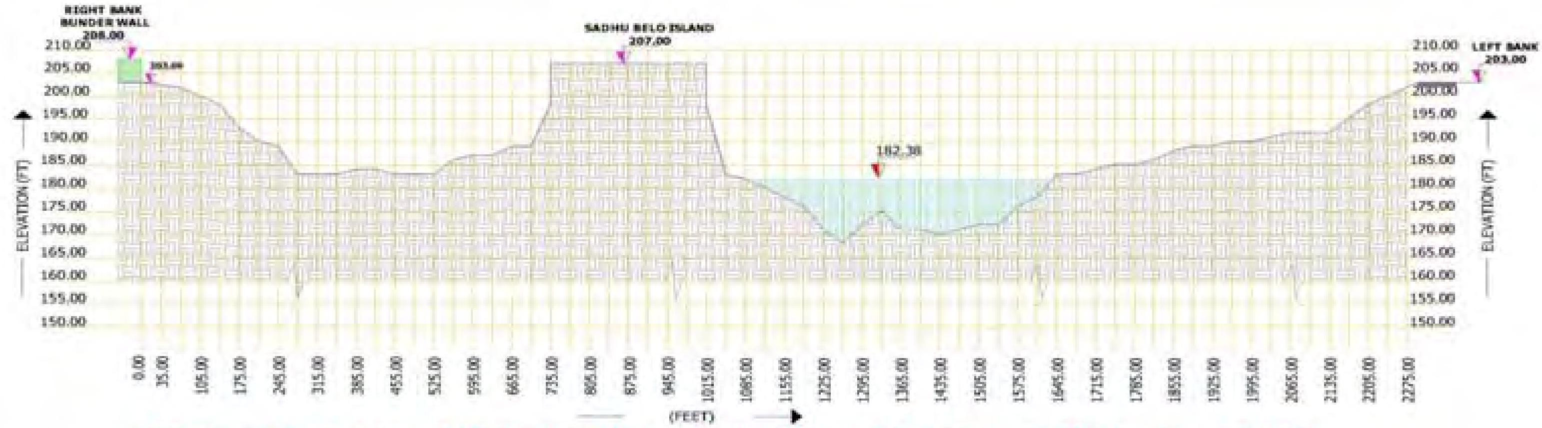


Figure no. 3.16 20 Year Return Period Cross Section @ Chainage +2000

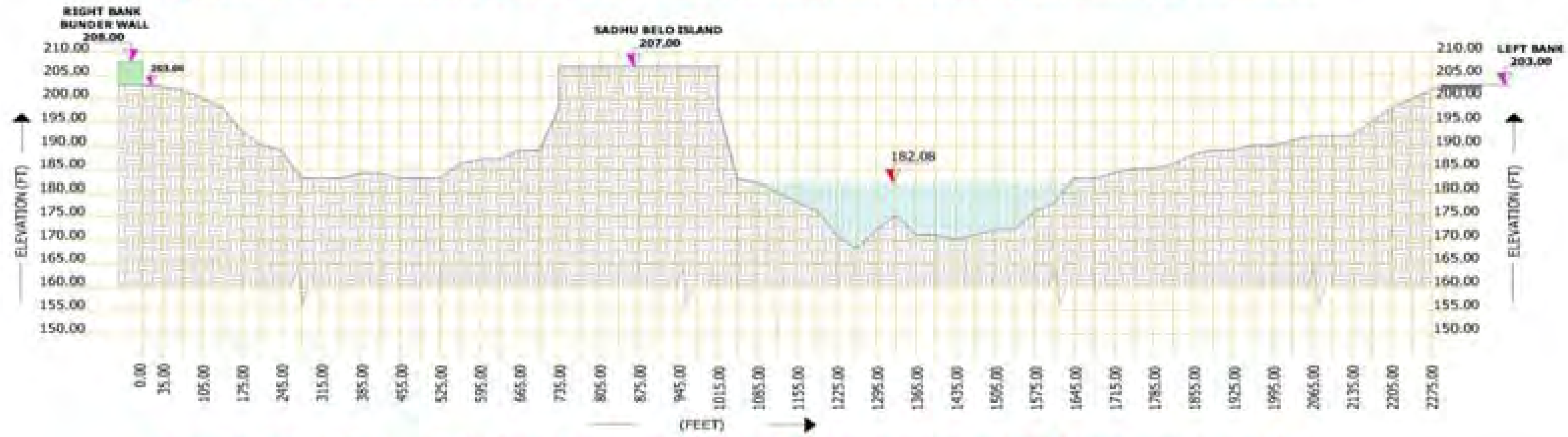


Figure no. 3.17 50 Year Return Period Cross Section @ Chainage +2000

ESTIMATES OF PROJECTED LOW FLOW LEVELS AT IPS PROPOSED ON NEAR SIDE OF SADHU BELO

Title	CONSULTING SERVICE FOR OPTIMAL APPROACHES, REVIEW & FEASIBILITY STUDY ON WATER AVAILABILITY AT SUKKUR INTAKE (ADB LOAN 2499-PAK)	Client	North Sindh Urban Services Corporation Limited	Consultants	RCC Consultants

4. EFFECTS OF SUKKUR BARRAGE GATE OPENINGS AND DIVERSIONS ON THE AVAILABLE LOW WATER LEVEL FOR WATER SUPPLY

4.1 HISTORY OF SUKKUR BARRAGE

The Sukkur Barrage is the oldest barrage of Sindh. It was built during the British Raj from 1923 to 1932 and was named as Lioyd Barrage but was later changed as Sukkur Barrage. It is located between Guddu & Kotri Barrages and has the largest command area. There are seven canals which take-off form Sukkur Barrage; three on the right side while four on the right side. Table 4.1 describes several features of these canals.

Table 4.1 Salient Features of Canal Off-taking from Sukkur Barrage

FEATURES	RIGHT BANK			LEFT BANK			
	North West Canal	Rice Canal	Dadu Canal	Kahirpur Feeder West	Rohri Canal	Khairpur Feeder East	Nara Canal
1. Start of Operation	1932	1932	1932	1932	1932	1932	1932
2. Culturable Commanded Area (Acres)	940,014	519,660	550,963	322,000	2,601,213	369,596	2,240,186
3. Original Design Discharge (Cusecs)	5,152	10,658	3,150	1,940	10,887	2,094	13,649
4. Maximum 10 days Av. withdrawl (1971-90)	9,600	13,500	5,700	2,600	16,600	3,190	13,600
5. Design Cultivation (Acres)							
(a) Kharif	27	88	27	32	27	32	28
(b) Rabi	54	-	54	48	54	48	53

In 1859, the then Superintendent Engineer with Government of Sindh Mr. Fife recommended a weir barrage, across the River Indus almost at the present position of Sukkur Barrage. Weir was to control the level of water in the River Indus and a canal was to take off from this point to Irrigate present Khairpur, Nawabshah and Hyderabad

Districts. The scheme underwent changes at various stages adding more canals and finally the present Sukkur Barrage was conceived. In 1859 the technology of engineering design was not highly advanced and machines were not available for construction purpose. Diesel and petrol engines were not yet invented and it was the age of steam engine with heavy boilers and yet it was a courageous proposal. Magnitude of this barrage can be gauged from the fact that the Suez Canal which was built in 1869 and considered to be an engineering milestone is only as wide as Nara canal (one of the seven canals at Sukkur Barrage) and only 20 miles long.

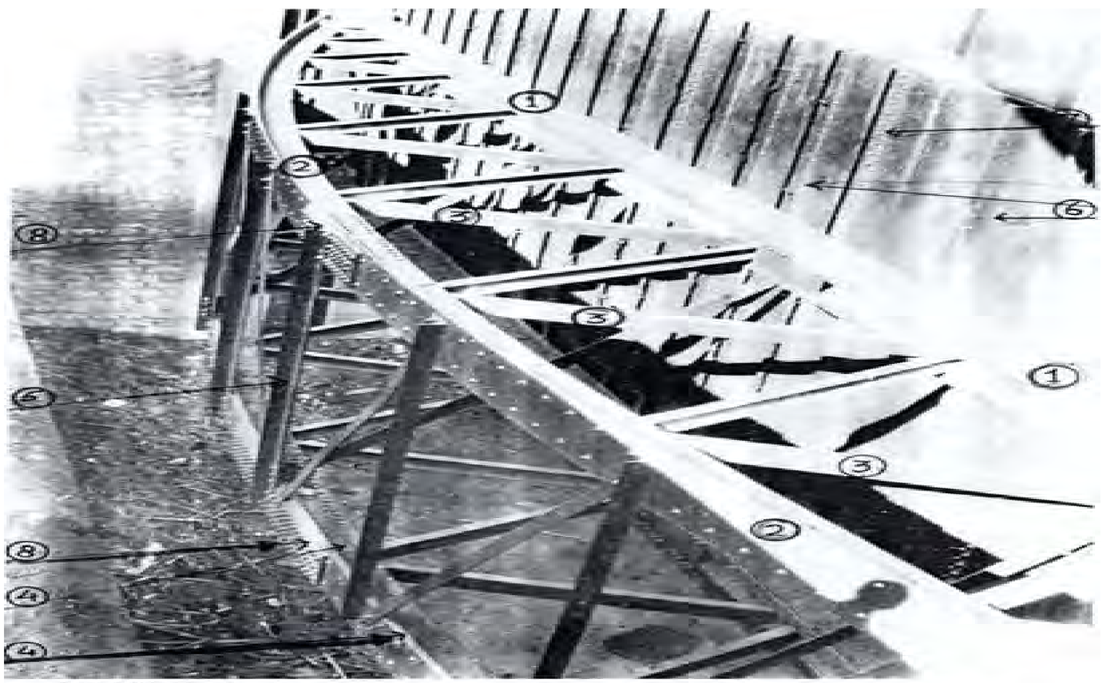
Sukkur Barrage is meant to maintain the desired level of water on the upstream side of River Indus called as pond. When water in the River is in excess, the surplus has to be allowed to flow downstream by raising the gates and in periods of short fall water to the downstream side is reduced to maintain desired level on the upstream side. The designed level of water as envisaged in the plan was 194.5 ft above sea level where as the bottom of the River at Barrage gates is maintained at 177 ft above sea level. There are 66 gates, 50 ft wide and 20 ft high to control the water level. The gates are separated by piers 10 ft, wide. Since construction of Sukkur Barrage, a large number of other Barrages have come upon the Indus and its tributaries. Presently 72% of total area within command of these canals is perennial i,e they get water year around instead of water availability for only 50-120 days pre-barrage era. The total area under the command for the Barrage is 82 lacs acres of which 76.3 lacs are cultivated and of this more than 90% is cultivated annually.

4.2 PURPOSE OF ANNUAL OPENING OF SUKKUR BARRAGE GATES

The canals of Sukkur Barrage close for annual repair normally form 25^{th} December to 10^{th} January, however delayed closures from January 6^{th} to 21^{st} are also seen in the data collected for lat 50 years. During canal closures, the gates of Sukkur Barrage are fully opened for annual maintenance. Sukkur Barrage gates consist of several components of steel structure. Figure 4.1 illustrates Gate No. 09 typical components.

The gate no-9 faces an island artificially created for the river training to reduce excessive silt entry into right Bank canals.

The typical gate originally was fabricated in three parts which were joined with riveted plates. Water is held on the front of the plates which are 50 ft wide and 20 ft high. The total pressure of water on the plates of each gate when submerged 18 ft deep would be about 300 tons. This pressure is borne by the bow-string girders. The horizontal braces are meant to strengthen the bow and string girder. The vertical braces equalize the load between upper and the lower girders, as there is more pressure on the lower girder than the upper one due to depth of water. The horizontal braces are formed form steel channels, and the vertical braces are made from angle iron.



Gate No. 9
Fig. 'A' shows upper bow-string girder. The lower bow is visible and vertical braces connecting the two girders are also seen. They are in good shape.

Figure: 4.1 Typical Components of Gate No. 09 of Sukkur Barrage

Iron and steel corrode due to action of oxygen of the atmosphere. Corrosion is increased if iron is submerged into water as dissolve oxygen in presence of water would react faster than if it were outside. If there is Hydrogen Sulphite present in the water corrosion is much faster. In case of gates the front plates remain partially submerged in water for some months and fully for the rest of the year. Water escaping underneath splashes over the lower bow-string girder and also the vertical braces. The action of corrosion is much faster in case water splashing on metal, than when fully submerged as more and more oxygen would come in contact with metal both form water and from atmosphere with every splash. This cannot be stopped or eliminated all together. As a mean of maintenance the gates are cleaned each year by sand blasting and painting. Every time the gate is sand blasted some of the metal is removed along with corroded material. The annual cleaning therefore results in thinning down of gates specially the lower braces and there is no escape from it. This would in general reduce the life of the gates and there would be a time limit when the gates would need replacement. It is therefore for these reasons that gates of barrage and as well of canals are opened for an average of 15 days a year for the essential maintenance, besides the maintenance of barrage structure.

4.3 EFFECT OF GATE OPENING ON POND WATER LEVELS

As soon the barrage gates are fully opened and the canal gates are fully closed the pond level drops and the ensuing dropped water levels then represent the natural river flow at that time. Analysis of last 50 years data indicate that during closure period average pond level drops to 184.0ft. Table 4.2 below gives data analysis report during closure periods from 1961 up to 2011.

Table: 4.2 Closure periods from year 1961 to 2011

YEAR	Closure days	Total No of Closure Days	Gauge Level	Closure Period	
				From	**To**
1961-1962	16	16	185.56	01-01-1962	16-01-1962
1962-1963	8	15	184.22	24-12-1962	17-01-1963
	7				
1963-1964	6	17	185.57	26-12-1963	11-01-1964
	11				
1964-1965	5	20	184.88	27-12-1964	15-01-1965
	15				
1965-1966	6	17	183.94	26-12-1965	11-01-1966
	11				
1966-1967	6	15	183.33	26-12-1966	09-01-1967
	9				

1967-1968	6 5	11	187.20	26-12-1967	06-01-1968
1968-1969	4 9	13	184.96	28-12-1968	06-01-1969
1969-1970	6 8	14	184.72	26-12-1969	06-01-1970
1970-1971	13	13	193.43	26-12-1970	06-01-1971
1971-1972	7	7	185.11	12-01-1972	18-01-1972
1972-1973	5 10	15	185.86	27-12-1972	10-01-1973
1973-1974	15	15	185.23	11-01-1974	26-01-1974
1974-1975	15	15	185.23	13-01-1975	28-01-1975
1975-1976	6 9	15	184.61	26-12-1975	11-01-1976
1976-1977	15	15	185.23	11-01-1977	26-01-1977
1977-1978	15	15	184.18	02-01-1978	16-01-1978
1978-1979	15	15	185.22	07-01-1979	21-01-1979
1979-1980	14	14	185.90	07-01-1980	21-01-1980
1980-1981	25	25	185.80	07-01-1981	31-01-1981
1981-1982	14	14	185.39	07-01-1982	20-01-1982
1982-1983	12 6	18	185.20	20-12-1982	06-01-1983
1983-1984	15	15	187.46	07-01-1984	21-01-1984
1984-1985	16	16	185.28	06-01-1985	21-01-1985
1985-1986	16	16	186.58	06-01-1986	21-01-1986
1986-1987	16	16	183.58	06-01-1987	21-01-1987
1987-1988	16	16	184.48	01-01-1988	16-01-1988
1988-1989	15	15	184.28	06-01-1989	20-01-1989
1989-1990	16	16	186.53	05-01-1990	20-01-1990
1990-1991	16	16	184.08	07-01-1991	21-01-1991
1991-1992	15	15	184.28	07-01-1992	20-01-1992
1992-1993	15	15	185.98	06-01-1993	20-01-1993
1993-1994	16	16	187.08	06-01-1994	21-01-1994
1994-1995	18	18	182.28	06-01-1995	23-01-1995
1995-1996	15	15	187.28	11-01-1996	25-01-1996
1996-1997	13	13	183.78	08-01-1997	20-01-1997
1997-1998	16	16	184.68	06-01-1998	21-01-1998
1998-1999	16	16	185.98	06-01-1999	21-01-1999
1999-2000	14	14	184.38	07-01-2000	20-01-2000
2000-2001	13	13	182.48	06-01-2001	18-01-2001
2001-2002	16	16	180.62	07-01-2002	22-01-2002
2002-2003	19	19	181.48	06-01-2003	24-01-2003
2003-2004	17	17	180.98	07-01-2004	23-01-2004
2004-2005	24	24	182.88	02-01-2005	25-01-2005
2005-2006	21	21	182.08	07-01-2006	27-01-2006
2006-2007	15	15	184.78	07-01-2007	21-01-2007
2007-2008	16	16	184.28	07-01-2008	22-01-2008
2008-2009	15	15	183.48	07-01-2009	21-01-2009
2009-2010	16	16	185.68	07-01-2010	22-01-2010
2010-2011	14	14	184.48	07-01-2011	20-01-2011

Following facts have been extracted from contents of table 4.2,

1. Total closure days since 1961 to 2011 :784 days
2. Average closure days per year :15.86 days
3. Minimum closure days (1971-72) : 7 days
4. Maximum closure days (1980-81) : 25 days

It is shown in River Bed Report section-3 that River Bed levels within pond area vary from 160.0 ft up to 188.0ft. Thus it is obvious that during closure period when levels fall as low as 182.0ft, river bed gets exposed at several locations. Cross section profile of River Indus during typical closure period at location of interests are shown in figures 4.2 to 4.4

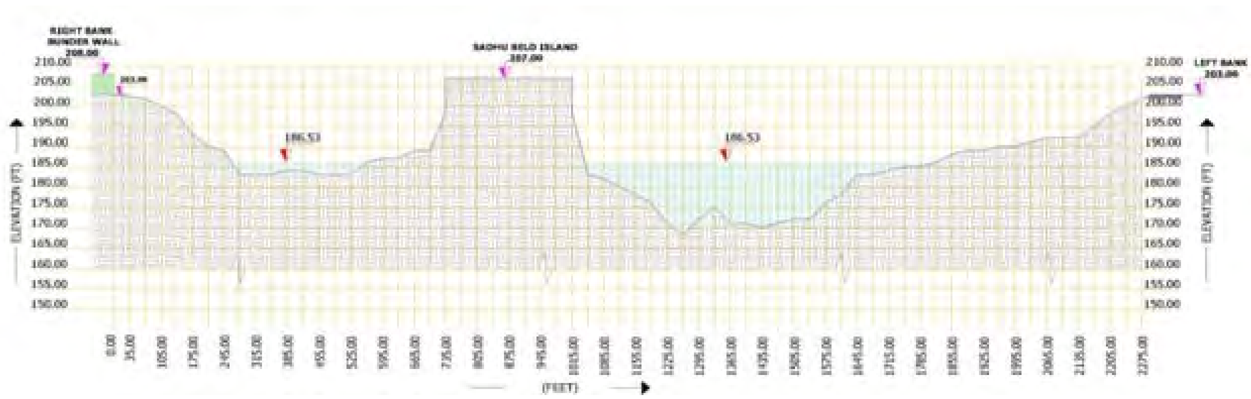


Figure 4.2 Low Flow Levels at Sadhu Bela

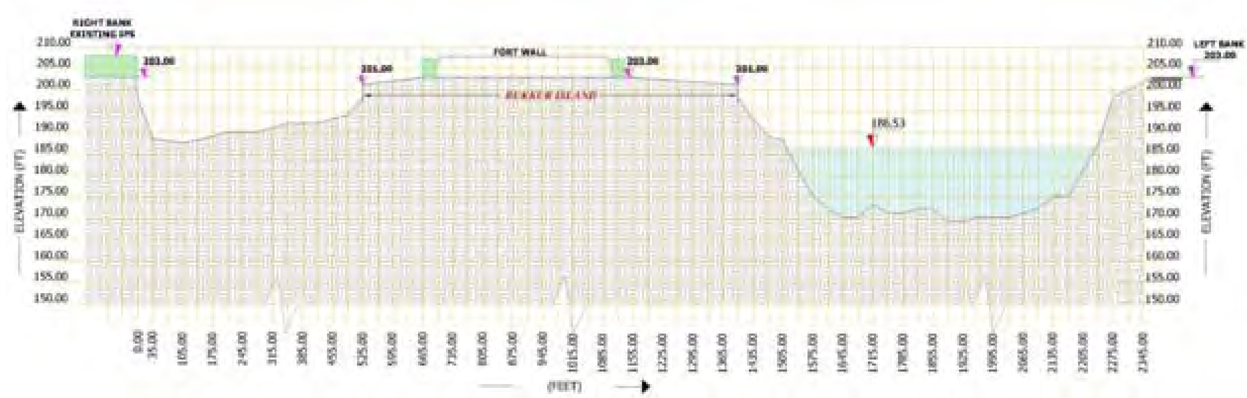


Figure 4.3 Low Flow Levels at Existing IPS

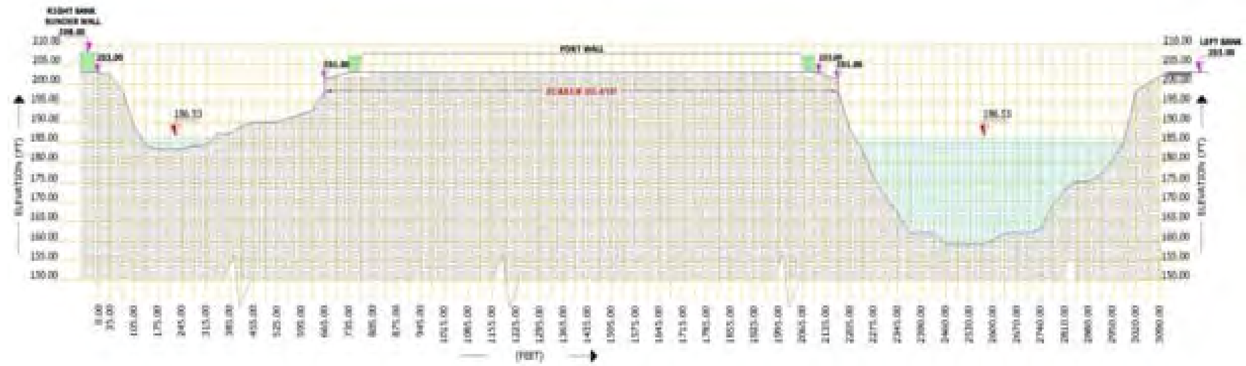


Figure 4.4 Low Flow Levels at Lansdowne Bridge

The above figures indicate that right side of river Indus within the surveyed area dries up completely and that the normal river flow occurs on the Left side during the closure period.

Using data analysis more clearer picture emerges in figure 4.5 where dried up bed and river flow path during the closure period is drawn statistically.

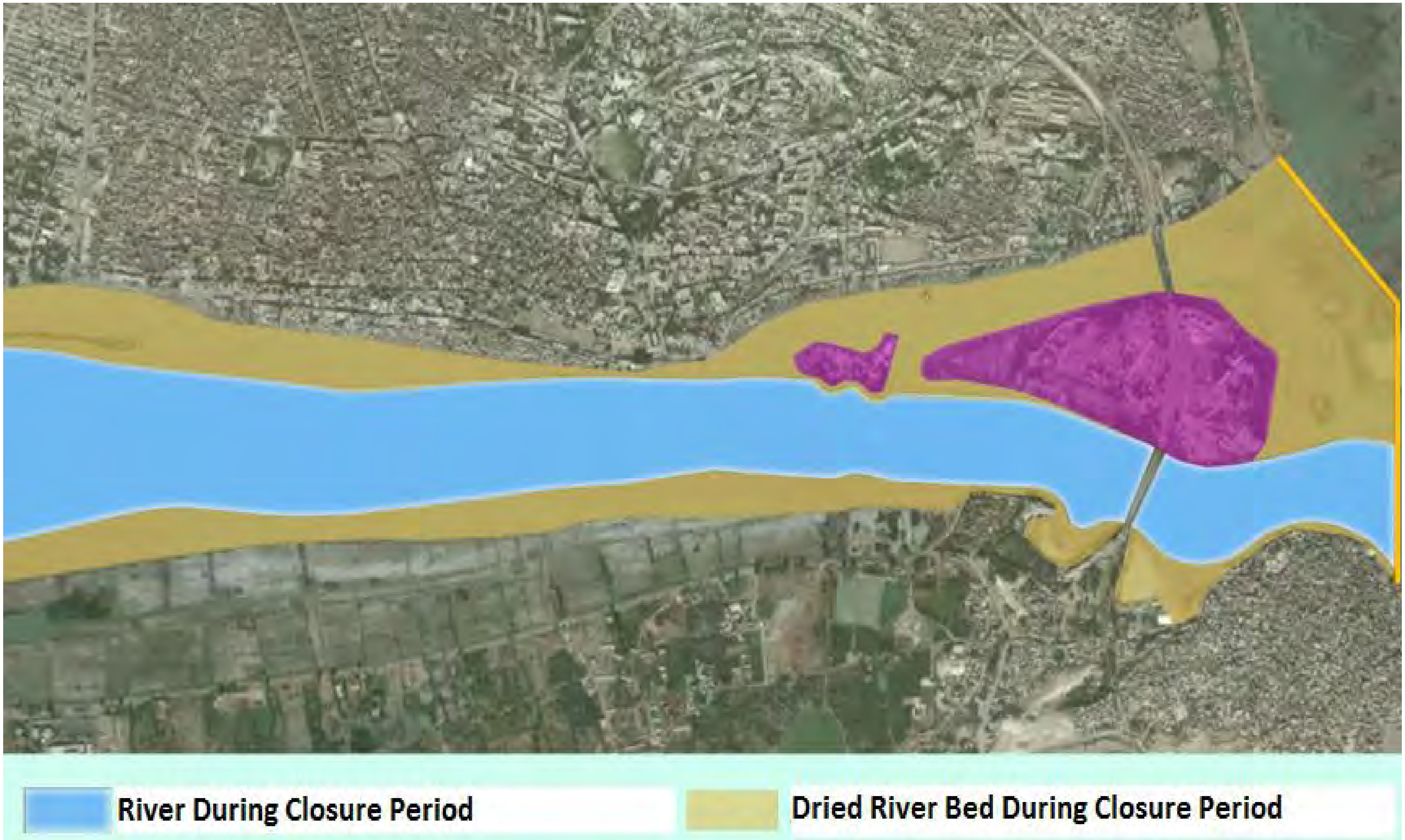


Figure: 4.5 Effects of Sukkur Barrage Gate Openings (Closure Period) on the available Low Water Level for Water Supply (Figure simulated based on 50 years data)

The figure shows that river bed is exposed at several locations including at present location of intake pumping station. It is further evident that shifting of existing IPS to near side of Island or moving down stream up to Sadhu Bela Island will not solve the problem during the closure period.

The figure further indentifies potential locations for new IPS, where round the year water shall be available and these are but not limited to, one opposite to present IPS on far side of Island and second on immediate upstream or downstream sides of Lansdowne Bridge.