SFG3971

Government of Sindh, Pakistan

Sindh Barrages Improvement Project -
Sukkur Barrage Rehabilitation and Modernization

ENVIRONMENTAL AND SOCIAL ASSESSMENT

EXECUTIVE SUMMARY

Sindh Irrigation Department

December 2017

Contents

List of Tables and Figures

List of Acronyms

Ac	Acre	Ha	Hectare
BCM	Billion Cubic Meter	HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
CEAP	Construction Environmental Action Plan	MEC	Monitoring and Evaluation Consultant
CIA	Cumulative Impact Assessment	MAF	Million Acre Foot
CO_2	Carbon dioxide	NEQS	National Environmental Quality Standards
CSC	Construction Supervision Consultant	OP	Operational Policies
Cumec or m^3/s	Cubic meters per second	PMO	Project Management Office
Cusec	Cubic feet per second	POE	Panel of Experts
dB	Decibels	RAMSAR	Convention on Wetlands Signed in Ramsar Iran
ECP	Environmental code of Practice	RPF	Resettlement Policy Framework
EHS	Environmental Health and Safety	SEPA	Sindh Environmental Protection Act
EIA	Environmental Impact Assessment	Sindh-EPA	Sindh Environmental Protection Agency
ESA	Environmental and Social Assessment	SID	Sindh Irrigation Department
ESIA	Environmental and Social Impact Assessment	SAP	Social Action Plan
ESMP	Environmental and Social Management Plan	SMF	Social Management Framework
g	Peak ground acceleration		
GDP	Gross Domestic Product		
GoS	Government of Sindh	WCA	Watercourse Associations
IBIS	Indus Basin Irrigation System	USD	United States Dollar
IEE	Initial Environmental Examination	WAA	Water Apportionment Accord
IFC	International Finance Corporation	WAPDA	Water and Power Development Authority
IRSA	Indus River System Authority	WBG	World Bank Group
IUCN	International Union for Conservation of Nature	WSIP	Water Sector Improvement Project
GRC	Grievance Redress Committee	WWF	World Wide Fund for Nature

Conversions

British Units	Metric Units	Metric Units	British Units
1 ft	0.305 m	1 m	3.28 ft
1 mile	1.609 km	1 km	0.621 miles
1 cusec	0.283 m^3/sec	1 m^3/sec	35.315 cusec
1 ac	0.405 Ha	1 ha	2.47 ac
1 MAF	1.2335 BCM	1 BCM	0.8107 MAF

1. Introduction

The Sukkur Barrage Rehabilitation and Modernization Project (the Project) is a proposed project, by the Government of Sindh (GoS), for rehabilitation of the 85-year old Sukkur barrage to enhance its useful life to safeguard the reliable supply of irrigation water to about 3.33 million ha[1]. The project is located near the towns of Sukkur and Rohri in Sindh province. The GoS has requested funding for this Project from World Bank through additional financing (AF) under the current Bank funded 'Sindh Barrages Improvement Project' (SBIP). Sindh Irrigation Department (SID) is the executing agency of the Project. SID has prepared a comprehensive Environmental and Social Assessment (ESA) for the Project and presented in a main ESA report. This Executive Summary presents a summary of the potential environmental and social impacts of the Project as described in the ESA. Mitigation measures are described and included in environmental and social management plan (ESMP) to address potential impacts as well as to enhance the environmental and social benefits of the project.

1.1. Background

Agriculture is the mainstay of Sindh economy. About 60 percent of 42 million Sindh population live in rural areas and mainly depend on agriculture and related activities for their livelihood. About 30-35 percent of Sindh's population lives below poverty line, and a majority of the poor are rural. Pakistan produces over 108 million tonnes of agricultural commodities worth over USD 13 billion annually. Sindh contributes about 23 percent to country's agriculture Gross Domestic Product (GDP). In recent decades, agriculture's contribution to Pakistan's GDP has declined; however, it still accounts for 21.6 percent of GDP. Agriculture GDP consists of 32.8 percent major crops, 11.1 percent minor crops, 53.2 percent livestock, 2.9 percent fisheries and forestry. Through its production, agriculture contributes 60 percent to the country's export earnings and 45 percent of the nation's labor force. Pakistan is among the top 20 global producers in over 48 different agricultural commodities and Sindh substantially contribute towards production of rice, sugarcane, wheat and cotton.

Irrigation is critical for agriculture in Sindh. Rain-fed agriculture is not possible in Sindh since it falls under 'hot desert climate' (Koeppan classification), where annual rainfall is very low (about 100 mm) compared to annual potential evapotranspiration (over 2200 mm). About 78 percent of groundwater in Sindh is generally saline (except along Indus) and not suitable for irrigation. Thus without canal irrigation, agriculture is not possible in Sindh. Even before construction of barrages, for centuries some areas in Sindh had depended on flood waters of Indus for agriculture through its old Inundation Canal Systems (artificial inundation canals that were linked to Indus and received water when there were high flows or floods). Inundation canals generally provided uncertain and precarious supplies during crucial sowing and maturity periods. Further, due to upstream construction of barrages, this region received only marginal supplies for inundation canals.

Indus Basin Irrigation System and barrages in Sindh. Pakistan's agricultural sector is almost wholly dependent on irrigation, particularly the Indus Basin Irrigation System (IBIS). IBIS accounts for approximately USD 300 billion of investment (at current rates), 22 percent of the country's GDP, 65 percent of its employment, and 70 percent of its export earnings. Sindh is the primary beneficiary of IBIS with three large barrages built on the Indus River. First barrage Sukkur was commissioned in 1932 followed by Kotri and Guddu in 1955 and 1962, respectively. These three barrages divert about 59 billion cubic meters (BCM) of water to a cultivable command area of about 5.1 million ha. Besides transforming desolate and barren lands of Sindh in to green fields

[1] The potential command area of Sukkur barrage is about 3.34 million ha, but actual irrigation area is about 3.08 million ha. About 600,000 farming households are directly benefitted by the barrage.

and fertile depository of grain, these barrages were also instrumental for establishment of agro-based and agro-allied industry to open and provide new vistas of employment and job opportunities for the expanding population of Sindh.

Sukkur Barrage has the largest irrigation network in the country. Sukkur Barrage is one of the most important and strategic structures of the Indus Basin Irrigation System. About 80 percent of the agriculture land in Sindh depends on the Sukkur barrage. The barrage has seven canals, four on the left bank (Nara, Khairpur Feeder East, Rohri and Khairpur Feeder West) and three on the right bank (Dadu, Rice and North Western). The left bank canals serve 11 districts of Sindh (Sukkur, Khairpur, Noshehro Feroze, Nawabshah, Sanghar, Mirpurkhas, Umarkot, Badin, Hyderabad, Tando Allahyar and Tharparker); while the right bank canals serve four districts of Sindh (Shikarpur, Larkana, Shahdad Kot and Dadu) and one district of Baluchistan (Dear Allah Yar). A total of 1,805 villages comprising of 13,746 settlements are located in the command areas of the seven canals. The barrage is also used for river control and flood management, act as a source of water supply for all sectors of the economy, function as a bridge over Indus. Therefore, the condition and the safe and reliable operation of the Sukkur barrage have far-reaching implications for the livelihood and economic growth of all segments of society in Sindh.

Need for improvement of Sukkur barrage. After eight decades of its useful life, the Sukkur barrage in Sindh have developed major safety issues. The feasibility study of Sukkur barrage has identified many issues such as (i) insufficient flood evacuation capacity through the barrage arches under the gates, (ii) sedimentation of the left and right pockets in front of the intakes of the canals, (iii) silting up of right bank canals, (iv) scour at the left pocket, (v) outdated equipment and electrical system, and (vi) need for some local structural repairs on arches, piers and road deck. There is a risk to the barrage in case of large flood events, and any failure of the barrage during those events is likely to be catastrophic affecting water supplies to all the irrigated areas of the barrage and flooding the Sukkur town. The feasibility study concluded that substantial rehabilitation, maintenance and improvement works, including critical structural repairs, desilting, upgrading of the gate lift structure and electric wire system; the current barrage can increase the flood passage capacity to 1.2 million cusec (33,980 m^3/s) from the current flood capacity of 1.9 million cusec (25,485 m^3/s).

1.2. Sindh Barrages Improvement Project (SBIP)

SBIP is an ongoing Bank funded project for rehabilitation of the fifty-year-old Guddu barrage to enhance its useful life to safeguard the reliable supply of irrigation water to about 1.05 million ha. SBIP became effective in November 2015.

Safeguard instruments of SBIP: The SID has prepared an ESA and Social Management Framework (SMF) for the Guddu Barrage Rehabilitation. The ESA has adequately prepared all the environmental and social management plans (ESMP) to address the impacts associated with implementation of Guddu rehabilitation. Indus River between the Guddu and Sukkur barrages is a designated game reserve for Indus River dolphin. The ESA has included a dolphin conservation and management plan to strengthen the ongoing conservation activities as well as cumulative impacts associated with the operation of all three barrages in Sindh. During the preparation of SBIP, no land acquisition or resettlement was anticipated for Guddu Barrage rehabilitation. The SMF was prepared, including Resettlement Policy Framework (RPF) to guide preparation of resettlement action plans (RAP) for any unforeseen land acquisition, a Social Action Plan (SAP) to support local area development programs, and a Communication Strategy to support continued consultations during project implementation. The SMF including the RFP has been updated for the proposed AF and presented in a separate cover.

Location of Sukkur Barrage: Sukkur barrage is located across the River Indus some 362 km from Karachi. The Sukkur city (population 0.523 million) is located on the left bank of the barrage

and the Rohri town is located on the right bank of the barrage. The location map of Sukkur barrage and its command area is shown in Figure 1. The Barrage is located about 185 km downstream of Guddu Barrage and about 550 km upstream of Kotri Barrage.

The Proposed Project for Additional Financing: The proposed rehabilitation and modernization works for Sukkur barrage are as follows:

- Removal of about 1.5 million cubic meters (MCM) of sediments from both left and right pockets of the barrage and right bank tail channel through dredging (about 0.75 MCM) and excavation (about 0.75 MCM).
- Removal of about 4.24 MCM of sediments from the right bank canals (3.07 MCM from a 25 km length of Rice canal; 0.92 MCM from a 7 km length of North Western canal; and 0.25 MCM from a 7 km length of Dadu canal)
- Gates and mechanical works for improved gate operations and increasing the gate height by 61 cm (2ft)
- Civil works to improve the strength of barrage structure (RCC arches, stone arches, stone piers, etc.), and
- Electrical works for improved reliable operations

1.3. The Environmental and Social Assessment

Studies and basic data: This ESA is based on field studies and data collected between 2012 and 2017 by the consultant team charged with the design of the project and their reports on Environmental Impact Assessment and Social Impact Assessment.

Independent consultants: A team of independent consultants was retained by SID to validate design consultants reports and prepare independent ESA report this Executive Summary as per guidelines of World Bank. The team comprises Dr. Venkata Nukala (team leader, environmental specialist, email: venkata@eiaPractitioner.com), Dr. Najam Khurshid (ecologist), Mr. Haider Bhugri (social specialist) and Mr. Nijaz Lukovac (engineer). During the ESA process, the independent consultants regularly interacted with the design consultant, carried out their own field visits, participated in consultations, and conducted their independent analysis and impact assessment.

Contents of the present document: After a description of the Sindh and Pakistani legal and administrative framework and the applicable World Bank policies in chapter 2, a project description is presented in chapter 3, followed by a discussion of project alternatives in chapter 4. A description of the physical, chemical, biological and socio-economic environment is given in chapter 5. Potential adverse effects of the project are described in chapter 6 and a review of potential cumulative impacts and concerns associated with other barrages of Sindh are presented in chapter 7. Possible mitigating measures to address potential negative impacts of the project are included in the Environmental and Social Management Plan (ESMP) that is summarized in chapter 8; these measures are presented in more detail in the accompanying ESA. Finally, chapter 9 provides an overview of all stakeholder consultations and activities for disclosure and access to the information.

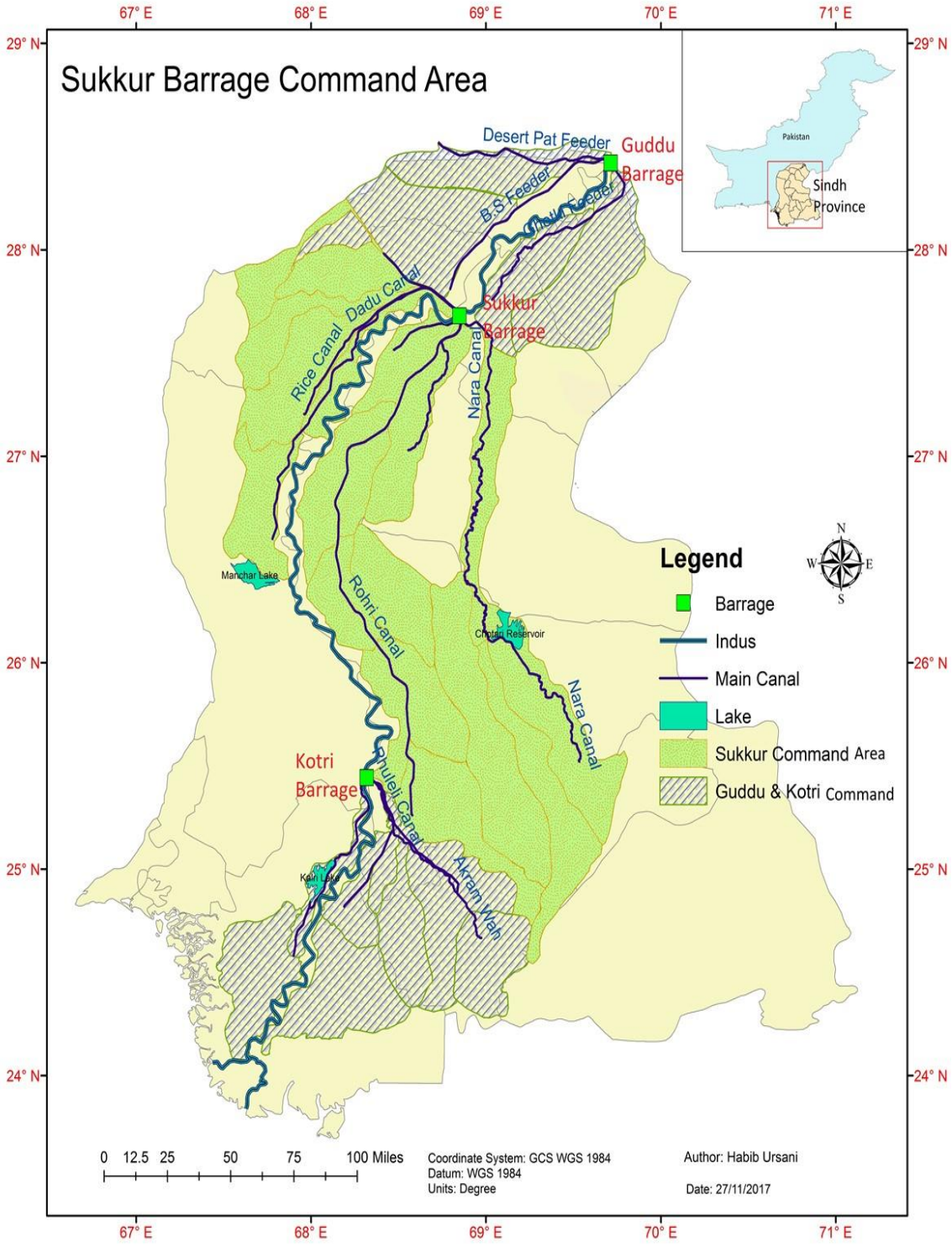

Figure 1: Location of Sukkur Barrage in Pakistan

2. Policy, Legal and Administrative Framework

2.1. Applicable Legislation and Policies in Sindh, Pakistan

Sindh Environmental Protection Act, 2014: The Sindh Environmental Protection Act (SEPA) enacted on March 20, 2014. SEPA is the basic legislative tool empowering the Sindh government to frame regulations for the protection of the environment. The Act provides the framework for protection and conservation of species, wildlife habitats and biodiversity, conservation of renewable resources, establishment of standards for the quality of the ambient air, water and land, establishment of Environmental Tribunals, appointment of Environmental Magistrates, Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) approval. It also describes the powers and functions of the Sindh Environmental Protection Agency (Sindh EPA). The requirement to conduct environmental IEE or EIA before commencing developmental projects is a requirement under this Act.

Other Relevant Legislation in Sindh: legislation and regulations relevant to the proposed project are listed below

- Sindh Wildlife Protection Ordinance (2001)
- Wild Birds and Animals Protection Act (1912)
- Sindh Fisheries Ordinance (1980)
- The Sindh Water Management Ordinance (2002)

Other Relevant Legislation in Pakistan: Other legislation and regulations relevant to the proposed project are listed below.

- Pakistan Penal Code (1860) deals with offences against public interests, e.g., to control noise, toxic emissions and disposal of effluents;
- Land Acquisition Act (1894) is the key legislation has direct relevance to resettlement and compensation in Pakistan. Each province has its own interpretation of the LAA, and some provinces have also passed provincial legislations. The LAA and its implementation rules require that before implementation of any development project the privately owned land and crops are compensated to titled landowners and/or registered tenants/users etc.;
- Factories Act (1934) provides regulations for safe handling and disposal of toxic and hazardous materials by contractors;
- Protection of Trees Act (1949) prohibits cutting and logging of trees planted by the Forest Department along roads and canals;
- Antiquity Act (1975) protects antiquities and empowers the GoP to prohibit excavation and construction works in any area that may contain objects of archaeological or cultural historic value;
- Motor Vehicle Ordinance (1965) empowers licensing and other authorities to regulate traffic rules, speed and weight limits and vehicle use;
- Labor Laws: labor rights are provided in the Constitution of Pakistan; various acts and ordinances provide additional rules for working hours, minimum working age and conditions of employment;
- Highway Safety Ordinance (2000) includes provisions for licensing and registration of vehicles and construction equipment;

- Local Government Ordinance (2001) deals with enforcement of laws for land use, conservation of natural vegetation, air, water, disposal of solid waste and wastewater effluents, public health and safety; and

Regulations and Guidelines: The regulations and guidelines relevant for the present ESA are listed below.

- Pakistan EPA Initial Environmental Examination (IEE) and EIA Regulations (2000);
- National Environmental Quality Standards (NEQS) (2000), with updates in October 2010;
- Guidelines for the Preparation and Review of Environmental Reports (1997);
- Guidelines for Public Consultations (1997);
- Guidelines for Sensitive and Critical Areas (1997); and
- Policy and procedures for filing, review and approval of Environmental Assessments (2000).

International Treaties signed by Pakistan: Pakistan is a signatory to a number of international environment-related treaties, conventions, declarations and protocols. The following are the relevant international treaties and conventions to which Pakistan is a party:

- Convention on Biological Diversity, Rio de Janeiro (1992);
- United Nations Framework Convention on Climate Change, Rio de Janeiro (1992);
- Vienna Convention for the Protection of the Ozone Layer, Montreal (1987);
- Convention on Wetlands of International importance especially as Waterfowl Habitat, Ramsar (1971) and its amending protocol, Paris (1982);
- Convention on Conservation of Migratory Species of Wild Animals (1979);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington (1973);
- Convention concerning the Protection of World Culture and Natural Heritage (World Heritage Convention) (1972);
- International Plant Protection Convention (1951); and
- Kyoto Protocol (1997) and Copenhagen Accord (2009) on climate change.

2.2. Environmental Procedures

Environmental Impact Assessment: In accordance with the Sindh Environmental Protection Act of 2014 and the Pak-EPA IEE and EIA Regulations, 2000, an EIA is required for major barrage rehabilitation projects.

EIA Approval: The owner of the project, i.e., SID shall submit EIA to the provincial environmental authority, Sindh-EPA. After submission of the EIA report, a thirty (30) day period for public comment shall be provided. The assessment will be completed within a period of ninety days from receipt of the complete documents, and earlier than this wherever practicable. Following the completion of public hearing, if required, and the provision of any further data from the proponent, the decision shall be made and conveyed thirty days thereafter.

2.3. World Bank Safeguard Policies

The World Bank's environmental and social safeguard policies relevant to the project are summarized in Table 1 and include the following. The AF does not trigger any new policy.

Environmental Assessment (OP 4.01): The original operation is classified as Category A due to the major rehabilitation works on Guddu Barrage and potential impacts on the core habitat of

endangered Indus River Dolphin located immediately downstream of Guddu Barrage. The classification remains the same for the proposed AF.

Natural Habitat (OP 4.04): The Indus River between the Guddu and Sukkur barrages is the nationally designated game reserve for Indus River Dolphin and also a RAMSAR wetland of international importance. This part of the river contains large population of dolphins. Impacts of construction activities on dolphins were assessed and mitigation measures are proposed in ESMP. A dolphin conservation and management plan is being implemented under SBIP to strengthen the ongoing conservation activities.

Involuntary Resettlement (OP 4.12): No land acquisition is anticipated for the proposed AF. However, minor temporary or permanent land acquisition or resettlement might be required, depending on contractor's camp location or if a location study during the AF implementation indicates removal of an bank island and/or a shoal (or bela in the local language) on the right bank. A resettlement policy framework (RPF) has been prepared for the original project and updated for the proposed AF.

Safety of Dams (OP 4.37): The dam safety Policy is triggered and an action plan has been developed, including establishment of an independent panel of experts to review the project design and emergency preparedness plan.

International Waterways (OP 7.50): The project is located on the Indus River, which is an international waterway shared by Afghanistan, China, India and Pakistan. Therefore, OP 7.50 International Waterways is triggered but the AF falls within the exception to the notification requirement set forth in paragraph 7(a) of OP7.50, because project investments primarily involve rehabilitation of existing barrage facilities and have no impact on water use or quantity of water flows of Indus River.

Access to Information: This policy sets out the Bank's requirements for disclosing and sharing information. The policy reaffirms the Bank's commitment to transparency and accountability in its activities for promoting development effectiveness and poverty reduction. The ESA report and this Executive Summary will be disclosed at SID website and World Bank Info Shop in addition to sharing them with the stakeholders including the local community.

In addition, the following policies and guidelines have been taken into account in the project design:

Environmental Health and Safety Guidelines: The World Bank Group Environment, Health, and Safety (EHS) General Guidelines (2007) contain performance levels and measures for development of industrial projects that are considered to be achievable in new facilities at reasonable costs by existing technology. The EHS guidelines relevant to the Project are General[2], Ports, Harbors and Terminals[3] (relevant sections on dredging activities); and Construction Materials Extraction[4].

Gender Policy (OP 4.20): The World Bank's Gender Policy aims to reduce gender disparities and enhance women's participation in the economic development of member countries. During the ESA, gender aspects have been considered and women's participation has been ensured as far as possible while carrying out the stakeholder consultations.

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[2] http://www.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES

[3] http://www.ifc.org/wps/wcm/connect/d2f2cf88-ce22-4a48-86fc-45ee3b8e9e45/20170201-FINAL_EHS+Guidelines+for+Ports+Harbors+and+Terminals.pdf?MOD=AJPERES

[4] http://www.ifc.org/wps/wcm/connect/d6bb0e80488551afa93cfb6a6515bb18/Final%2B-%2BConstruction%2BMaterials%2BExtraction.pdf?MOD=AJPERES&id=1323162191491

Environmental and social policies of the World Bank that are not applicable to the project include:

Pest Management (OP 4.09): No pesticides, herbicide or fungicides will be used in any of the project activities and hence this policy is not applicable. To address the increased use of pesticides in Sindh, a pesticide management plan has been implemented under the World Bank funded Sindh On Farm Water Management Project (OFWMP),

Indigenous People (OP 4.10): This policy has defined Indigenous Peoples for policy application as well as the planning process to be followed if a Bank-funded project affects Indigenous Peoples. In Pakistan, the World Bank has concluded through its operational experiences that only Kalash people in Chitral district of Khyber Pakhtunkhwa province meet the definition of Indigenous Peoples as described in this policy. Since no Kalash people live in the project area, this policy is not applicable.

Physical Cultural Resources (OP 4.11): There are no known cultural or archaeological heritage sites within the project area. Hence, this policy is not triggered. However, procedures dealing with "chance finds" are to be included in the bidding documents for the construction contracts.

Forestry (OP 4.36): No forests are located in the project area and hence this policy is not applicable.

Projects in Disputed Areas (OP 7.60): Projects in disputed areas may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the borrower and one or more neighboring countries. This policy is not applicable, since the project is not located in or near any disputed territory.

Table 1: World Bank Policies Triggered under the Proposed AF

Directive	Policy	Triggered	Comments
Environmental Assessment	OP/BP 4.01	Yes	As the Project falls into Category A, a full ESA has to be carried out. It is the basis of this ESA document.
Natural Habitats	OP/BP 4.04	Yes	The Indus River between the Guddu and Sukkur barrages is the nationally designated game reserve for Indus River Dolphin and also a RAMSAR wetland of international importance. This part of the river contains large population of dolphins. Impacts of construction activities on dolphins were assessed and mitigation measures are proposed in ESMP. A dolphin conservation and management program is being implemented under SBIP.
Indigenous Peoples	OP 4.10	No	Not triggered since no Indigenous People are living in the area.
Physical Cultural Resources	OP 4.11	No	Not triggered since there are no known cultural or archaeological heritage sites within the project area. However, procedures dealing with "chance finds" are to be included in the bidding documents for the construction contracts.
Involuntary Resettlement	OP/BP 4.12	Yes	No land acquisition is anticipated for the proposed AF. A resettlement policy framework (RPF) prepared under SBIP has been updated to deal with any unexpected land acquisition required for the proposed AF. The updated RPF will guide the planning and implementation of compensatory measures in line with relevant Pakistani laws and OP 4.12.
Forests	OP/BP 4.36	No	Not triggered since no forests are located in the project area.
Pest Management	OP 4.09	No	Not triggered. No pesticides, herbicide or fungicides will be used in any of the project activities.

Directive	Policy	Triggered	Comments
Safety of Dams	OP/BP 4.37	Yes	The dam safety Policy is triggered and an action plan has been developed, including establishment of an independent panel of experts to review the project design and preparation of emergency preparedness plan.
Projects in International Waterways	OP/BP/ GP 7.50	Yes	This policy is triggered but an exception to notification is applied because project investments primarily involve rehabilitation of existing barrage facilities and will have not adversely change water use or quantity of water flows of Indus River.
Projects in Disputed Areas	OP/BP 7.60	No	Not triggered since the project area is not located in a disputed territory.
Access to information			The EIA reports of design consultants have been disclosed in SID's website in July 2017. This ESA and the executive summary (including its Sindhi and Urdu translation) along with the main ESA will be will be posted to SID's website; and will be sent to the World Bank's external website.

3. Project Description

3.1. Description of Sukkur Barrage

Salient Features of the Sukkur Barrage. Construction of Sukkur barrage started in 1927, and the barrage was commissioned in 1932. Total width of the barrage between the two abutments is 1.4 km. The structure is mainly of stone masonry construction with reinforced concrete arches spanning 18.29m (60') openings for the two bridge decks; an upper deck used for operating the gates and a lower road deck. The canal head regulator structures on both the banks control flow in the three right-bank canals and four left-bank canals. Layout of the barrage is shown in Figure 2. The barrage has the following eight sections

- **Right Pocket (Bay 1: Spans 1 to 5):** This is the section between right bank abutment and right divide wall. This right pocket controls the flow to the right bank canals. This section also contains scouring sluices for facilitating flushing of deposited sediments.
- **Closed Spans and Middle Bank Island (Bay 2: Spans 6 to 14)**: After commissioning of the barrage in 1932, it was observed that the right bank canals were drawing excessive silt. This situation was investigated through developing a physical model and based on the model recommendations, this section of the barrage with nine river sluices is permanently closed (middle bank island, constructed between the right divide wall and outer bank) and new river training works were constructed (outer bank), to stop the entering of silt in to canals.
- **Tail Channel (Bay 3: Spans 15 to 23):** This is section between middle bank island and outer bank wall. The purpose of the channel is to induce secondary currents at the location of the submerged weir to ensure that sediment laden flow is carried down the tail channel and water with lower sediment content discharges into the right pocket.
- **Main River Channel (Bay 4 to 7: Spans 24 to 59)**: This is the main section of the Barrage.
- **Left Pocket (Bay 8: Spans 60 to 66)**: This is section between left abutment and left bank wall. This section of the barrage controls flows from the left pocket

Barrage irrigation function. The primary purpose of the barrage is to raise the water level in the Indus in order to divert river water into seven irrigation canals. The canals irrigate 3.34 million ha (8 million acres) of cultivated land. Irrigation allowances are regulated by the 1991 Water Apportionment Accord, which allows an average volume of 2.17 BCM (1.76 million acre feet, MAF) per month to be diverted from the Indus between October and April (the dry season crops, Rabi) and an average volume of 3.98 BCM (3.23 MAF) per month to be diverted between May and September (the monsoon crops, Kharif). The canals are generally closed annually during January for about four weeks for maintenance works; and for about two weeks in April. However, Rice Canal is closed for about 6 months during October to March.

Barrage flood discharge function. In 1932, the Sukkur Barrage and its protection works were constructed to safety pass a flood of 1.5 million cusecs (42,475m^3/s). However, the modifications done during 1940 in right side river training works (which included closure of 10 gates, construction of a submerged weir and an island in front of closed gates) reduced the flood capacity to 0.9 million cusecs (25,485 m^3/s). Meanwhile, the flood volumes in Indus have been increased due to construction of flood embankments on both sides of Indus. Almost since its inception, the Barrage has been facing hydraulic, functional and structural problems over its life of 85 years, during which about 11 super floods with discharges more than 0.9 million cusecs (25,485 m^3/s) have passed through Sukkur Barrage.

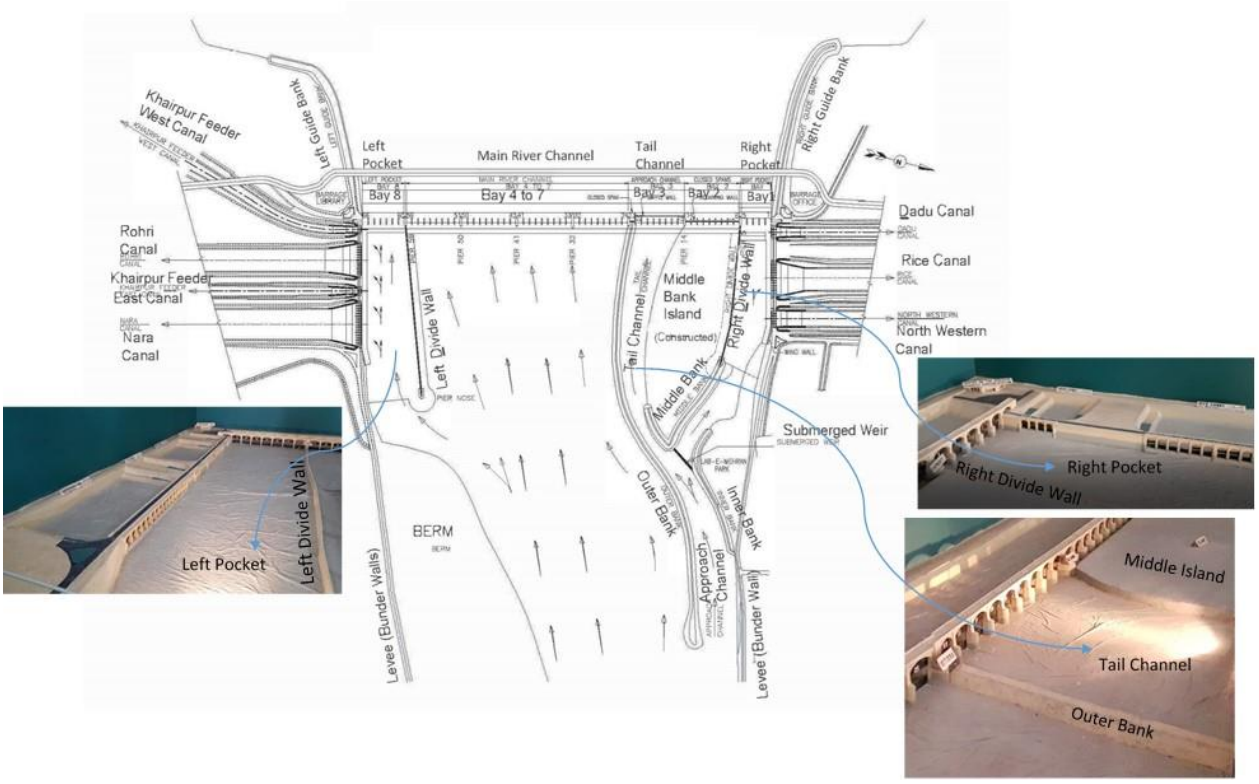

Figure 2: Existing Layout and sections of Sukkur barrage

3.2. Project Components for the Proposed AF

(a) Component A: Rehabilitation of Sukkur Barrage. This component will support all civil and mechanical works proposed for rehabilitation of the barrage and its associated structures. The proposed scope of investment under this component would include:

Mechanical Repairs and Improvement. The works will include gate repair works to improve the regulation and the flow of the barrage. This includes increasing of Gates Height by 61 cm (2ft); increasing of freeboard for fully opened condition; replacement of Roller Trains, Bottom & Side Seals and other Components; removal of Counterweights and Installation of Required Powerful Lifting Motors; and remote gate operation from Central Control Office and from Gate Deck as well as hand wind facility for manual operation.

Repairs to the barrage structure. The works included repairs of (i) RCC arches of the barrage at about 200 locations; (ii) minor stone reconstruction of broken stone edges of head regulators, (iii) complete replacement of gate deck flooring, (iv) inspection of foundations and carrying out necessary repairs, and (v) improvement of storm water drainage.

Desilting of the left and right pockets, and tail channel. About 1.5 MCM of sediments will be removed from both the left and right pockets, and tail channel of the barrage through dredging (about 0.75 MCM) during high flow season and through excavation (about 0.75 MCM) from dry river bed during low flow season. Locations of the areas to be desilted are shown in Figure 3.

Desilting of Right Bank Canals. About 4.24 MCM of sediments will be removed from the right bank canals. About 3.07 MCM of sediments will be desilted from the Rice Canal (from a length of 25.6 km from the starting of canal off-take point at the barrage), 0.92 MCM material will be desilted from North Western Canal (from the first 7 km of the canal), and 0.25 MCM material will be desilted

from Dadu Canal (from the first 7 km length of canal). Locations of canals to be desilted are shown in Figure 3.

***(b) Component B: Improved Barrage Operation*.** This component will support modernization and improvements to the barrage operation and maintenance. This will include necessary upgrades to the instrument monitoring systems such as piezometers, gate positioning and gauging, training and capacity building for staff, replacement of surveillance and maintenance boats and procurement of hydrographic equipment. The project will provide new covered workshops and a stock of spare parts for maintenance activities. The instrument monitoring system for the barrage will be renovated and the operating staff will be equipped with an upgraded operation, maintenance, and surveillance manual. This component will lead to upgrading of the operating facilities with a higher level of control and improved operation and maintenance.

(c) Component C: Project Management Coordination and Monitoring and Evaluation, and training. This component will support the coordination of all project-related activities as well as training and technical assistance in procurement, financial, social and environmental safeguards and communication. Activities will include the establishment of an independent Panel of Experts (POEs) to review, monitor, evaluate, and help guide the rehabilitation process with regard to the safety of the barrage.

(d) Component D: Technical studies. This is a new component under the proposed AF. It would support: (a) a study for exploring suitable locations for a new Sukkur Barrage (detailed in Section 4.2), and (b) a detailed hydraulic study to determine the optimal design for the riverbank training and the needs for raising the height of the bund wall, and (c) preparation for a possible second phase rehabilitation with environmental and social safeguards documents.

(e) Component E: Integrated Riverine Management. This also is a new component under the proposed AF, which will upgrade the Social Action Plan (SAP) under the Social Management Framework (SMF) as a standalone component to focus on social development and environment management of the stretch of Indus River between Guddu and Sukkur Barrages. It would comprise activities supporting: (a) dolphin management and conservation, (b) community fisheries co-management, (c) sustainable agriculture, (d) technical studies (e.g., design for fish passage gates) and (e) water quality and pollutant studies. This component would be implemented in collaborations with the Sindh Environmental Protection Agency (SEPA), Wildlife Department, Forest Department and Agriculture Department, and Fishery Department. World Wildlife Fund (WWF) would also participate in implementation of this component.

3.3. Construction Methodology

Dredging and Dredged Material Management: The dredging of sediments (estimated volume is 0.75 MCM) will be carried out through hydraulic cutter suction dredgers during high flow season of July and August and dredged material will be placed 'in-river' on the downstream of the barrage through hydraulic pipes. The rationale for selection of dredging methods and dredging season and dredged material placement in the river are further discussed in Chapter 4 and mitigation measures associated with the dredging are discussed in Chapter 6. The river bed sediments are found to be clean without any contamination.

Excavation of Sediments and Sediment Material Placement: Two sites have been identified, one on right bank and the other on left bank, for placement of material to be excavated from the right bank canals and from the barrage. Locations of these two placement sites are shown in Figure 3. This location has also been used for excavated material placement during previous dredging works. These locations are part of the river bed, and no cultivation or residences located in these areas, thus there is no land acquisition or resettlement is required for these two sites. Excavated material from the barrage site will be placed on the left bank placement area; while the excavated material from the first 7 km length of canals will be placed at the right bank placement

area. The material excavated beyond the 7 km of the Rice canal, will be used to strengthen the existing embankment. The material excavated from the first 7 km of the canals cannot be used for strengthening of canal embankments since they are occupied by about 300 squatters' households and illegal constructions.

Excavation Methods and Transportation Routes: The desilting of the Dadu and North Western canals is planned to be carried out over a period of two years, but only during the month of January, when the canals are closed annually for maintenance works. On the other hand, desilting of Rice Canal will be carried out over a period of 3 months (October to December) during its six month of canal closure period. Normal means of excavations using excavators and dumpers will be used for de-silting. The closure period with no flows in canals will allow movement of heavy machinery in the canal bed, avoiding the use of canal embankments which are heavily congested by squatters and illegal constructions in the first 7 km length of the canals. The entrance and exit of excavators and dumpers taking out the excavated silt from canal bed will be controlled near the canal bridge crossing at km 1.3 (RD 4) and km 5.1 (RD 17). The de-silted material will be transported through the existing highways to the right bank placement area and will have minimum interaction with local communities. About 80 trucks will be used daily during one month of excavation period for transport of de-silted material. The excavated material from the barrage area to the left bank placement area will be transported through a 1.5 km river and canal embankments (local roads) and passes through settlements. About 20 dumpers will be used daily during low flow season of excavation in the barrage. Traffic management will be in place by the contractor with adequate placement of traffic signals and traffic control personnel, when the vehicles are passing through the local roads.

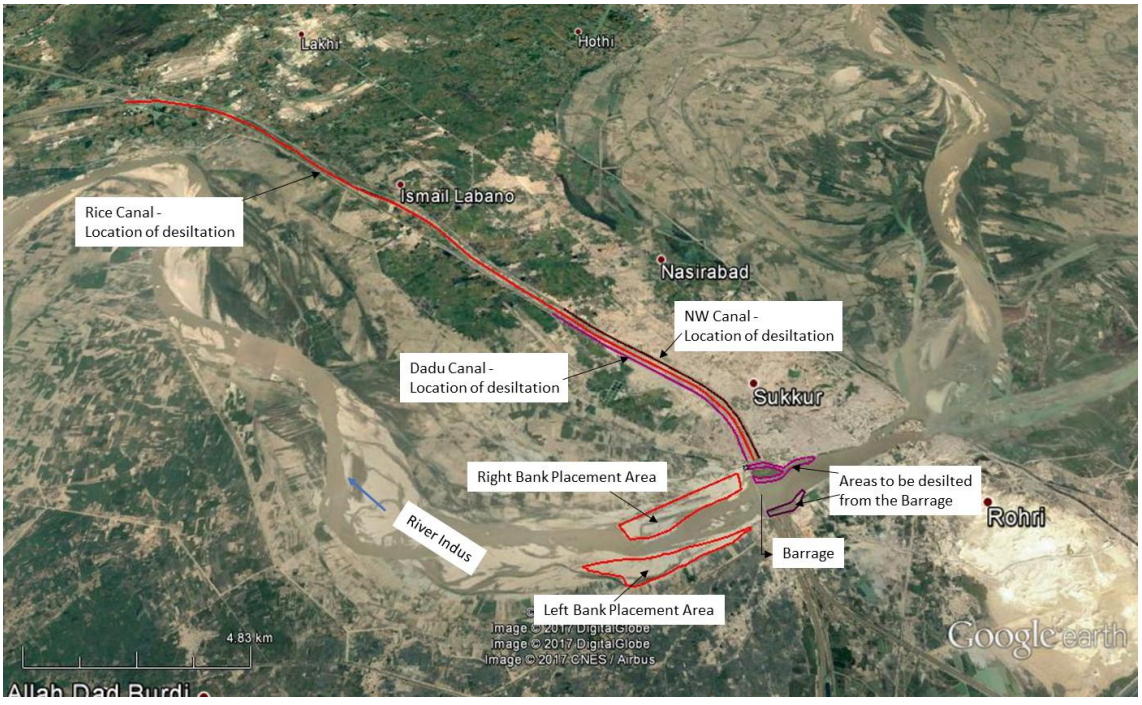

Figure 3: Locations of dredging and excavated material placement

3.4. Construction Material and Sources

The proposed works will require stones for bed and scour protection (78,680 m^3) and aggregates for concrete (7,930 m^3) and these will be procured from the existing government approved quarry sites located at Rohri, 10 km from the barrage. Due diligence will be carried to ensure the proposed quarry is being operated as per the provisions of the permits issued by the provincial Environmental Protection Agency (EPA). Before procurement of the material, the environmental specialists from the Project Management Office of SBIP will visit these areas to ensure the environmental safeguards are in place; and also consult with the EPA on the record of any compliances related to the quarry operator. It is expected that about 50 trucks per day will be used for transport of quarry material over a period of one month. The cement would be brought from cement factories located near Hyderabad while steel may be procured from Karachi.

Average labour requirement per day is 200 while peak time requirement estimated to be 350. Unskilled workers will be mainly hired locally. The number of skilled workers to be brought by the contractor from other parts of Pakistan or abroad (migrant workers) will be around 70. A workers' camp will be established by the contractor near the barrage site (this location has also used by contractors of previous rehabilitation works). The contractor will provide adequate accommodation, transportation, and basic services including water, sanitation and medical care for the workers.

3.5. Construction Costs and Schedule

The total cost of the Project is about USD 100 million and the estimated construction period is 3.5 to 4 years. The proposed construction schedule is shown in Figure 4. De-siltation works using dredging will be carried out during one high flow season; while the desiltation works using excavation will be carried out during one or two low flow seasons. Canal desilting will be carried out during canal closure period. It is expected that all desilting works will be carried out in one season, however if they could not be finished in one season, they will be carried out during next season.

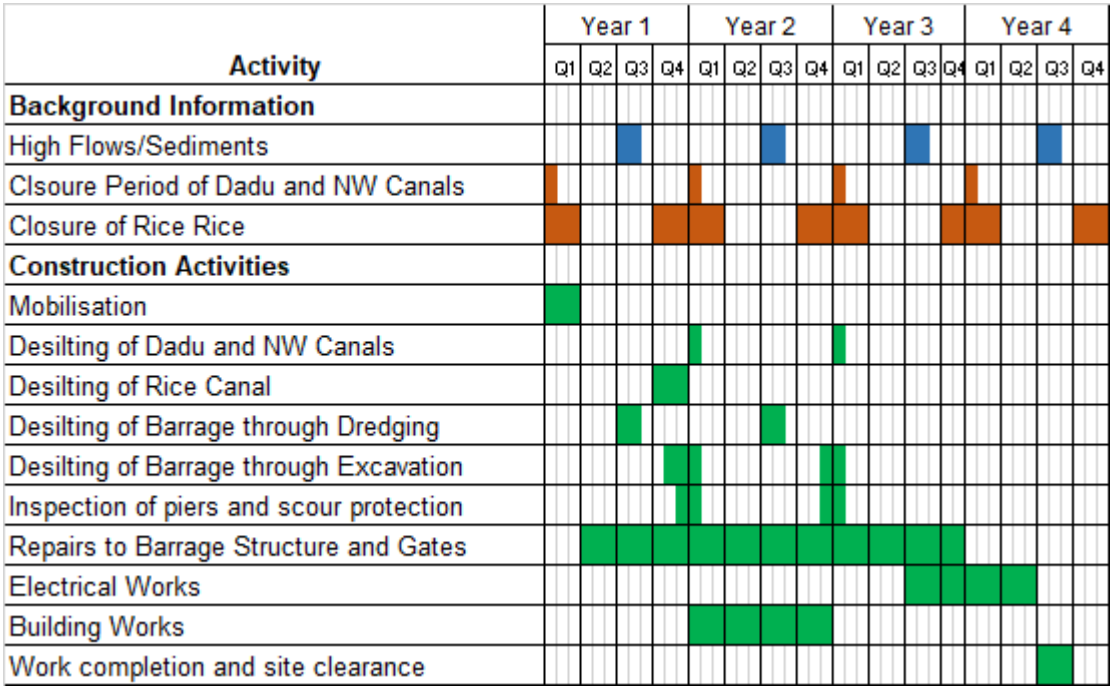

Figure 4: Proposed Construction Schedule

4. Project Alternatives

4.1. No Project alternative

Sukkur barrage has already completed 85 years of active service. Details of the current condition of the barrage and associated facilities are explained in earlier chapters. The barrage requires repairs, deferred maintenance works, and critical modernization in order to minimize the risk of structural failures and ensure adequate function. The flood carrying capacity of the barrage has been now reduced from 1.2 million cusecs (33,980 m^3/s) to 0.9 million cusec (25,500 m^3/s). Failure of the barrage due to severe floods will be catastrophic, affecting irrigation supply to the entire command area of 3.34 million ha. This in turn will affect livelihood of about 0.6 million farming households; and flooding of Sukkur town. Hence not carrying out any rehabilitation works will severely affect the economy of the region and the country at large.

4.2. Alternative to the Project

New construction to replace the Sukkur Barrage has been considered and rejected by both GoS and the Bank mainly due to the underlying soundness of the existing structure including foundations. With proper interventions, the existing structure can last for an indefinite period and can pass a flood of 1.2 million cusecs; with proper riverbank training works, the flood passage capacity can be further increased. The difficulties of identifying a suitable location for the new barrage, technically, socially and environmentally, and the culture value of the current barrage also contributed to the decision. However, Sukkur Barrage is absolutely critical for Sindh's rural economy, and GoS is keen to carry out a feasibility level analysis which would concentrate on identifying suitable locations for a new barrage which might have to be built in the medium to long term.

4.3. Alternatives to Flood Management

The feasibility study indicated that the current flood passing capacity of the barrage is 0.9 million cusecs (25,485 m^3/s), which is equivalent to 7 to 8 years of flood event), which needs to be increased to at least 20 years' occurrence floods - 1.2 million cusecs (33,980m^3/s). This increase can be achieved by increasing of freeboard below the fully opened gates, by raising the gates 6ft higher. In addition, extensive additional river training works will be needed in the future to improve the flood capacity of the barrage for 100-years occurrence floods (1.34 million cusec) and for the structure to last long. However, before taking up of any river training works, extensive studies would be required through developing physical modes. Hence, the Project support both the alternatives, by taking up the first alternative of raising gates; and financing the studies for design of river training structures.

4.4. Options for Desilting of Sediments from the Barrage Area

About 1.5 MCM of desilted material will be removed from the barrage. There are two options for desilting of the sediment deposits from the barrage. Generally, desiltation from the dry river beds will be carried out using excavation methods, and desiltation of sediments under water will be carried out using dredging methods. The project will use the both type of desiltation methods. Excavation will be used during low flow season when both the pockets are dry (in the months of December to February). The approximate volume of excavation is 0.75 MCM. The dredging will be carried in high flow season (July to August) when the river water levels are generally high and the river carries high sediment load. The approximate volume of dredging will also be 0.75 million cubic meters.

4.5. Alternatives to Dredging

General types of dredging suitable for the sediment removal from the Project are mechanical and hydraulic dredgers. Key environmental issues to be considered while selecting type of dredgers are: (i) low risk of sediment dispersal during excavation (most of the sediment excavated should be captured by the dredger to minimize sedimentation); (ii) low risk of sediment releases from lifting (most of the sediment captured should be lifted efficiently to minimize the re-suspension of sediments); and (iii) low risk of leakage from transportation. The hydraulic dredgers are capable of doing these functions compared to the mechanical dredgers; and hence hydraulic dredgers such as cutter suction dredgers will be used for the project from environmental perspective. The Indus carries about 100 million tonnes of sediments at Sukkur during high flow season of July and August, and the water in this period is highly turbid (turbidity is generally more than 900 NTU and 1200 mg/L of suspended solids). If the dredging and dredge material placement in the river is carried out during these months, the additional sediment load and turbidity generated by cutter suction dredgers would be minimal. Hence, it is decided to carry out dredging during high flow season. Environmental monitoring would be in place during this process to ensure no impacts on the river morphology and sediment load, and on fisheries.

4.6. Alternatives to Dredge Material Management

The options for dredged material management can generally be classified in to two categories: (i) placement on the land for beneficial uses and (ii) placement in the river. The beneficial uses for dredged material (if suitable, environmentally acceptable and there is a demand) for on land use is engineering fill (foundation basis for construction, earth fill); and construction (reclamation of new land, aggregate, roads, dikes and bunds. The placement of dredged material on the land has not been considered as the preferred option since all the land along the river are either densely populated or intensively cultivated. Placement of the material in the river, on the downstream of the barrage, is considered as a preferred option in this project since removal of sediment, by dredging, from its natural path or cycle, may have damaging environmental consequences (in the delta, the balance between erosion and accretion is disturbed by reduced water flows and sediments). Therefore, it can be beneficial to return the material into the originating system, rather than removing it to a separated site. This also supports the Indus delta and its ecosystem, which has been under threat due decreased sediment and river flows to the delta.

4.7. Options for Desilting of Sediments from the Right Bank Canals

Desilting of canals can be carried out either by using dredgers during regular canal flow season or by excavators during canal closure period when the canal bed is dry. If the dredging is used, the desilted material need to be transported through the canal embankments to the right bank placement areas through trucks. In the first 7 km of the canal embankments, where most of the desilting will be carried out, has been occupied about 300 squatters' households and illegal construction of houses. All these families would have to be resettled during dredging operations, mainly for transport of the desilted material. The other option is to carry out the desilting activities in the canal closure period using excavators. The canal bed can be used for movement of excavators and transport of sediment through trucks, thus avoiding the use the canal embankments and also avoiding the need of any resettlement on the embankments. Hence, the Project will carry out desilting operations using normal excavators during canal closure period

5. Description of Environment

5.1. Physical Environment

Definition of the study area: The study area of the Project includes impact area of the project and its area of influence. The impact area of the Project includes all areas that are likely to be directly or indirectly affected by the proposed desilting and construction activities. On the upstream of the barrage, the impact area extends up to 2 km to cover the desilting works and downstream up to 10 km to monitor changes associated with dredging and dredge material placement in the river. Along the banks, the impact area extends to one km away from the river to cover the areas that could be influenced by the impacts from construction works. The project influence area covered for impact assessment also broadly covers this impact area, but on the upstream it extends up to Guddu barrage to cover the dolphin game reserve. The impact area for the canal excavation will be primarily limited to the canals and its embankments.

Physiography: The physiography in this area is dominated by characteristics of braided Indus river (meandering channels, temporary shoals and alluvial sand tracts), barrage pondage and floodplain agriculture. Indus downstream of Sukkur is extensively braided with a width of 10 to 15 km with constantly shifting channels. The river generally carries water through its entire width during high flow season of June to September, while the water will be limited to few channels during remaining months. Before construction of the Sukkur barrage, the area is a desolated terrain with some agriculture in the floodplains, but the barrage transformed these barren lands in to vast agricultural tracts. Flood embankments have been constructed all along Indus. The river carries high sediment loads during months of July and August when the river flows are at maximum.

Physical Setting and Land use: The barrage is located in an urban setting with all areas around the barrage and Indus are urbanized by Rohri town on the right bank and Sukkur city on the left bank. Sukkur is the third largest city in Sindh province with a population of about 0.5 million. The barrage office and colony are located close to the barrage. The road (lower deck) on the barrage is extensively used by local traffic, mostly motorbikes and small cars; and heavy traffic is not allowed on the barrage. The average daily traffic on the barrage is about 8,000 vehicles. A national highway is located about 150 m away on the downstream of the barrage, and average daily traffic on this highway is about 24,000 vehicles (50 percent of which are heavy traffic).

Climate: According to Koeppen climate classification, the Sukkur area can be classified as 'desert hot climate' because of its low annual rainfall compared to potential evapotranspiration, and high temperatures. The average annual rainfall is about 120 mm with nearly 61 percent of rainfall falls in monsoon months of July and August. Average annual potential evapotranspiration is 2,216 mm. Between May to September, day time temperatures exceed 35 °C and during winter months the night time temperatures may drop up to 2 °C.

Geology: Indus and floodplains near Sukkur barrage is underlain by very thick (more than 100 m) alluvial sand deposits over a basement of limestone and sandstone rocks. Surface soils are silty and clayey loams and contain adequate nutrients and drainage required for agricultural use.

Seismicity: The Sukkur Barrage is located in seismically inactive region with history of low to medium magnitude earthquakes in its near vicinity. According to building code of Pakistan Seismic Provisions (2007) the site is located in zone 2A with recommended peak ground acceleration of 0.08 to 0.16g. It has been found that the Sukkur barrage has been originally designed on conservative side of 0.22 g.

Indus River: The Indus drains an area of about 950,000 km^2 and generates a mean annual discharge of 6,682 m3/s. The hydrograph of the river at Sukkur is strongly seasonal with a long low water season between October and May (low flow season) and a high water season between

June and September (high flow season) – driven primarily by summer snowmelt in the upper catchment and monsoon rainfall. The river usually peaks in mid-August or early September. River flow upstream of Sukkur barrage varies from a monthly average flow of approximately 22.83 MAF in August, to a monthly average flow of approximately 1.44 MAF in January. The corresponding figures downstream of barrage are approximately 20.06 MAF and 0.29 MAF in August and December respectively.

Floods: Floods in Indus generally occur due to heavy and prolonged storms and intensive/extreme glacier and snow melting. High discharges above 0.9 million cusec (25,485 m^3/s) are termed as super floods. A number of such floods have been recorded historically near Sukkur (1950, 1956, 1957, 1973, 1975, 1976, 1978, 1986, 1988, 1989, 1992, 1995, 2010 and 2011). However, the Sukkur barrage with a current flood capacity for 0.9 million cusec (25,485 m^3/s) has safely passed all the historical floods, mainly due to breaching of flood embankments in upstream areas of Sindh and Punjab.

5.2. Chemical Environment

Sampling and analysis: Sampling and analysis of surface water and river bed sediments were carried out at four locations during high flow season of August 2017. Two samples have been collected on upstream side (one from each pocket of the barrage) and two samples have been collected about 500 m downstream of the barrage area. The samples have been tested for physical and chemical parameters, organics, nutrients, pollutants and metals to establish baseline conditions.

Indus water quality: The water quality of the Indus in high flow season is highly turbid ranging from 970 to 1220 NTU and with a total suspended solids of 1275 to 1860 mg/L. The electrical conductivity ranges from 515 to 577 µS/cm. The chloride level ranges from 11 to 18 mg/L. The water from irrigation canals is also being used for drinking purpose in Kotri and Rohri towns and in command area, where the groundwater is saline. The existing threats to Indus water quality are discharges of municipal and industrial waste waters.

Riverbed Materials: Riverbed materials are compared with OSPAR guidelines (Oslo/Paris convention for the Protection of the Marine Environment of the North-East Atlantic). The test results have shown all four samples from the high flow season are within the acceptable limit of OSPAR guidelines. No pollutants such as PCBs, POPs and hydrocarbons were detected in the sediments. The arsenic concentration in the sediment are less than 0.5 ppm (the standard is 30 to 80 ppm), cadmium concentration is less than 0.5 ppm (the standard is 1 to 2 ppm), and the chromium varies from 31 to 90 ppm (the standard is 150 to 200 ppm).

Groundwater: In the floodplain areas, the groundwater occurs at shallow depths (5 to 10 m) and is also being used extensively for drinking purposes. Though 80 percent of Sindh is underlain by saline groundwater, the groundwater in the floodplains is generally good due to regular recharge from Indus.

Air quality: Air and noise quality data was collected at the barrage site in 2012. Air quality near the barrage area was found to exceed national standards of ambient air quality. Concentrations of particulate matter ($PM_{2.5}$) ranges from 80 to 240 $\mu g/m^3$ (the standard is 35 $\mu g/m^3$) and concentrations of PM_{10} ranges from 270 to 300 $\mu g/m^3$ (the standard is 120 $\mu g/m^3$). Carbon Monoxide ranges from zero to 10 $\mu g/m^3$ (the standard is 5 $\mu g/m^3$). Vehicular traffic and industries are the major sources of air pollution.

Noise quality: Noise levels near the barrage are generally high due to vehicular traffic and have also exceeded the national standards. The night time noise levels were found in the range of 60 to 70 dB, and day time noise levels were found in the rage of 74 to 80 dB.

5.3. Biological Environment

General Biodiversity: The Indus and its riparian forests have a unique freshwater ecosystem that supports both terrestrial and aquatic biodiversity. In Sindh, 105 species of plants, 150 species of avifauna, 16 species of mammals, 15 species of reptiles, 4 species of amphibians and 67 species of fish are reported. Among the animal species only Indus River Dolphin (Platanista gangetica minor) is the endangered species located close to the barrage area. Hilsa (Tenualosa ilisha) and Barramundi (Lates calcarifer) are the two migratory fish species and commercially very important fish species in Indus. Hilsa (locally known as palla) is an anadromous fish that lives in sea and migrate to Indus reportedly as far as up to Multan (located about 300 km upstream of Guddu) for breeding before construction of barrages. Construction of barrages has restricted the migration of Hilsa up to only Kotri barrage. Barramundi is a catadramous fish that lives in Indus (close to the coast) and migrates in to the sea for breeding.

Protected and sensitive areas: A 170 km stretch of the River Indus between two irrigation barrages Guddu and Sukkur is the designated national protected area for Indus River Dolphin, and is known as Indus Dolphin Game Reserve. The total area of the reserve is 125,000 ha and has a 3km buffer zone on the floodplains. This dolphin game reserve was also declared as Ramsar site (wetland of international importance) in year 2000. According to estimates in 2011, the reserve holds a population of 918 dolphins. Where as in 1975, only 150 dolphins were recorded from this reserve signifying the conservation efforts carried out by the Sindh Wildlife Department.

Terrestrial ecosystems and species recorded: The natural ecosystem in the project area was altered by the clearing of lands for cultivation and livestock grazing. Common tree species such as acacia and eucalyptus are generally planted along the margins of agricultural lands. Seasonally inundated floodplains within the marginal bunds of the barrage and shoals (locally known as belas) found to consists of 105 grass species (predominantly tamarix species), belonging to 81 genera and 36 families. These grasses are generally cut and carried for fodder by local communities. 86 species of birds were recorded within the game reserve out of which 41 species are migratory but due to the developmental activities around the project areas urban bird species are dominant. The riparian forests between Guddu and Sukkur along Indus are once reported to provide a habitat for fishing cat and hog deer (IUCN endangered) and smooth coated otter (IUCN vulnerable), but none of these species are now reported to be present in these areas due to conversion of these forests in to agricultural lands and plantation areas, and poaching. Otter population is reportedly declined by pesticide laden return flows from agricultural fields and development of fish farms along the Indus.

Aquatic ecosystems and species recorded: This Indus and its floodplains formed a unique ecosystem that supports wide variety of fish and most importantly Indus River Dolphin. During high flow season water covers the entire river width, as water recede some natural water ponds are developed in the depressions of floodplains. These stagnant pools are suitable habitat for water birds especially ducks and waders. The other aquatic species recorded are: two crustaceans, two water insects, 61 species of zooplankton and 7 species of Phytoplankton. Composition of phytoplankton is indicative of oligotrophic nature of the water. Construction of the barrages and flood embankments along Indus in Sindh have altered the aquatic and floodplain ecosystem. Construction of Sukkur and Rohri towns have further destroyed the floodplain ecosystem.

Indus River Dolphin: The Indus River Dolphin (locally known as Bulhan) is one of four river dolphins of the world and used to inhabit Indus and its tributaries in Pakistan and India, but now most of their population is restricted to lower Indus. In a survey conducted in 2011 by Sindh Wildlife Department between Guddu and Sukkur barrages (170 km of protected area), 18 major schools of dolphins were noticed with a total population of 918 dolphins in which 804 were mature 47 were

the young and 67 were juvenile. While in 500 km stretch between Sukkur and Kotri barrage only 29 dolphins were noticed. Dolphins are generally noticed in the deepest river channels where fish prey is high and are less common in secondary channels and small braids. Dolphins rely on vocals for communication and identification of prey because of their poor eyesight. There is no particular season for breeding of dolphins since calves are born at different times throughout the year, but appeared to be peak during July and August. The gestation period for the dolphins is approximately 10 months and a single calf is born every two years. Juveniles are weaned at around one year of age, but do not reach sexual maturity until around 10 years of age. This species is thought to live at least 28-30 years in the wild.

Current threats to dolphin population in the game reserve: Dolphin population in Indus is currently under threat of habitat fragmentation by the barrages, trapping in irrigation channels of Sukkur, reduced flows in the river during low flow season, sedimentation of the river beds, depletion of prey base, pollution from the agricultural return flows and municipal wastes, entanglement in fishing gears and poaching for their oil for use in traditional medicines.

Fish: Twenty-two species of indigenous fish were identified from the barrage area. Carps, catfishes and snakeheads are the dominant fish species and represent most of the fish catch.

Bird Migration: The migration of water birds occurs in north-south direction and vice versa. The birds breeding in central Asia migrate to various destinations in Pakistan, following the Indus valley and plains down to the Indus delta. This flyway of migratory birds is a corridor of international importance, the so-called “Central Asian – South Asian Flyway.” Large numbers of water birds and other birds like teal, pintail, mallard, gadwall, white-headed duck, and houbara bustard follow the Indus on their way towards the wetlands of southern Sindh, which are the most important major wintering grounds of migratory water birds in the region. Ten wetlands of Sindh have been designated as Ramsar Sites to provide safe refuge to these birds. A total of 41 migratory bird species were recorded in these areas. Out of recorded species, 13 are abundant to the area, 23 are common, 2 are less common and 3 are rare. Two threatened bird species, Greater Spotted Eagle (IUCN vulnerable) and Long-tailed grass warbler (IUCN Pakistan vulnerable). However, both upstream and downstream of Sukkur Barrage and its pond areas do not provide any opportunity for migratory birds to roost and use as staging ground in winter due vehicular traffic on the bridges and urbanization along the river banks.

5.4. Social and Economic Environment

Surveys: The socioeconomic environment has been assessed through household and village profile surveys conducted in the whole canal command area, and with the communities located near the barrage.

Demography: Sindhis share the biggest segment of population in Sukkur and Rohri city areas (70.50%), followed by Muhajirs (15.50%), Pashtoon (2.50%), Seraiki (1%) and Balochi (1%). Sukkur district is majority Muslim, constituting 96% of the total population, of which about 80% belong to the Sunni sect and 16% belong to the Shia sect. The minorities include Hindus (3.28%) and Christians about 0.51%. Sindhi is the most common language spoken in the command area. And 96% of the household survey respondents speak Sindhi as their primary language. Urdu is spoken and understood by 89.1% of the respondents.

Education: The socioeconomic survey shows that the literacy rate is low in the villages in the canal command areas, 36% as compared to the overall national level of 47%. The literacy ratio amongst male and female is 1.3:1. About 14% of school age children have never attended school. Among the illiterate, 11% could read (but not understand) the Holy Quran. 2.9% of the surveyed population is only able to write their names or read newspapers to some extent. Formal education level was achieved by 16.5% for primary education, 14.1% for matriculation, 3.1% for intermediate,

1% for graduation and 0.5% for post graduation. There are seven universities, 812 secondary and higher schools, and over 19,000 primary schools in the districts of the command area.

Livelihoods: Agriculture is the main source of livelihood for 77% of the households. Other sources of income are labour and daily wages, employment with the government, and remittances from the family members working in the cities. 58% households also have secondary sources of income from activities including labour, livestock, trading etc.

Income and Poverty: Given that the primary source of income for people living in the barrage command area is agriculture, the majority of households do not have regular monthly income, but rather have seasonal income from crops. The socioeconomic survey of the project area indicates the minimum monthly income as Rs. 6,000/- (Rs. 200/- per day). The survey also reveals that 60% of the people of the project area live below the poverty line, the majority of whom live in rural areas.

Agriculture: Wheat, rice, cotton, sugarcane, maize (grain and fodders), pulses, orchards and vegetables are found in the majority of villages. Wheat is the dominant crop, being cultivated by 90% of the village, followed by cotton (57%), rice (55%) and sugarcane (43%). 29% villages also have orchards which include dates, mango and banana. The overall cropping intensity is estimated as 107.9% with Kharif 53.9%, Rabi 42.6% and orchards as 11.5%. The highest intensity is at Nara canal at 123.9% followed by Dadu canal at 123.8%; and North Western canal at 116.2%. The lowest intensity is at Rice canal (which is closed for six months) at 80.5%.

Livestock: Goats and poultry are owned by more than 90% of the farming households. Buffalo are owned by 60% of the households, cows by 31% and sheep by 26% of the households.

Fisheries: Fish is an important natural resource in the Indus River. The fisheries department gives permits for the fishermen for fishing in Indus. However, close to the barrage, fishing is banned by the government due to security issues. Fishing is also not allowed in high flow season. According to Fisher Folk (NGO), there are three traditional fishing villages of about 500 households in the 10 to 15km radius of Sukkur Barrage. However, because of overall reduction in fish population in Indus, number of these households stopped fishing. Alternatively, they are working as laborers in agriculture or at commercial fish ponds. There still are around 30 to 35 fishing boats in these villages, and fishing households earn about Rs. 7,000 per month

Health Facilities: A total of 47 government hospitals are located in all districts of the command area. There are also 453 Basic Health Units, 35 Rural Health Centers, over 2500 registered medical practitioners, and over 1000 hakims and homeopaths. In addition, there are several private health facilities in the Sukkur city.

Water Supply and Sanitation: As per the socioeconomic survey, the population of about 76% villages, located in the command area of the Barrage relies on tube wells fitted with hand pumps for drinking water. More than 28% of the villages also get drinking water from canals. Only 6% of the villages have piped water supply.

Gender: In rural areas, women have limited decision making powers inside the household, and none outside the household. They are refused the access to education, hospital or travel. In urban areas, however, the women have access to education, employment, travel and medical treatment. Women have high involvement in household activities and child rearing. The only economic activities with some involvement of women is livestock rearing and farming.

Physical cultural resources: Five sites of cultural and historical importance are located in Sukkur. These include Sadhu bela, a Hindu temple located about 4 km upstream of the barrage on a shoal (island) in Indus. There will be no impact on these sites due to proposed project activities.

Livelihoods on Middle Bank Island and Shoals. The barrages' s middle bank island and shoals (silt deposits, locally known as belas) on barrage's outer bank wall and along upstream river banks are being used by squatters for cultivation during low flow season when these lands are emerged above water levels. Most squatters, who are cultivating on belas and middle island live in the Sukkur town or nearby villages. The Middle Bank Island consists of 45 acres and it is being used by 14 squatters. Among these 14 squatters, 5 squatters also have residential structures in the main bank island and live with their families. The Outer Bank Bela consists of about 5 acres and is being used by 2 squatters for cultivation of crops during low flow season. The Left Bank Bela consists of about 120 acres and some part of this land is being used by 24 squatters for cultivation of crops when these lands emerge above water levels during low flow season for a few months in winter. The extent of bela varies every year due to erosion of the river or deposition of more silts by the river. The squatters, from both left bank bela and outer bank bela, live in Sukkur town and their primary income is business; and they cultivate these lands as a source of secondary income. They access the island and the outer bank bela by boat.

6. Potential Impacts and Mitigation Measures

6.1. General

Sukkur barrage has been in operation for about 85 years and the proposed rehabilitation works will not alter the current operational regime of the barrage and hence will not create any additional impacts. The proposed activities are limited to the existing footprints of the barrage and no additional land acquisition is required, hence most of the impacts from the proposed activities are temporary in nature and limited to construction period. There will be no impact on the canal releases. The negative impacts associated with the construction are mostly related to dredging and excavation activities for sediment removal. However, the extent of dredging to be carried out under the project (0.75 MCM of dredging during high flow season) is very limited compared to the annual sediment load of about 100 million tonnes carried out by the Indus during high flow season. Dolphin game reserve located immediately upstream of the barrage is the most significant receptor susceptible from impacts of the desilting and construction works. The overall positive impact of the project, which is the enhancement of the life of the barrage to safeguard the livelihoods of 0.6 million farming households in the command area through provision of irrigated water for 3.34 million ha, will be experienced countrywide.

6.2. Impact Assessment Methodology

Potential environmental and social impacts were identified on basis of review of feasibility study reports, field visits and stakeholder consultations. The significance of potential impacts was assessed using the following criteria:

Impact Magnitude: The potential impacts of the project have been categorized as major, moderate, minor or negligible based on consideration of the parameters such as: (a) duration of the impact; (b) spatial extent of the impact; (c) reversibility; (d) likelihood; and (e) legal standards and established professional criteria.

Sensitivity of Receptor: The sensitivity of a receptor has been determined based on review of the population (including proximity/numbers/vulnerability) and presence of features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic.

Assigning Significance: Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in Table 2.

Table 2: Significance of Impact Criteria

Magnitude of Impact	Sensitivity of Receptors			
	Very High	High	Medium	Low
Major	Critical	Major	Moderate	Minimal
Moderate	Major	Major	Moderate	Minimal
Minor	Moderate	Moderate	Minor	Minimal
Minimal	Minimal	Minimal	Minimal	Minimal

6.3. Summary of Assessed Impacts

The project's potential impacts and their significance have been assessed using the methodology described in Section 6.2 above. A summary of these impacts and their significance is presented in Table 3.

Table 3: Potential impacts and their significance

Impact from various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Environmental impacts during construction stage:					
Impact of dredging on aquatic and benthic habitat	Very high	Moderate	Major adverse	• Dredging during high flow season (July and August) • Dredging through cutter suction dredger • Implementation of environmental code of practices (ECP) on dredging	Minimal
Sediment dispersion from dredging activities	Very high	Moderate	Major adverse	• Dredging during high flow season (July and August) • Dredging through cutter suction dredger • Ecological monitoring	Minimal
Impact of in-river placement of dredged material	Very high	Moderate	Major adverse	• Placement of material in active river channels in high flow season; placement in the scours if required • Submerged discharge of material	Minimal
Effluents and emissions from dredgers and associated vessels	Very high	Moderate	Major adverse	• Emergency preparedness plan by contractors (e.g. booms and skimmers in place for separation of oil spills from river) • Regular maintenance of water borne equipment • No disposal of bilge water from the boats/barges in to the river Maintenance of equipment	Minimal
Impact of underwater noise levels on dolphins' vocalization and behavior	Very high	Moderate	Major adverse	• Monitoring for dolphins within 500 m from dredging areas; and chase away dolphins from those areas using pingers. • 'soft start' (gradually ramping up sound levels) approach during dredging to chase away dolphins	Minimal
Risk of dolphin collision with construction vehicles	Very high	Minor	Moderate adverse	• Restrict the motor boat speeds to 15 km/hour • Restrict the boat movement within the construction area •	Minimal
Impacts from excavation activities in the barrage	High	Minor	Moderate adverse	• Excavation will be carried out only in dry river beds • Pollution prevention and control measures • Traffic management along sediment transportation routes	Minimal
Impacts from excavation activities in the right bank canals	High	Minor	Moderate adverse	• Desilting only during canal closure period. • Use canal beds for construction equipment movement. • Scheduling the desilting activities of Rice canal without overlapping of desilting activities in Dadu and NW Canals • Traffic control measures through adequate traffic signs and traffic control personnel	Minimal
Risk of entrapment of dolphins, turtles, and other aquatic fauna in construction areas	Very High	Minimal	Minimal adverse	• Rescue of the animals and release them back in to the river • Availability of dolphin rescue facilities with the contractor	Minimal
Impact of excavated material placement on the dry river banks	Medium	Minimal	Minimal adverse	• Uniform distribution of the material in the placement areas • Limiting the height of material dumps to not more than 6 ft.	Minimal

Impact from various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Disposal of replaced mechanical and electrical parts	Medium	Major	Moderate adverse	• Waste material such as steel and gate wheels and hoists will be sold to steel industry through open auction and finally will be transported to Lahore or Karachi to steel industries • Rubber seals will be sold to rubber industry through open auction	Minimal
Potential risk of soil and water pollution by construction works	Medium	Moderate	Moderate adverse	• Management plans for pollution prevention • Implementation of ECPs by Contractor • Compliance with NEQS on waste water discharges	Minimal
Air and noise pollution from construction and traffic	High	Moderate	Major adverse	• No construction activities during night time near the villages • Dust and noise control measures as per ECPs • Compliance with NEQS on vehicle and machinery emissions	Minimal
Risk of pollution from solid waste and waste effluents	Medium	Moderate	Moderate adverse	• Waste management plan by the contractor • Use of available municipal waste disposal facilities in Sukkur • Use of approved facilities for hazardous waste disposal	Minimal
Impacts from borrow and quarry activities	Medium	Moderate	Moderate adverse	• Source material only from licensed operators • Due diligence to ensure the proposed licensed quarry is being operated in accordance with environmental permits	Minimal
Social Impacts during Construction:					
Land acquisition and resettlement	Very high	Minimal	Minimal	• Proposed project activities do not require any land acquisition. However, if any land acquisition is required, RAP will be prepared and implemented according to RPF.	Minimal
Impact on irrigation releases from the barrage	Very high	Minimal	Minimal	• Works that require temporary canal closures will be carried out only during regular canal closure period.	Minimal
Impact on traffic on the barrage	Medium	Moderate	Moderate adverse	• Advance notification on traffic closure	Minimal
Generation of employment	Medium	Moderate	Moderate beneficial	• Notifying employment opportunities as per the communication strategy •	Moderate beneficial
Increased economic activity	Medium	Moderate	Moderate beneficial	• Establishment of new businesses and commercial enterprises; local employment	Moderate beneficial

Impact from various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Safety hazards due to increased traffic especially for children and elderly people	High	Moderate	Major adverse	• Traffic Management Plan addressing general access • Safety and security actions and procedures to protect local community •	Minimal
Impacts from the influx of labour from the outside areas	Low	Moderate	Minimal adverse	• About 60 non-locals will reside in a camp that will be set up on ID owned land. Contractor follows IFC Performance Standards on Labor and Working Conditions; • ECPs on management of labour influx and worker's camps • Grievance redress mechanism •	Minimal
Possible cultural conflicts between communities and workers and health impacts, including women's privacy and access	High	Moderate	Moderate adverse	• Awareness campaign; Code of conduct for workers • Grievance mechanism	Minimal
Workers health and safety	High	Moderate	Major adverse	• Occupational Health and Safety Plan to be implemented • Emergency Preparedness Plan; Safety training for workers • Adequate water supply and sanitation facilities, medical and first aid care facilities	Minimal

6.4. Environmental impacts during Construction Stage

Impact of Dredging on Aquatic and Benthic Habitat: Dredging activities may cause several negative impacts on the aquatic habitat and fauna due to generation of high sediment flows, disturbance of benthic habitat, noise and emissions from construction machinery, and accidental spillage of fuels. Various stages of the dredging and potential impacts from each of these stages is summarized below.

- Excavation: Excavation is the process of physical removal of the material from its in situ location on the bed of a water body. This will be done either hydraulically or mechanically by dredger heads. The physical changes that can take place during excavation are the generation of suspended sediments (causing an increase in turbidity, destruction of benthic environment, and changes to river morphology), mixing of soil layers and noise and air pollution from the equipment.
- Lifting: Lifting is the vertical transportation of the excavated material from the bed. Similar to excavation, this will also be done either hydraulically or mechanically. The physical changes that occur during lifting are the release of suspended sediments for example as overflow losses during loading. Sediment re-suspended in the water column in high concentrations can directly lead to physical abrasion of, for example, filter-feeding organs or gill membranes of fish and shellfish. Increase in turbidity, due to sediment resuspension, also reduces light penetration in to the water thus resulting in to reduction in primary productivity for phytoplankton. If the sediments are rich in nutrients and metals; the resuspension of sediments may release nutrients, organic matter and/or toxic chemicals in to the water.
- Transportation: Transportation is the process of transferring the excavated material to the placement location. This will be typically done hydraulically through a pipeline. The potential impacts during transportation are spillage and safety in relation to other transport users of the river.

The dredging activities will be carried out during high flow season of July and August when the river naturally carries high sediment load; and any impact on benthic habitat will be quickly restored by the new sediment load. During this season, the river carries about 100 million tonnes of sediment load, while the material to be desilted (0.75 MCM) during this season will be equal to only 1% of this load. The Contractor will use Cutter Suction Dredger, which is known to capture all the sediments removed by cutter heads and have a low risk of sediment releases from lifting. The mitigation measures for the dredging are given in Environmental Code of Practices (ECPs). The Contractor shall comply with the mitigation measures proposed in ECPs. An ongoing ecological monitoring will be in place to evaluate the impacts of the dredging and develop additional mitigation measures as required.

Sediment Dispersion from Dredging Activities: Sediment plumes will be generated from dredging activities increasing the turbidity and sediment load in the river. Increases in suspended sediments and turbidity levels from dredging and disposal operations may under certain conditions have adverse effects on animals and plants by reducing light penetration into the water column and by physical disturbance. Increased suspended sediments can affect filter feeding organisms. To minimize these impacts, the dredging activities in the project will be carried out during high flow season of July and August when the natural sediment load in the river is very high (about 100 million tons), river water is highly turbid (more than 900 NTC) and river carries high suspended solids (more than 1200 mg/l). Hence, any additional sediment concentration generated by dredging activities would be very minimal compared to the baseline concentrations. The contractor will use Cutter Suction Dredger, which is known to have a low risk of sediment dispersal. The suction action inside the Cutter Suction Dredger means that most of the sediment removed by the

cutter is captured. As high dredging efficiency and low turbidity at the cutter head are closely linked, it is uncommon for turbidity generated by the cutter head to cause environmental concern. An ongoing ecological monitoring will be in place by the contractor monitor the sediment load and, if necessary, the contractor shall modify the dredge operation to minimise fines, e.g. restrict the amount of material being dredged

Impact of Dredge Material Placement in the River: The dredged material will be placed in the river on the downstream of the barrage. The impacts from aquatic placement of dredged material will result in generation of high turbidity levels which may affect organisms that depend on light for their existence (photosynthesis) and fish. The impacts on turbidity and sediment dispersion associated with aquatic placement can be minimized by submerged discharge (placing the pipe line vertically one meter below the water column or just above the river bottom) which result in a decreased resuspension and spread of the lateral extent material. The bottom relief created by mounds of dredged material may also provide refuge habitat for some fish. Since the dredging and dredge material placement will be carried out during high flow season, it is not anticipated any impacts on the river morphology and flows. However, monitoring of sediment load and river morphology will be in place at the dredged material placement location and its downstream for any adaptive management if required.

Effluents and Emissions from Dredging Equipment and Associated Vessels: Solid and liquid waste effluents will be generated from the dredgers and associated vessels. The solid waste will be mainly from the vessel's kitchen and liquid waste is mainly bilge water. The solid waste and bilge water should be collected and properly disposed after adequate treatment. There is a risk of water pollution from accidental spillage of fuels, hazardous material and bilge water. The contractor will take utmost care to prevent such risks and will prepare an emergency preparedness plan to address these risks. The contractor will make booms, absorbents and skimmers available on site along with trained personnel to recover spilled oils from water surface. Noise and air emissions will also be generated by the dredging equipment, which can be minimized regular maintenance of the equipment as per manufacturers specification.

Impact of underwater noise levels on dolphin's vocalization and behaviour: Underwater noise levels generated by the dredgers and associated vessels may impact the dolphin's vocalization and behavior. Mitigation measures to reduce noise levels from dredging and to minimize the impacts on dolphins include (i) monitoring an exclusion zone of about 500 m radius for at least 30 minute before the start of dredging. If dolphins are observed in the exclusion zone, dredging works will be delayed until they have left the area. If dolphins enter the exclusion zone after dredging has commenced, dredging works would cease until they have left; (ii) adoption of a 'soft start'; using a low energy start to the dredging operations to give dolphins an opportunity to leave the area, and (iii) use pingers upstream and downstream to chase away dolphins.

Risk of dolphin collision with construction vehicles: There is a risk of collision between dolphins and motor boats used in the dredging and other construction works. To avoid such risks, speeds of motor boats will be restricted to 15 km/hour in accordance with best international practices. Pingers will also be used to chase away dolphins from the construction areas.

Impacts from excavation of sediments from the barrage: Excavation of sediments from dry river bed will be carried out during low flow season and there is no risk of sediment releases from excavation. If any sediment water released from the excavation activities, they will be contained by placing the silt fences, sediment traps around the excavation areas to prevent migration of silt in to the river. The impacts associated with the excavation activities will be mainly air and noise pollution from earth moving equipment and trucks. The excavated material from the barrage area will be transported to the left bank placement through a 1.5 km length of local roads. About 20 trucks will be used daily for transport of these material, and movement of these trucks along the local roads may cause safety hazards. To mitigate these impacts, strict traffic management will be

in place by the contractor with adequate traffic signals and traffic control personnel along the routes used by the trucks for transport of excavated material to the left bank placement area. All local roads that are damaged by the construction activities will be repaired to their original state after completion of works.

Impacts from canal desilting activities: Desilting activities carried out along the first 7 km of the right bank canals will cause significant nuisances through dust and noise pollution on the squatters living on the embankments. Canal beds will be used for movement of construction equipment and vehicles, instead of canal embankments. The desilted material will be carried out in covered trucks to control the dust emissions. Desilting activities will be limited to day time hours to avoid nuisance to the local communities.

Risk of entrapment of Dolphins and other Aquatic Fauna in Construction Areas: There is a risk that dolphin is trapped during desilting activities in the barrage area. Sometimes dolphins are drifted into canals and are stranded there when canal flows decrease. There are also chances that freshwater turtles are found. To address these risks, a dolphin rescue unit will be established by the contractor in the site to rescue dolphins that are entrapped in the construction areas. The dolphin rescue will include an ambulance, a stretcher, water facility and a trained rescue staff. The parent project, SBIP, is also supporting the local wildlife departments for establishing dolphin rescue team under dolphin conservation and management plan, and will also be available during the construction. Before initiating the desilting activities, an observation survey will be conducted in surrounding areas for presence of dolphins and turtles. The turtles will be rescued and released safety in to other canals before carrying out desilting activities

Impacts of excavated sediments placement on dry river banks: The excavated material from the barrage (0.75 MCM) and from the right bank canals (2.24 MCM) will be transported through trucks to the sediment placement area located on the downstream of the barrage. These parts of the river banks, used for proposed placement of desilted material, will only be submerged under water during super floods. Hence, the material will eventually go back to the river, when this section of river will be filled during super floods, Since, the river already carries huge sediment loads during super floods (more than 200 million tonnes of sediments) during high flow season, the joining of 3 MCM (roughly equal to 4 million tonnes) of sediment from placement areas will have minimal impacts on the sediment concentrations and downstream river morphology. The release of desilted sediments back to the river, to its natural cycle, is expected to have significant positive impacts. The movement of trucks and dumping of material may cause dust and noise pollution. To mitigate these impacts, the placement area will be marked in to several plots for uniform placement and distribution of material, to avoid improper dumping of material; and the height of each material dump will be limited to 6 ft.

Disposal of replaced mechanical and electrical parts: All scrap material will be sold to steel industries in Lahore and Karachi through an open auction. Similarly, rubber material will be sold to rubber industries through an auction. None of these waste materials will be disposed at the site.

Potential risk of soil and water pollution: During construction, there is a high risk of accidental spills and leakages from fuel and oil tanks, vehicles, machinery and stored chemicals that are used in construction areas, yards, batching plants, worker camps, and storage sites. These spills can pollute soils and contaminate surface and groundwater in the area. Contractors will take appropriate measures to avoid and contain any spillage and pollution of the soil and water resources both upstream and downstream of the barrage. A Pollution Prevention Plan will be prepared by the contractor prior to the start of work.

Noise and air pollution from construction works and traffic: Air and noise pollution may be caused by emissions from construction related traffic and machinery. To mitigate this pollution,

construction equipment and vehicles will be well maintained, so that emissions are minimal and comply with emission standards of NEQS. Dust generation from construction sites will be restricted as much as possible and water sprinkling will be carried out as appropriate.

Risk of pollution from solid waste and waste effluents: Repairing of existing structures generates debris. Further construction works also generate some excess materials from construction sites (concrete, discarded material) and wastes from worker's camp and construction yards, including garbage, recyclable waste, and food waste. In addition, small quantities of hazardous waste will be generated from maintenance activities, including oil filters and other waste products. The Contractor will prepare and implement solid waste collection and disposal plan. The existing municipal waste facilities will be used for disposal of solid waste. Siting of any fuel and hazardous material storage sites, including refueling facilities, batching plants and construction yards are to be located outside the flood embankments and at least 500 m away from any residential areas. Hazardous waste will be disposed of through Sindh EPA certified contractors.

Impact from borrow and quarry activities: About 0.80 million m^3 of stone and 0.08 million m^3 of aggregates will be required for construction activities. The environmental staff of Project Management Office (PMO) will visit the quarry sites proposed by the contractor and carry out due diligence to ensure the quarry operators are complying with the EHS requirements for licensing the EPA; before procurement of the material. PMO will also consult with EPA on the record of non-compliances if any with the proposed quarry operator.

6.5. Social Impacts during Construction Stage

Land Acquisition and resettlement: No land acquisition and resettlement would be required for the proposed interventions. A small piece of the left bank bela will be desilted, but there is no cultivation on this piece. The middle bank island and the outer bank bela will remain intact, as civil work will be carried out around the island. Squatters on the island and the outer bank bela will be given safe, dedicated access during desilting. No land acquisition will be required for desilting in canals, as civil work will be confined within the canals. However, there could be some land requirement for any unforeseen works or as an outcome of the studies during implementation. Should land acquisition be required, SID will prepare resettlement action plan (RAP), including compensation details, according to RPF, and will seek World Bank approval.

Impact on irrigation releases from the barrage: The proposed activities in the Project do not require closure of any canal gates and hence there will be no impact on the irrigation releases from the barrage. Further, desiltation of the canals will also be carried out only during their regular annual canal closure period.

Impact of traffic on the barrage: The barrage also acts as a road connecting right and left banks. The current traffic levels on the existing barrage is about 8,000 vehicles per day, most of which are small cars and motor cycles. The road access on the barrage is generally closed for one month in January for routine inspection and maintenance works. During these days, the traffic will either use national highways on the downstream (located 150 m away) or Lansdowne bridge on the upstream (located 6 km away). During proposed construction period, the traffic on the barrage may need to be closed for more time than the normal closure. This may cause inconvenience to the road users who are located close to the barrage site. The public will be informed in advance about the road closure periods through bill boards near the barrage site; and by placing adequate traffic diversion structures.

Generation of employment in the project area: About 200 skilled and non skilled workers will be required during construction on continuous basis for about 4 years. Contractors are recommended to employ local workers and technicians to the extent possible. Populations in project and command areas will be notified about these opportunities, as described in the communication strategy.

Increased economic activity in the project area: The influx of migrant workforce will stimulate the local economy. There will be a higher demand for locally produced food, goods and services benefiting local farmers, and small businesses, such as hotels, shops, fruit sellers, tea cabins and poultry stalls.

Safety hazards for children and elderly people due to increased traffic: The construction activities can potentially impact the residents of communities near the barrage, particularly the movement and safety of local people. The increased use of trucks and other vehicles on barrage and local roads may increase risk of traffic accidents on pedestrians, particularly elderly people and children. The Traffic Management Plan that will be implemented with aim at ensuring access to residential areas, and preventing unsafe situations, especially near schools, housing areas, construction areas, camps and office.

Impacts from labour influx: It is estimated that about 70 migrant workers work in this project. The influx of migrant labour generally have significant impacts on the local communities and environment. The project area is located in an urban setting, as Sukkur is the third largest city in Sindh after Karachi and Hyderabad. Hence general impacts associated with the labour influx are not expected to be significant. The Contractor shall ensure provision of adequate accommodation, transportation, and basic services including water, sanitation and medical care for all migrant works. A grievance redress mechanism will be in place by the contractor to raise work place concerns.

Possible cultural conflicts between communities and immigrant workforce and health impacts: There could be potential conflicts between the local community and migrant workforce. Workers coming from different parts of Pakistan or other countries may have norms and values in social behavior and religion that differ from those of the resident population. The influx and accommodation of a work force of about 70 non local workers could result in increased concerns for the health and safety of local population. This will be addressed by an awareness campaign implemented in the beginning of the construction phase. The Contractors will be made aware of the possibility and risks of miscommunications between local residents and workers, which easily could lead to conflicts. The awareness campaign will also be aimed at the risk of interaction between the resident population and the construction work force, including the spreading of sexually transmitted diseases such as HIV/AIDS. The Contractor shall develop a Worker Code of Conduct to govern the behavior of workers on site, in camps, and in local communities.

Workers health and safety: Construction activities from the dredgers, boats and barges need to be paid close attention due to the increased risk of accidents, drowning, unsafe working conditions and health risks. The Contractors shall comply with World Bank Group's general and sector specific Environment, Health, and Safety (EHS) Guidelines. Appropriate PPEs will be worn by all workers. Special attention will be focused on safety training for workers to prevent and minimize accidents and also on how to deal with emergencies. Emergency response mechanism will be put in place for to rescue workers from drowning and providing immediate treatment to the injured workers.

7. Cumulative Impact Assessment

7.1. Objective

A cumulative impact assessment has been carried out under SBIP covering rehabilitation of both Guddu and Sukkur barrages, and was presented in the ESA report of Guddu barrage. The objective of the current cumulative impact assessment is to review the assessment provided in SBIP and present a summary of this assessment. The study has focused on two valued environmental components (VECs) related to barrages in Sindh, which are dolphin habitat and fish migration and irrigation.

7.2. Dolphins Habitat Fragmentation

Baseline conditions and trend: In 1870's, the Indus dolphin inhabited the lower Indus and its four major tributaries, Jhelum, Chenab, Ravi and Sutlej. By the early 1990's, Indus dolphins had undergone an 80% reduction in the original range, having been extirpated from four tributaries and also in upper parts of Indus. They are now confined to five contiguous 'river sections' on the Indus main stem in Pakistan, separated by barrages, and in the Beas River (tributary of Sutlej) in India. According to a survey in 2006, there were 1,406 dolphins in Indus and 90 percent of them are located in the dolphin game reserve, between Guddu and Sukkur barrages. Other major concentrations were noticed between Chashma to Taunsa barrages. While in 1975, only 150 dolphins were recorded from the game reserve. The most recent counts conducted by Sindh Wildlife Department in 2011 found 918 dolphins in the game reserve, and 29 between Sukkur and Kotri barrages.

Cumulative Impacts: Construction of irrigation barrages between 1886 and 1971 has fragmented the dolphins' historical home range and confined them into a number of smaller river sections. Changes of river flows in these river sections, particularly low flow discharges in winter have further significantly reduced its habitat range, required water depths and velocities, and availability of fish prey. Studies on dolphin habitats in these river sections found, dolphins are still intact in those sections where the average monthly low flow discharges are 873 cumec (flow range is 205 to 1332 cumec) and dolphins were extirpated in the sections where average discharges are 227 cumec (range 0 to 1,076 cumec). Dolphin game reserve located between Guddu and Sukkur barrages is currently under threat from reduction of prey base; stranding and mortality in the irrigation canals of Sukkur; depletion of prey base due to use of small size mesh nets; poaching for their oil for use in traditional medicines; entanglement in fishing nets; and pollution from domestic, agricultural and industrial waters.

Recommendations: There is a need for better management of water flows in Indus during winter season to maintain the habitat of dolphins, which is a responsibility of national level stakeholders and should be resolved within the framework of WAA. During rehabilitation of Sukkur barrage, measures are to be taken to prevent entry of dolphins into canals through installation of screens in the canal gates or installation of dolphin deterrent devices such as pingers. SID will engage in consultations with federal government for better management of flood flows and minimum flows to preserve the aquatic biodiversity. Under the current project, a dolphin conservation and management plan is recommended to strengthen conservation measures in the dolphin game reserve. The plan will cover (i) detailed surveys on population status for two years covering both high flow and low flow season in each year, (ii) threat assessment surveys and develop mitigation plan, (iii) recommending no fishing zone in the river stretches that support breeding population, (iv) capacity building of the line government agencies and universities on dolphin research, conservation and management, (v) development of sustainable fishery management plan, (vi) involving local communities in dolphin conservation and management, (vii) supporting wildlife department in establishing rescue units to rescue dolphins stranded in canals, (viii) education and

awareness programs, and (ix) conducting an international workshop in Karachi to learn and share dolphin conservation and management options.

Actions taken by SBIP: The PMO of SBIP has started implementation of these recommendations. It has conducted a one day international conference on dolphin conservation and management on 15 May 2017 at Karachi. For implementation of other recommendations, SBIP is in the process of procurement of Sindh Wildlife Department. The wildlife department has already submitted a detailed proposal and budget for implementation of the plan and the PMO is currently reviewing their proposal. These activities will be expected to start from early 2018.

7.3. Hilsa Fish Migration

Baseline Conditions and Trend: Hilsa, also called as 'palla' or 'shad' is an anadromous fish; migrate from sea to Indus for breeding, spawning and growth. Historically, early migration of hilsa in to the Indus was in between January and February and later migration was during summer and monsoon floods between April and July. Before the construction of barrages in Indus, hilsa was reported to travel a distance of 1,000 km up to Multan. After construction of Sukkur barrage in 1932, hilsa migration was limited to Sukkur barrage since it doesn't have any fish passes. Kotri and Guddu barrage, which were constructed in 1956 and 1962, have included fish passes to facilitate hilsa migration. Fish passes in Kotri barrage were not properly designed to facilitate migration of hilsa. Hence, after 1956 the migration of hilsa has been restricted up to Kotri barrage, 300 km from the sea. This obstruction has deprived hilsa of two-third of their previous spawning area. Hilsa fishery has been providing livelihood to a large number of fisherman in Sindh, some of them migrate to Kotri barrage area from Sukkur and Larkana districts.

Cumulative Impacts: When hilsa migration starts in January, there is hardly any water available in delta for hilsa to migrate to upstream. Annual hilsa catch have been reduced considerably from last four decades from 11,800 t in 1973 to 266 t in 2012. The declines in hilsa catch are primarily due to reduction in flows below Kotri, loss of its original migration range, and advent of motorized fishing boats.

Recommendations: The overall situation of hilsa fishery is in severe stress and vulnerable to overexploitation. Serious attention is required to provide appropriate access for hilsa to the Indus River during migrations, and impose a ban on fishing during the upstream migration and the prevention of undersized catch. Fish ladders in Kotri and Guddu barrages must be rehabilitated to work effectively and new fish pass should be installed in Sukkur barrage. Design of rehabilitation of fish passes should be based on detailed understanding of hilsa swimming capabilities and its biological needs. Further studies are recommended to understand the biological requirements of hilsa, especially on its swimming capacity and attraction velocities to a fish way, breeding habitats, spawning grounds, migration route, and depth of water requirement for migration etc.

Actions taken by SBIP: Further studies will be taken under AF of SBIP to implement the above recommendations The Project Component E. Integrated Riverine Management will cover these aspects.

8. Environmental and Social Management Plan

8.1. General

Various categories of mitigation measures: The ESMP includes various categories of mitigation measures and plans: (i) generic and non site-specific measures in the form of environmental codes of practices (ECPs) presented in Annex D of the main ESA; (ii) project specific and to the extent possible, site-specific mitigation measures discussed in Chapter 6; (iii) construction environmental action plan (CEAP) with site-specific and contract-specific management plans to be prepared by various contractors; and (iv) Social Management Framework (SMF) updated for the proposed AF, including revised RPF.

Inclusion of ESMP in contract documents: In order to make the Contractors fully aware of the implications of the ESMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in ESA as well as World Bank Group safeguard polices and EHS guidelines. The Contractor shall be made accountable through contract documents for the obligations regarding the environmental and social components of the project.

Construction of Environmental Action Plan: Contractors need to prepare site specific management plans to address various environmental issues, and to demonstrate the manner in which the Contractor will comply with the requirements of ECPs and ESMP. It will be reviewed and approved by construction supervision consultant (CSC), project management office (PMO) and World Bank before implementation of construction works.

8.2. Institutional Arrangements

Project Management Office (PMO) has already been established under the Project and would be responsible for all aspects of project implementation including technical, operational, financial management, and overseeing the implementation of ESMP. The environmental and social staff in PMU are (i) Deputy Director Environment, (ii) Deputy Director Ecology (iii) Deputy Director Communications, (iv) Deputy Director Resettlement, (v) Deputy Director Social, and (vi) three environmental surveyors. The responsibilities of the environmental and social staff are: (i) supervising, facilitating and coordinating implementation of environmental and social plans including ESMP and SMF; (ii) preparation of resettlement action plans (RAPs) for any land acquisition and resettlement activities, (iii) ensuring that contractors follow Sindh-EPA regulations, World Bank Safeguard Policies, and other requirements mentioned in the ESMP and SMF; (iv) identifying any issues of non-compliance and report these; (v) suggesting mechanisms to link contractor performance in relation to the ESMP to the timing of financial payments, incentives or penalties; (vi) interacting with stakeholders for their concerns about the construction activities, and (vii) prepare quarterly monitoring reports on ESMP implementation. PMO is located in Karachi and Sukkur (for both Guddu and Sukkur Barrage rehabilitation), and all environmental and social staff are located in Sukkur. The organogram of PMO is shown in Figure 5.

Construction Supervision Consultants (CSC) will be responsible for supervising the contractors for the implementation of ESMP. For this purpose, the CSC will appoint an environmental specialist, a social specialist, an ecologist and an occupational health and safety specialist and environmental inspectors to ensure the ESMP implementation during the project. They will supervise the contractor for the ESMP implementation, particularly the mitigation measures. They will also be responsible for implementing the monitoring of effects of these measures.

Contractors are also required to appoint an environmental officer, a health and safety officer, an ecologist (to deal with impacts of dolphin), a community liaison officer and a human resources

officer at the site for the implementation of ESMP in the field, particularly the mitigation measures. The contractor will also be responsible for communicating with and training of its staff in the environmental/social aspects.

Monitoring and Evaluation Consultant (MEC) will be recruited by PMO to carry out independent monitoring of implementation of ESMP. The MEC will have environmental and social experts and shall carryout intermittent third party monitoring of the project

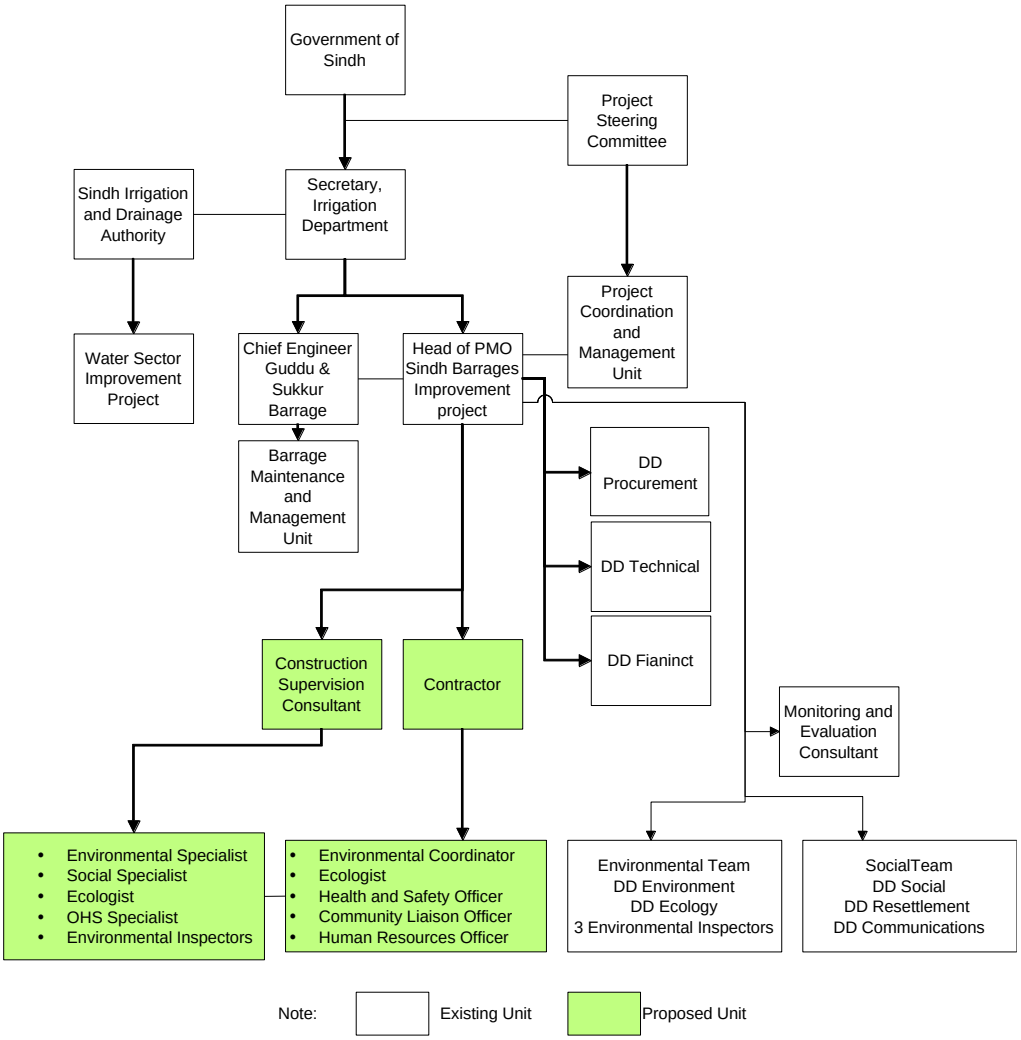

Figure 5: Proposed Institutional Structure for Implementation of ESMP

8.3. Environmental and Social Management

(a) Environmental Codes of Practice

A set of environmental codes of practice (ECPs) has been prepared for various environmental and social management aspects: ECP 1: Waste Management; ECP 2: Fuels and Hazardous Goods Management; ECP 3: Water Resources Management; ECP 4: Drainage Management; ECP 5: Soil Quality Management; ECP 6: Erosion and Sediment Control; ECP 7: Top Soil Management; ECP 8: Topography and Landscaping; ECP 9: Quarry Areas Development and Operation; ECP 10: Air Quality Management; ECP 11: Noise and Vibration Management; ECP 12: Protection of Flora; ECP 13: Protection of Fauna; ECP 14: Protection of Fisheries; ECP 15: Road Transport

and Road Traffic Management; ECP 16: Labour Influx Management and Construction Camp Management; ECP 17: Cultural and Religious Issues; ECP 18: Workers Health and Safety; ECP 19: Dredging Management; and ECP 20: Dolphins Management from Construction Impacts. The Contractors will be contractually obligated to comply with these ECPs, presented in Annex D of the main ESA.

(b) Site-specific Plans in CEAP

The following site-specific plans will be prepared by Contractors to manage and mitigate/reverse potential adverse environmental impacts on the basis of mitigation measures provided in Chapter 6 and ECPs. These plans will be reviewed and approved by the CSC, PMO and World Bank, before initiation of the construction works.

- **Dredging Management plan** describing the methodology to be adopted for dredging and dredged material placement and disposal, and documentation to be maintained for the dredging activity.
- **Dolphins Management Plan from Construction Impacts** describing the methodology to be adopted by the contractor to manage construction related impacts on dolphins.
- **Excavation Management plan for Desilting of Barrage and Canals** describing the methodology to be adopted by the contractor to manage the desilting activities and transportation of material from excavation sites to placement sites.
- **Erosion, sediment and drainage control plan** with storm water and sediment removal designs.
- **Pollution Prevention Plan** describing measures to address water, air, noise and soil pollution.
- **Waste Disposal and Effluent Management Plan** for management of various types of wastes.
- **Traffic Management Plan**, after discussion with SID and authorities responsible for roads and traffic.
- **Occupational Health and Safety Plan** describing various risks associated with the construction activities and how they will be addressed
- **Drinking Water Supply and Sanitation Plan** describing the laboratory test results of drinking water quality and design of sanitation works.
- **Management Plan for Protection of Flora and Fauna** with measures to add general construction related impacts on flora and fauna
- **Labour Influx Management and Construction Camp Management Plan** with the details of construction camp design and facilities in the camp.
- **Fuel and Hazardous Substances Management Plan** with all the procedures for handling oils and chemical spills.
- **Instream Construction Works Management Plan** to address the environmental concerns associated with use of motor boats and barge mounted equipment
- **Emergency Preparedness Plan** to address all potential risks and hazards that could be encountered during construction in the Indus and in the floods.
- **Communication Plan** in line with the SMF communication strategy to demonstrate how they will communicate with local community leaders, provide details regarding employment opportunities at mobilization, and traffic management throughout the construction period.

(c) Social Management Framework (SMF)

Resettlement Policy Framework (RPF): The project doesn't require any land acquisition. However, as a part of SMF, a RPF has been prepared by SID for SBIP in case of any unforeseen land acquisition is required for the project and also to guide temporary land acquisition by the

contractors. The updated RPF presents (a) principles and legal framework applicable for mitigation of these losses; (b) eligibility and entitlement criteria, (c) valuation methods; and (d) process of preparation of resettlement action plan.

Social Action Plan (SAP): SAP was developed to mitigate potential project social impacts (such as potential extended canal closure) and support local area development for Guddu barrage rehabilitation. To better align the project affected areas between Guddu and Sukkur barrages, SAP has been upgraded as a standalone component, the new Component E Integrated Riverine Management Plan, which would support development of alternative livelihoods for traditional fishing communities.

Communication Strategy: A formal communication strategy was prepared for the project to lay out various communication needs and outreach tools and explain the responsibility of PMO to convey the awareness of the project impacts and its impacts to various stakeholders. A key aspect of this strategy shall be the communication of any project related impacts. The Strategy has been reviewed and revised to include Sukkar Barrage rehabilitation.

8.4. Monitoring Plan

Proposed monitoring plan to be carried during implementation of the project to ensure contractors compliance with the mitigation measures is given in Table 4 along with the monitoring indicators and frequency. CSC will be responsible for supervision of implementation of the plan.

Table 4: Effects Monitoring Plan

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Ecological monitoring (dolphins, turtles, fish)	Field investigations for observations on dolphin or turtle entrapment or their presence to close to construction areas	During desilting of barrage and canals (daily)	Contractor	CSC, PMO
River morphology at the dredged material placement location	Sediment load and morphological conditions	During dredging and placement (monthly)	Contractor	CSC, PMO
Surface water quality	Sampling and analysis of river water quality and waste water discharges for the parameters given in NEQS 2000	Quarterly	Contractor	CSC, PMO
		Annually	External Monitor (PMO through a nationally recognized laboratory)	CSC, PMO
	Spot measurements of pH, conductivity, turbidity; visual inspection of presence of petroleum products	Monthly	CSC	CSC, PMO
Groundwater quality	Sampling and analysis groundwater quality for drinking water	Quarterly	Contractor	CSC, PMO
		Annually	External Monitor (PMO through a nationally recognized laboratory)	CSC, PMO
Air Quality (dust, smoke)	Visual inspection to ensure good standard equipment is in use and dust suppression measures (sprinkling) are in place	Daily	Contractor	CSC, PMO
	Visual inspection to ensure dust suppression work plan is being implemented	Daily	Contractor	CSC, PMO
		Prior to Construction	Contractor	CSC, PMO

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Air Quality (PM_{10}, NO_2, SO2, CO_2, CO)	Air quality monitoring for 24 hours for the parameters specified in NEQS 2000	Quarterly	Contractor	CSC, PMO
		Annually	External Monitor (PMO through a nationally recognized laboratory)	CSC, PMO
Emissions from plant and equipment	Visual inspection	Monthly	Contractor	CSC, PMO
Noise and vibration	24 hour noise monitoring	Quarterly	Contractor	CSC, PMO
	24 hour noise monitoring	Annually	External Monitor (through a nationally recognized laboratory)	CSC, PMO
	Spot measurements	Monthly	CSC	CSC, PMO
Waste Management	Visual inspection that solid waste is disposed of at designated sites	Monthly	Contractor	CSC, PMO
Spills from hydrocarbon and chemical storage	Visual inspection for leaks and spills	Monthly	Contractor	CSC, PMO
Operation of borrow sites	Visual inspection of quarry sites	Monthly	Contractor	CSC, PMO
Traffic safety	Visual inspection to ensure Traffic Management Plan is implemented	Monthly	Contractor	CSC, PMO
Local roads	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	CSC, PMO
Community relations	Consultations with community members	Monthly for the first year, then quarterly	Contractor	CSC, PMO
Laborers	Number and percentage of skilled and unskilled laborers hired locally.	Quarterly	Contractor	CSC, PMO
Drinking water and sanitation	Ensuring construction workers are provided with safe water and sanitation facilities on site	Weekly	Contractor	CSC, PMO
Safety of workers	Usage of personal protective equipment	Monthly	Contractor	CSC, PMO
Erosion	Visual inspection in all areas where run-off leaves bare and at important drainage features (ditches, gullies, etc.) after major rainfall events	Weekly	Contractor	CSC, PMO
Reinstatement of work sites	Visual Inspection	After completion of all works	Contractor	CSC, PMO

8.5. Capacity Building

The environmental and social trainings will help to ensure that the requirements of the ESMP are clearly understood and followed by all project personnel. The primary responsibility of providing these trainings to all project personnel will be that of the contractor and Supervision Consultants. The trainings will be provided to different professional groups separately such as managers, skilled personnel, unskilled labors, and camp staff.

8.6. External Monitoring

The SID will engage an Independent Monitoring & Evaluation Consultant to conduct external and independent monitoring and evaluation of the ESMP implementation. The main purpose of the external monitoring will be to ensure that all the key entities including PMO, CSC, and contractors

are effectively and adequately fulfilling their designated role for ESMP implementation and that all the ESMP requirements are being implemented in a timely and effective manner.

8.7. Grievances

Grievances are actual or perceived problems that might give grounds for complaints. As a general policy, PMO will work proactively towards preventing grievances through the implementation of impact mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances. For the original project, a project level grievance redress mechanism has been established and the same will be used for Sukkur Project also. Community grievance redress mechanism (CGRM) addresses complaints related to both Guddu and Sukkur's ESMP/SMF as well as the project implementation, while procurement grievance redress mechanism specifically addresses procurement related issues. For CGRM, a complaint cell has been set up at PMO in Sukkur, chaired by Deputy Project Director. If a complaint is not resolved locally, it could be escalated to a grievance redress committee set up in Karachi.

8.8. Reporting

Proper arrangements are necessary for recording, disseminating and responding to information that emerges from the various environmental monitoring and management programs. They are also necessary for rendering the environmental management systems "auditable." The CSC and PMO will prepare monthly and quarterly reports covering various aspects of the ESMP implementation including compliance and effects monitoring, capacity building, and grievance redressal. In addition, CSC and PMO will also prepare semi-annual reporting for OHS related issues.

8.9. Cost of ESMP

Implementation of environmental management plans proposed in the ESA will be contractor's obligation and no separate amount will be paid. The cost of environmental monitoring and capacity building activities have been assessed as 0.5 million USD. The cost of implementation of SMF has been assessed as 1.5 million USD.

9. Stakeholder Consultations and Disclosure

9.1. Overview

Extensive consultations were carried out throughout the project preparation. Initial consultations were held at the early stages of the project preparation (2012-2013) and also during 2015 with the farming communities in the canal command areas to share the project objectives and terms of references of the proposed environmental assessment study. Consultations involved multiple methods – for example, household level interviews, village wise meetings, focus group discussions and workshops. Second round of consultations were carried out in 2017 to share the findings of the draft ESA. Details of participants consulted are given in Table 5 and they include (i) population around the project area and community representatives. (ii) farmers in the command area of Sukkur barrage, (iii) squatters in the project area, (iv) district and provincial government authorities responsible for district administration, forest, agriculture, fisheries, wildlife and environmental protection, (v) conservation agencies such as WWF and (vi) community based originations.

Table 5: Number of Persons Covered in Various Consultation Meetings

	Activities	No. of participants
A.	**First Round of Consultations (2012-2015)**	
1.	Village wise meetings in the left bank command area (35 villages)	432
2.	Meetings in the right bank command area (23 villages)	235
3.	Community consultations near the barrage site, including squatters	94
4.	Government stakeholders	24
B.	**International Seminar on Dolphin Conservation (May 2017)**	
1.	A one-day international seminar in Karachi on dolphin conservation and management	148
C	**Second Round of Consultations (in 2017)**	
4.	Public Consultation at Sukkur	30
5	Consultation workshop with downstream stakeholders at Jamshoro	59
6	Consultation workshop with provincial stakeholders	14
Total		**1,036**

During first round of consultations, 785 people were consulted through village wise meetings in the barrage command areas, and meetings with the communities around the barrage site. The Project information has also been shared with 148 experts participated in the international seminar on dolphin conservation and management conducted by SBIP in May 2017.

The second round of consultations were carried out through public consultations at Sukkur and consultation workshops at downstream Kotri barrage, and in Karachi. Public consultations were conducted on 7th August 2017 at PMO office in Sukkur. Prior notices are given through newspaper advertisements (in English and Sindhi dailies on 29th July 2017) and invitation letters. The EIA and SIA documents prepared by the design consultants have been disclosed on the website of SID prior to the consultations. The scope of the proposed project activities, dredging and dredge material management plans have been discussed in these consultations. Participants have fully

supported all the proposed activities including dredging and dredge material placement in the river.

9.2. Consultations Feedback

A summary of main issues raised with various stakeholders and how these issues are addressed and incorporated are shown in Table 6 for the first round of consultations, and in Table 7 for second round of consultations.

Table 6: Feedback from First Round of Consultations

	Comments and Suggestions	**Action Point**
A	**Farmers of Command Area**	
1	Farmers are very happy about the proposed rehabilitation and modernization works and said that it will improve their livelihoods, and will also benefit the whole province.	The Project will enhance the life of Sukkur barrage and thus safeguards the livelihoods of 0.6 million farming households.
2	Project activities should be designed in a such way that irrigation releases to the canals will not be stopped, particularly during summer months for the *Kharif* crops like cotton, which will not survive more than 6 to 7 days without the water. In some areas, where the soils are sandy, the soil quality will also be affected if the irrigation releases are stopped during summer months. In some villages, where the groundwater is saline, the canal water is being used for drinking purposes.	The proposed project activities will not require stoppage of any canals or will not interference with the irrigation releases to canals.
3	Regular canal closure periods should be maintained during proposed constructing works, and if the canals need to be closed other than regular periods, the irrigation department should share this information well in advance so that farmers will skip the cultivation during that season.	Regular canal closure periods will be maintained. Desilting of canals will be carried out only during their annual canal closure periods.
B	**Communities near the Barrage**	
4	Communities are using the belas (silt deposits) along the banks for cultivation whenever it is possible as a secondary source of income, and any project activities in these areas will affect their livelihood.	The proposed desilting activities will not affect any farm lands in the belas.
5	The proposed construction activities should be limited to the existing barrage areas. If the Project require any land acquisition, the compensation for all losses should be paid at market rates.	The proposed project activities will not require any land acquisition. If any land acquisition would be needed during implementation stages, a resettlement action plan will be developed in accordance with Resettlement Policy Framework of SBIP.
6	Employment opportunities during construction period be provided to the communities living close to the barrage area	Preference will be given to local communities for unskilled labour work with the contractor.
C	**District Level Stakeholders**	
7	Dolphin is the only threated species in the barrage area and no other threated fauna or flora species were reported or sighted.	Dolphin is the only threatened species recorded in the project area.

8	Dolphins should be given special attention while executing the project activities and developing mitigation plans for the construction impacts. However, dolphin have a large home range between Sukkur and Guddu barrages, and it will temporarily move away from the construction areas.	Mitigation plans have been prepared to address construction related impacts on dolphins
9	Wildlife department would like to associate with the construction monitoring activities as they have experience in monitoring related to impacts on dolphin.	A dolphin conservation and management program will be implemented under the SBIP by the Sindh Wildlife Department

Table 7: Feedback from Second Round of Consultations

	Comments and Suggestions	**Action Point**
1	The area between the Sukkur and Guddu barrage area is dolphin game reserve. Sindh Wildlife Department is interested to participate in the monitoring of dredging and dredge material placement activities to ensure these activities will not affect the dolphin and fish. WWF has suggested that they have dolphin rescue team, and would be interested to provide their services if required. WWF has also recommended measures to ensure dolphins not present in the construction areas.	The SID is already in the process of engaging the Sindh Wildlife Department for carrying of dolphin conservation activities under SBIP. Schedules of dredging activities will be shared in advance with the wildlife life departments for participation in the monitoring activities. Mitigation measures proposed by WWF to ensure dolphins not to present in the construction area have already been included in the ESMP.
2	High flow season of Indus is the breeding season of many fish species. Measures should be taken during dredging to minimize the generation of sediment plumes. Sindh Fisheries Department would like participate in the monitoring activities along with the wildlife department.	Dredging and dredged material placement activities will be carried out during high flow season when the natural sediment load in the river is very high. The proposed dredging and placement methods considered in the project will have minimal impacts on the fish. Schedules of dredging activities will be shared in advance with the fisheries department for their participation in the monitoring activities.
3	Canals of Sukkur barrage have been silted up. The silting of canals, particularly the Rice canal, should be included in the scope of the Project to reap full benefits of the barrage retaliation.	Dredging of intake of the right bank canals have been included in the scope of the project
4	The common concern of all stakeholders is that extended closure of canals will seriously affect socio-economy of the command area. Regular scheduled canal closure period is about 3 to 4 weeks during month of April; and about 2 weeks during January. If the closure period is extended, it will seriously affect their crop and livestock production. If any canal closure is required for construction, the farmers should be informed one season in advance.	Canals will not be closed during the barrage rehabilitation period. Any works that require canal closure will be carried out during routine canal closure periods. Canal desilting will also be carried during canal closure period.
5	Local community should be given preference in employment in the construction activities.	The PMO will pursue with the contractor to hire all unskilled labour from local community and also skilled labour if available.

6	Construction works during night time should be avoided.	Construction related impacts such as noise and dust pollution are addressed in the ESMP and ECPs. No construction activities will be carried out during night time close to the communities.
7	Indus delta has been under threat of retreating due to reduced sediment and river flows from the upstream barrage.	The management plan on desilted material, from the barrage and canal, proposed for the project will release all the sediment material back to the river.
8	The barrage authorities should carry out adequate maintenance works regularly to avoid desiltation problems in future	The project will support developing necessary facilities required for adequate maintenance works of the barrage.
9	Resilience of the barrage structure for earth quakes.	Barrage site is located in a seismically inactive region. Barrage is strong enough to withstand earth quakes. The barrage has been originally designed to withstand higher earth quake intensity than the required
10	WWF was involved in dolphin rescue operations in Sukkur area and would provide support to the project.	Dolphin rescue team will be established by the Project under the dolphin conservation program, and the contractor will also maintain a dolphin rescue team.

9.3. Disclosure

This ESA summary and ESA reports will be disclosed in the SID website and will be sent to World Bank's external website. The ESA summary will be translated in to Urdu and Sindhi language and will be uploaded in to the SIDs website. The hard copies of the documents will be made available to the communities through the library of the Sukkur barrage.