PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

DASU HYDROPOWER PROJECT

ENVIRONMENTAL MANAGEMENT ACTION PLAN

Volume 2: ENVIRONMENTAL IMPACT ASSESSMENT

General Manager (Hydro) Planning, WAPDA, Sunny View, Lahore, Pakistan

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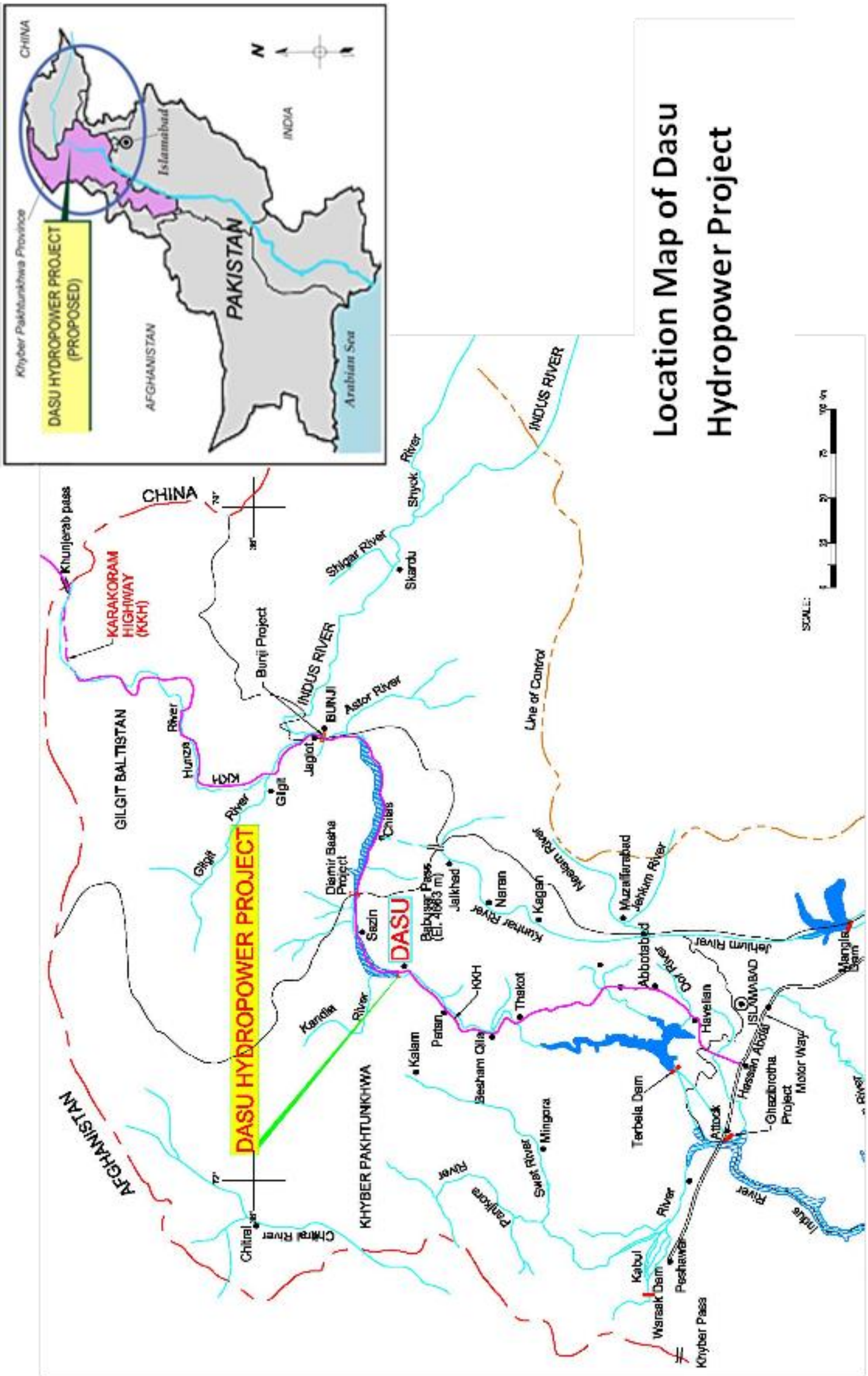
Location Map of Dasu Hydropower Project
DASU HYDROPOWER PROJECT (PROPOSED)
Khyber Pakhtunkhwa Province
AFGHANISTAN
PAKISTAN
INDIA
CHINA
Islamabad
Arabian Sea
DASU HYDROPOWER PROJECT
DASU
KARAKORAM HIGHWAY (KKH)
Khunjerab pass
GILGIT BALTISTAN
KHYBER PAKHTUNKHWA
INDUS RIVER
Line of Control
Burji Project
Diamir Basha Project
Tarbela Dam
Mangla Dam
Warsak Dam
Khyber Pass
ISLAMABAD
SCALE

ENVIRONMENTAL MANAGEMENT ACTION PLAN

ABBREVIATIONS

ACO	Assistant Coordinating Officer
ADB	Asian Development Bank
AIS	Air Insulated System
AMIFP	Annual Maximum Instantaneous Flood Peak
ANZECC	Australian and New Zealand Environment and Conservation Council
BDF	Basic Design Flood
BHU	Basic Healthcare Unit
BOQ	Bill of Quantities
BP	Bank Procedure
C&W	Communication and Works
CCA	Community Conservation Areas
CDE	Carbon Dioxide Equivalent
CDM	Clean Development Mechanism
CEAP	Construction Environmental Action Plan
CERs	Certified Emission Reductions
CESSD	Communication for Effective Social Services Delivery
CIIA	Cumulative and Induced Impact Assessment
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CRFD	Concrete Faced Rockfil Dam
CRS	Catholic Relief Services
CSC	Construction Supervision Consultant
CSG	Cemented Sand And Gravel
CVC	Conventional Vibrated Concrete
D/S	Downstream
DHP	Dasu Hydropower Project
DOAM	Directorate of Archaeology and Museum
DRO	District Revenue Officer
DSO	Dam Safety Organization
EA	Environmental Assessment
ECA	Employment of Child Act
ECP	Environmental Code of Practices
EEC	Environmental Enhancement Committee
EF	Emission Factors
EF	Environmental Fund
EHS	Environmental, Health, and Safety
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPI	Expanded Programme of Immunisation
EU-CSC	Environmental Unit in CSC
EU-DHP	Environmental Unit in DHP
FGD	Focus Group Discussions
FHWA TNM	Federal Highway Administrators Traffic Noise Model
FS	Feasibility Study
FSL	Full Supply Level
FWO	Frontier Works Organization
GB	Gilgit-Baltistan

GCISC	Global Change Impact Studies Centre
GCM	Global Circulation Model
GDP	Gross Domestic Production
GHG	Green House Gas
GIS	Geographical Information System
GIS	Gas Insulated Switch Gear
GLOF	Glacial Lake Outburst Flood
GMRC	Global Monitoring and Research Centre
GOP	Government of Pakistan
GRC	Grievance Redress Committee
GWP	Global Warming Potential
HFO	High Sulfur Fuel Oil
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
HK	Hindu Kush-Karakoram
HSD	High Sulphur Diesel
ICOLD	International Commission on Large Dams
IEE	initial environmental examinations
ILRP	Income and Livelihood Development Program
IPCC	Intergovernmental Panel on Climate Change
IRS	Indus River System
ISC	International Seismological Centre
ISWDO	Indus Social Welfare and Development Organization
IUCN	International Union for Conservation of Nature
KDO	Karakoram Development Organization
KKH	Karakoram Highway
KP	Khyber Pakhtunkhwa
KPK	Khyber Pakhtunkhwa
L&FS	Life and Fire Safety
LAA	Land Acquisition Act
LGO	Local Government Ordinance
LHV	Lady Health Visitor
LLO	Low level outlets
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
MAF	Million Acre Feet
MASL	Meters Above Mean Sea Level
MBT	Main Boundary Thrust
MCE	Maximum Credible Earthquake
MFT	Main Frontal Thrust
MIC	Maximum Instantaneous Charge
MKT	Main Karakoram Thrust
MM	Modified Mercalli
MMT	Main Mantle Thrust
MO	Medical Officer
MOL	Minimum Operating Level
MW	Megawatt
Mw	Moment Magnitude
NADRA	National Data Base Registration Authority
NCS	National Conservation Strategy
NEIC	National Earthquake Information Centre
NEPPO	Near East Plant Protection Organisation
NEQS	National Environmental Quality Standards

NIDA	National Integrated Development Pakistan
NMVOC	Non Methane Volatile Organic Compounds
NOC	no objection certificate
NTDC	National Transmission and Dispatch Company
OEAP	Operation Environmental Action Plan
OHS	Occupational Health and Safety
OP	Operational Policy (of World Bank)
OPC	Ordinary Portland Cement
PA	Per Annum
PAK-EPA	Pakistan Environmental Protection Agency
PAP	Project Affected People
PCR	Physical and Cultural Resources
PDA	Palas Development Association
PEPA	Pakistan Environmental Protection Act
PEPCO	Pakistan Electric Power Company
PEPO	Pakistan Environmental Protection Ordinance
PH	Powerhouse
PHAP	Public Health Action Plan
PMD	Pakistan Meteorological Department
PMF	Probable Maximum Flood
PMU	Project Management Unit
POE	Panel of Experts
PPE	Personal Protective Equipment
PRA	Participatory Rural Appraisal
PRO	Project Resettlement Office
RAP	Resettlement Action Plan
RCC	Roller Compacted Concrete
RCM	Regional Climate Model
RCNM	Roadway Construction Noise Model
RHC	Rural Health Centre
ROG	Reactive Organic Gases (Volatile Organic Compounds)
ROR	Run of River
RWL	Reservoir water level
SCF	Safety Check Flood
SRMP	Social and Resettlement Management Plan
STI	Sexually Transmitted Infections
TR	Transformer
TTS	Temporary Threshold Shift
U/S	Upstream
UIB	Upper Indus Basin
UNDP	United Nations Development Programme
USEPA	United States Environmental Protection Agency
VC	Village Committee
WAPDA	Pakistan Water and Power Development Authority
WB	World Bank
WCAP	Water Sector Capacity Building and Advisory Services Project
WEC	WAPDA Environmental Cell

Volume 2
ENVIRONMENTAL IMPACT ASSESSMENT

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INTRODUCTION

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1. INTRODUCTION

1.1 OVERVIEW

Pakistan is suffering from an acute power and energy crisis which is primarily caused by insufficient energy supply and increasing demand. The total installed capacity of the country was 24,173 MW, yet only a peak demand of 19,924 MW could be served in 2011, indicating significant shortfall of 4249 MW. Power shortages resulted in long hours of load shedding, impacting households, industrial and commercial activities. Power shortages coupled with fuel shortages impacted export performance and economic growth. The impact of load shedding has been estimated at 3% to 4% of GDP, costing about US$ 10b a year. Further, Pakistan's energy sector is currently marked by high dependence on non-renewable fossil fuels much of which has to be imported, making energy production more expensive and affecting the national balance of payments. Pakistan per capita energy consumption is one of the lowest in the world with 450 kWh compared to the world average of 2,730 kWh.

Pakistan Water and Power Development Authority (WAPDA) has prepared 'Vision 2025' program for improving hydropower generation capacity to cope with the increasing water and power demands of the country. This program is a US$ 25 to 33 billion development program with the projects that could generate 16,000 MW of additional hydropower plants. The Dasu Hydropower Project (DHP or the Project) is a major investment project proposed by the Government of Pakistan (GOP) to inject about 18,440 GWh to the national grid and expand the energy sector of the country, while shifting from thermal generated electricity to low cost and high reward, clean generation of hydropower. DHP is included as one of the priority project in Vision 2025 program. Feasibility study conducted by WAPDA confirmed the technical, environmental and economic viability of the Project. The detailed design of the Project is being undertaken with the financial assistance from the World Bank through its ongoing project with WAPDA, 'Water Sector Capacity Building and Advisory Services Project (WCAP).

DHP is a run-of-river project planned for development on the Indus River near 7 km upstream of Dasu town in Kohistan district of Khyber Pakhtunkhwa (KP) province, located about 350 km north of Islamabad. Location of the Project is shown in Figure 1.1.

DHP will be comprised of a 242 m high concrete gravity dam and 73 km long reservoir behind the dam. The reservoir will have average width of 365 m and, at full supply level (FSL) elevation (El) of 950m above sea level (masl), an area of about 23.85 km^2. The Project will have an underground powerhouse housing 12 turbines, each of which will produce 360 MW power, and a total maximum capacity to produce 4320 MW. WAPDA is the proponent and executing agency of the Project. World Bank is considering financing this Project for implementation.

The Project also includes construction of 62 km of Karakoram Highway (KKH) realignment due to inundation of part of the current road and about 300 km of two 500 kV transmission lines from Dasu damsite to Pathar Garh, near Hasan Abadal. The design of a transmission route is being carried out through a separate study by National Transmission and Dispatch Company (NTDC) and hence not covered in this study.

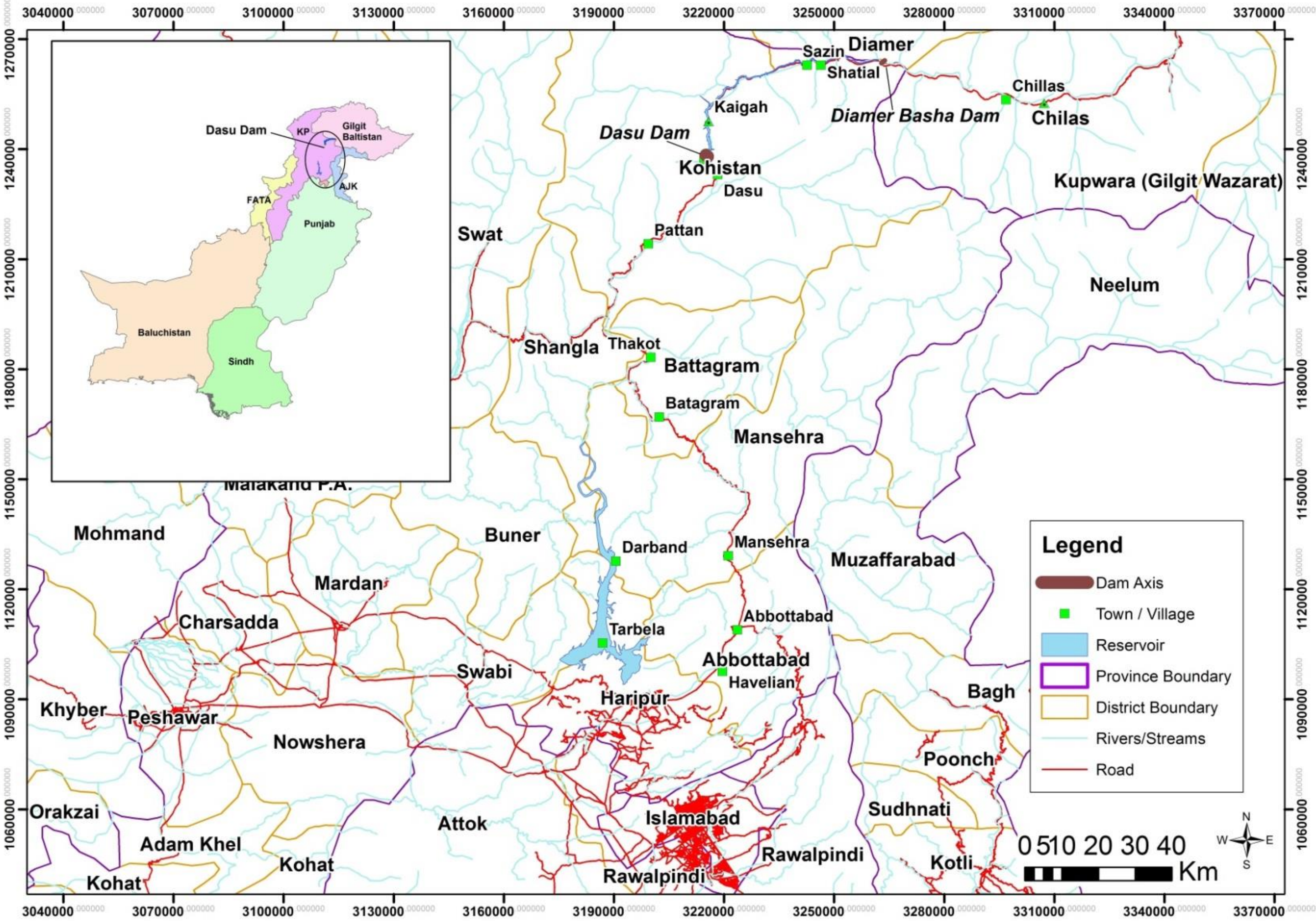

Figure 1.1: Location of DHP

1.2 BACKGROUND OF THE PROJECT

WAPDA conducted a study in 1981(MONENCO 1981) to identify potential hydropower and storage development projects in the Upper Indus Basin (UIB). The study recommended and ranked 25 major potential sites (9 on Indus and 16 on tributaries), each having an installed capacity of more than 100 MW. DHP was ranked second in this study following the Diamer Basha Dam Project (Basha Project).

At about 74 km upstream of DHP dam site, the site of Basha Project dam is located, which will be a storage dam for power generation as well as seasonal storage to supplement irrigation supplies downstream of Tarbela dam. Detailed design of Basha Project was completed in 2009 and was ready for implementation.

The river reach between Diamer Basha dam and Dasu dam is a narrow gorge of limited capacity, which would form a reservoir for Dasu dam without much storage. Water will be impounded in the reservoir by constructing a high dam to create a high head. Water will be released downstream of Dasu dam through turbines for generating hydropower, and as spill through the spillway. Being a run-of-river project the operation of Dasu dam will not affect the operation of any other dam located downstream on Indus River. As such, operation of the Dasu Project will stand alone with the sole objective of power generation.

A feasibility study (DHP Feasibility Study, 2009) was conducted for DHP during 2006 to 2008 to identify the location of the Project and prepare preliminary engineering designs and an Environmental Impact Assessment (EIA). A 'no objection certificate (NOC or Legal Environmental Approval)' was obtained from the KP Environmental Protection Agency (EPA) on the Project in November 2011 (Annex 1.1). The preliminary design was prepared with a concept that Basha Project will be constructed prior to the DHP.

Detailed design of the Project was started in September 2011 by Nippon Koei, Japan (joint venture with Dolsar Engineering, Turkey in association with three Pakistani firms: Development Management Consultant, National Development Consultants and Pakistan Engineering Services). During the detailed design, the Project was designed with a concept that DHP will be implemented prior to Basha Project, which is a major conceptual shift from feasibility study to detailed design study. This was due to the reason that there was no committed funding available for implementation of the Basha Project.

An environmental assessment (EA) has been carried out as part of the detailed engineering design of the Project and this EIA report is an outcome of this EA process. The studies for EA are carried out mostly during April to December 2012.

1.3 ENVIRONMENTAL ASSESSMENT

The World Bank requires EA of projects proposed for its financing to help ensure that they are environmentally sound and sustainable. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EIA is the outcome of the Bank's EA process on DHP. This EIA essentially addresses national as well as WB requirements on project approval.

1.3.1 EA Documentation

A set of twenty two (22) volumes have been prepared as a part of EA documentation. The packaging of the EA documentation demonstrates the full coverage of impacts in the form of Environmental Management Action Plan (EMAP) and Social and Resettlement Management Plan (SRMP). EMAP (8 volumes, Table 1.1) provides comprehensive coverage of the different environmental issues and project impacts, including mitigation measures and management plans. Similarly SRMP (a set of 15 volumes, Table 1.2) provides detailed coverage of social and resettlement issues of the Project.

Table 1.1: Environmental Management Action Plan (EMAP)

Vol. 1	Executive Summary
Vol. 2	Environmental Impact Assessment
Vol. 3	Terrestrial Ecology
Vol. 4	Aquatic Ecology
Vol. 5	Physical Cultural Resources
Vol. 6	Environmental Baseline Quality
Vol. 7	Cumulative and Induced Impact Assessment
Vol. 8	Environmental Management Plan

Table 1.2: Social and Resettlement Management Plan (SRMP)

Vol.1	Executive Summary
Vol.2	Socioeconomic Baseline and Impact Assessments
Vol. 3	Public Consultation and Participation Plan
Vol. 4	Resettlement Framework
Vol. 5	Resettlement Action Plan
Vol. 6	Gender Action Plan
Vol. 7	Public Health Action Plan
Vol. 8	Management Plan for Construction-related Impacts
Vol. 9	Grievances Redress Plan
Vol. 10	Communications Strategy
Vol. 11	Downstream Fishing Communities: Baseline and Impact Assessments
Vol. 12	Area Development and Community Support Programs
Vol. 13	Costs and Budgetary Plan
Vol. 14	Safeguards Implementation and Monitoring Plan.

1.3.2 Organization of EIA Report

Following this Introduction Chapter, the EIA report is divided into thirteen chapters as follows:

- Chapter 2 - Policy, Legal and Administrative Framework: This chapter contains the Government of Pakistan (GOP) and World Bank guidelines on environmental assessment and their applicability to DHP, EIA review and approval process by EPA, and details of international treaties and conventions signed by the GOP.
- Chapter 3 - Description of the Project: This chapter contains a brief description of various project components, project location and setting, project design details, size or magnitude of operation, sourcing of resources for implementation, and proposed schedule of project implementation.
- Chapter 4 - Description of the Environment: Explains the general description and background of physical resources, ecological resources, environmental quality baseline, social and cultural profile, and economic activities.
- Chapter 5 – Alternative Analysis: This chapter describes the alternatives considered for various project components. For each alternative, a set of criteria and sub criteria consisting of social, environmental, technical and economical parameters are used to compare the various alternatives.

- Chapter 6 – Climate Change Impacts and Risks: This chapter covers the impact of climate change on the project and impact of the project to climate change. A climate change consideration is undertaken for anticipated environmental conditions. The studies carried out by Global Climate Change Impact Study Centre of Pakistan are used as the basis for analysis.
- Chapter 7 – Potential Environmental Impacts and Their Mitigation: This chapter provides a detailed analysis on project related significant Impacts/risks on various environmental components, and provides mitigation measures for all the impacts.
- Chapter 8 – Potential Social Impacts and Their Mitigation: This chapter provides a detailed analysis of impacts related to social and resettlement issues, and mitigation measures.
- Chapter 9 – Environmental Management Plan (EMP): The chapter addresses the impacts to be mitigated, and activities to implement the mitigation measures, including how, when, and where they will be implemented. The environmental monitoring plan describes the impacts to be monitored, and when and where monitoring activities will be carried out, and who will carry them out. In addition, EMP also provides the cost associated with each mitigation and monitoring measures.
- Chapter 10 – Potential Impacts of Relocation of KKH: This chapter provides summary of impacts and mitigation measures associated with construction of 62 km of relocated KKH.
- Chapter 11 – Cumulative and Induced Impact Assessment (CIIA): This chapter covers the incremental impacts of Dasu in combination with existing and proposed hydropower development projects in Upper Indus Basin over a period of next 10 years.
- Chapter 12 – Public Consultations and Information Disclosure: Covers the process of various consultations held during the detailed design stages. Also covers the details of the consultation meetings, comments received and incorporated in the detailed design and public disclosure of the EIA.
- Chapter 13 – Conclusions: The chapter provides the summary of all findings, issues addressed and concluding remarks on the future safeguard requirements.
- Chapter 14 – References: Covers the details of references used in this report.

1.4 COMPOSITION OF STUDY TEAM

The EA of the Project was undertaken by a team of national consultants with the support of international consultants.

Environment Team who prepared the EMAP reports is as follows:

The national team members include Zafar Iqbal Chaudry and Mudassar Hassan (Environment Specialists), Dr. William George and Prof. Tahir Omer (Fish Experts), Dr. Sajid Nadeem (Wildlife expert), Dr. Rehmatullah Qureshi (Vegetation Expert), Prof. Ihsan H. Nadiem and Irshad Ahmad Soomro (PCR Specialists), Dr. Allah Bakhsh Sufi (CIIA Specialist), and Noman Saeed (GIS Specialist).

The international team members include Dr. Venkata Nukala (Lead Environmental Specialist), Malcolm Winsby (Aquatic Ecologist), Dr. Kashif Sheikh (Terrestrial Ecologist) and Dr. Masud Karim (Environmental Specialist – Climate Change).

Social Team who prepared the SRMP reports is as follows:

The national team members include Maqsood Ahmed, Dr. Ramzan Chaudhary and Awais Hassan Khan (Resettlement Specialists), Anwar Fazal Ahmed and Arslan Tariq (Sociologist), Saima Raoof and Ujala Saleem (Gender Specialists), Rana Muhammad

Saleem (Consultation Specialist), Ahmed Saleem (Communications Specialist), Noorul Hadi (Livelihood Specialist), and Dr. Ilyas Quershi (Public Health Specialist).

The international experts include Dr. Mohamad Zaman, Sunil Gonnetilleke and Dr. Haimin Wang (Resettlement Specialists), Dr. Iffat Idris (Social/Conflict Analyst), and Dr. Bernhard Eder (Public Health Specialist).

The team was supported by WAPDA's Independent Reviewers (Reiste Koopmans and Muhammad Omar Khalid) and International Panel of Experts (Prof. Shi Gouqing and Erik Helland-Hansen). World Bank's Lead Safeguard Specialist, Chaohua Zhang and Senior Environmental Specialist, Javaid Afzal provided useful guidance to the team through the study period.

Chapter 2

POLICY LEGAL AND ADMINISTRATIVE FRAMEWORK

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2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 NATIONAL FRAMEWORK

Government of Pakistan (GOP) policies, statutory and administrative framework related to environmental issues of the country are presented in the following sections.

2.1.1 National Legal framework

The development of statutory and other instruments for environmental management has steadily gained priority in Pakistan since late 1970s. The Pakistan Environmental Protection Ordinance, 1983 was the first piece of legislation designed specifically for the protection of the environment. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency (Pak EPA), the primary government institution dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which culminated in the drafting of the Pakistan National Conservation Strategy. Provincial environmental protection agencies were also established at about the same time. The National Environmental Quality Standards (NEQS) were established in 1993. The enactment of the Pakistan Environmental Protection Act (PEPA), 1997 conferred broad-based enforcement powers to the environmental protection agencies. The publication of the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations (IEE-EIA Regulations), 2000 provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA). In addition to the PEPA, 1997, Pakistan's statute books contain a number of other laws that have clauses concerning the regulation and protection of the environment.

2.1.1.1 Eighteenth Amendment Act, 2010

Amendment XVIII (the Eighteenth Amendment) of the Constitution of Pakistan was passed by the National Assembly of Pakistan on April 8, 2010. According to this amendment, the Ministry of Environment has been dissolved and the provinces have been authorized to make the laws and regulations regarding environment. The powers of Pak-EPA have now become the powers of Provincial EPAs. Every province is making its own environment protection act. Although, work on this has initiated however, to date law has not been enacted in KP and PEPA 1997 continues to be the prime legal instrument for environmental protection. Based on consultation with KP EPA, it is understood that they are still drafting the act based on the PEPA 1997 and the whole text of PEPA, 1997 will remain almost same with following amendments:

- for the words "Federal Government", wherever occur, the word "Government" shall be substituted;
- for the words "Federal Agency", wherever occur, the words "Provincial Agency" shall be substituted;
- for the word "National", wherever occurs, the word "Khyber Pakhtunkhwa" shall be substituted.
- for the word "Pakistan" wherever occurs, the word "Khyber Pakhtunkhwa" shall be substituted.
- The Government shall, by notification in the official Gazette, establish a Council to be known as the Khyber Pakhtunkhwa Environmental Protection Council consisting of Chief Minister, Provincial Environment Minister and members.

2.1.1.2 Pakistan Environmental Protection Act, 1997

The Pakistan Environmental Protection Act, 1997 is the basic legislative tool empowering the government to frame regulations for the protection of the environment.

The act is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. In context of the Act "environment" means- “(a) air, water and land; (b) all layers of the atmosphere; (c) all organic and inorganic matter and living organisms; (d) the ecosystem and ecological relationships; (e) buildings, structures, roads, facilities and works; (f) all social and economic conditions affecting community life; and (g) the inter-relationships between any of the factors in sub-clauses (a) to (f). The following key features of the Act have a direct bearing on the proposed project:

- Section 11 (Prohibition of Certain Discharges or Emissions): states that “Subject to the provisions of this Act and the rules and regulations made there under, no person shall discharge or emit, or allow the discharge or emission of, any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the NEQS”.
- Section 12-I (IEE and EIA); requires that “No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an IEE or, where the project is likely to cause an adverse environmental effect, an EIA, and has obtained from the Federal Agency approval in respect thereof.”
- Section 12-2b (Review of IEE and EIA): The Federal Agency shall review the EIA report and accord its approval subject to such conditions as it may deem fit to impose, or require that the EIA be re-submitted after such modifications as may be stipulated or rejected, the project as being contrary to environmental objectives.
- Section 14 (Handling of Hazardous Substances); requires that “Subject to the provisions of this Act, no person shall generate, collect, consign, transport, treat, dispose off, store, handle, or import any hazardous substance except (a) under a license issued by the Federal Agency and in such manner as may be prescribed; or (b) in accordance with the provisions of any other law for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement, or other Instrument to which Pakistan is a party.” Enforcement of this clause requires the EPA to issue regulations regarding licensing procedures and to define ‘hazardous substance.’
- Section 15 (Regulation of Motor Vehicles): Subject to provision of this clause of the Act and the rules and regulations made there under, no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the NEQS, or where the applicable standards established under clause (g) of subsection (1) of Section-6 of the Act.
- Section 17 (Penalties): Whoever contravenes or fails to comply with the provisions of section 11, 12, 13, or section 16 or any order issued there under shall be punishable with fine which may extend to one million rupees, and in the case of a continuing contravention or failure, with an additional fine which may extend to one hundred thousand rupees for every day during which such contravention or failure continues: Provided that if contravention of the provisions of section 11 also constitutes contravention of the provisions of section 15, such contravention shall be punishable under sub-section (2) only.

2.1.1.3 Review of IEE and EIA Regulations, 2000

The Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000, prepared by the Pak-EPA under the powers conferred upon it by the PEPA, 1997 provide the necessary details on the preparation, submission, and review of the initial environmental examination (IEE) and the environmental impact assessment (EIA). Categorization of projects for IEE and EIA is one of the main components of the IEE/EIA Regulations, 2000.

Projects have been classified on the basis of expected degree of adverse environmental impact. Project types listed in Schedule II of the regulations are designated as potentially seriously damaging to the environment, and those listed in Schedule I as having potentially less adverse effects.

Schedule-I projects require an IEE to be conducted, rather than a full-fledged EIA, provided that the project is not located in an environmentally sensitive area. The projects listed in Schedule-II are generally major projects and have the potential to affect a large number of people in addition to significant adverse environmental impacts. For the Schedule II projects, conducting an EIA is necessary. Dams and reservoirs with a maximum storage volume greater than 50 million m^3 or a surface area greater than 8 km^2, and hydroelectric power generation projects over 50 MW, fall under Schedule-II (list of projects requiring EIA) The prescribed procedure for review of EIA by the EPA is presented in Figure 2.1.

DHP falls in Schedule II as per EPA classification, because the power generation is 4320 MW and the reservoir area is 23.85 Km^2 having reservoir volume 1,410 million m^3. Feasibility Study of EIA of DHP was already approved in 2011 (Annex 1.1) by KP EPA. No further approval of EIA is required. However, the revised EIA shall be submitted to KP EPA.

2.1.1.4 Other Relevant Laws

Other Relevant Laws Pakistan Penal Code, 1860

The Pakistan Penal Code deals with offences where public or private property and/or human lives are affected due to the intentional or accidental misconduct of an individual or body of people. In the context of the environment, the Penal Code empowers local authorities to control noise, toxic emissions and disposal of effluents.

Pakistan Explosives Act, 1884

This Act provides regulations for the handling, transportation and use of explosives during quarrying, blasting and other purposes.

Land Acquisition Act, 1894

Land Acquisition Act 1894 provides the acquisition of private properties for public purposes including development projects in Pakistan. It comprises fifty five sections dealing with area notifications, survey, acquisition, compensation, apportionment awards, disputes resolutions, penalties and exemptions. The latest revision/amendments including land acquisition rules 1983 and general regulation called standing order No. 28 shall be applicable.

Telegraphy Act, 1910

Telegraphy Act of 1910 was promulgated for installation of telegraph poles and stringing. The Act allows provision for installing poles and towers without the need to acquire any land. However there is provision for temporary acquisition of land during the construction period of such infrastructure. In such circumstances compensation is made just for the loss of crop for a specific period of temporary occupation for construction.

Forest Act, 1927

Forest Act of 1927 establishes the right of the Government to designate areas for reserved forest, village forest and protected forest, and they may acquire such areas in order to prohibit or restrict the public use of such resources or other activities within them.

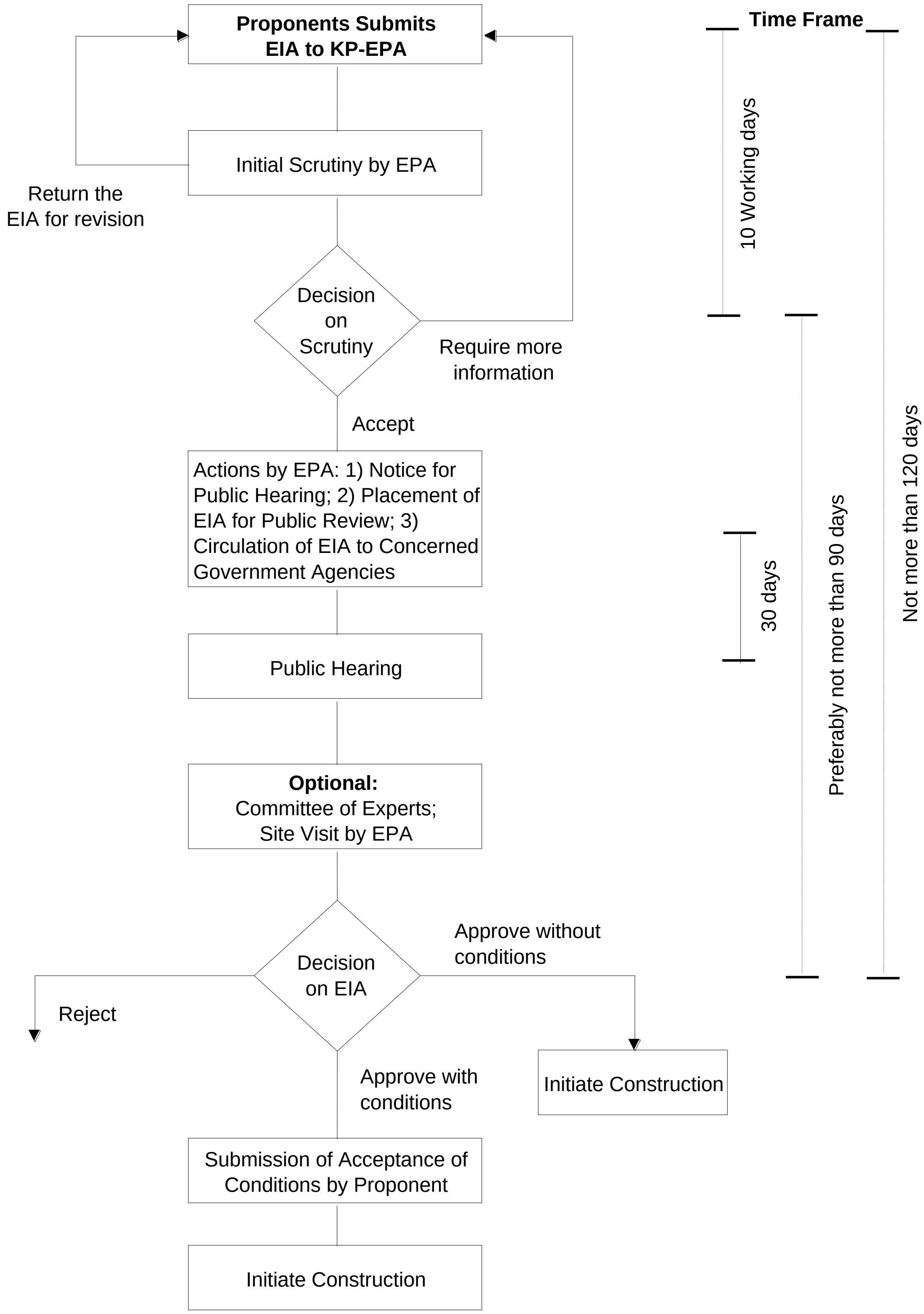

Figure 2.1: Review and Approval Process of EIA

Factories Act, 1934 (as amended to 1997)

The clauses relevant to the project are those which concern health, safety and welfare of workers, disposal of solid wastes and effluents, and damage to private and public property. The Factories Act also provides regulations for handling and disposal of toxic and hazardous materials. As construction activity is classified as 'industry', these regulations will be applicable to the project construction contractors. Particular sections of the act applicable to DHP project are:

- Section 13(1): Every factory shall be kept clean and free from effluvia arising from any drain, privy or other nuisance.
- Section 14(1): Effective arrangements shall be made in every factory for the disposal of wastes and effluents due to the manufacturing process carried on therein.
- Section 16(1): In every factory in which, by reason of the manufacturing process carried on, there is given off any dust or fume or other impurity of such a nature and to such an extent as is likely to be injurious or offensive to the workers employed therein, effective measures shall be taken to prevent its accumulation in any work-room and its inhalation by workers and if any exhaust appliance is necessary for this purpose, it shall be applied as near as possible to the point of origin of the dust, fume or other impurity, and such point shall be enclosed so far as possible.
- Section 16(2): In any factory no stationary internal combustion engine shall be operated unless the exhaust is conducted into open air and exhaust pipes are insulated to prevent scalding and radiation heat, and no internal combustion engine shall be operated in any room unless effective measures have been taken to prevent such accumulation of fumes there from as are likely to be injurious to the workers employed in the work-room.
- Section 20(1): In every factory effective arrangements shall be made to provide and maintain at suitable points conveniently situated for all workers employed therein a sufficient supply of whole-some drinking water.
- Section 26(1) d(i): In every factory the following shall be securely fenced by the safeguards of substantial construction which shall be kept in position while the parts of machinery required to be fenced are in motion or in use, namely – (a) every part of an electric generator, a motor or rotary convertor.

Hazara Forest Act 1936

An act to consolidate and amend the law relating to reserved forests and waste lands in the Hazara District. This act applies to the whole of the Hazara Division.

Protection of Trees Act, 1949

This Act prohibits cutting or lopping of trees along roads and canals planted by the Forest Department, without permission of the Forest Department.

The West Pakistan Board of Revenue Act 1957

This act is to provide for the constitution of a board of revenue for West Pakistan. The Board shall be the controlling authority in all matters connected with the administration of land, collection of land revenue, preparation of land records and other matters relating thereto. The Board shall be the highest court of appeal and revision in revenue cases in the Province.

Pakistan Water and Power Development Authority Act, 1958

The Act provides for the unified and coordinated development of the water and power resources of Pakistan. This Act authorizes WAPDA to develop water and power resources in the country through construction and operation of water storages and power houses and erecting electrical transmission lines. WAPDA also has the powers and obligations of a licensee under the Telegraphy Act of 1910. This Act also establishes policy for land acquisition and compensation, as well as the degree of liability of WAPDA for damages sustained by landowners or other parties. WAPDA is the owner of DHP and its development is covered under this Act.

The West Pakistan Firewood and Charcoal (Restriction) Act 1964

This act is to prohibit and regulate the burning of firewood and charcoal in West Pakistan. This act extends to the whole of the province of West Pakistan, except the tribal areas.

Motor Vehicle Ordinance, 1965 and Rules, 1969

The Motor Vehicles Ordinance, 1965, has been extended with effect from March 05, 1978, to the whole of Pakistan. It deals with the licensing requirement for driving; powers of licensing authority, Regional Transport Authority and those of Court vis-à-vis disqualification for license and registration requirements to control road transport; compensations for the death of or injury to a passenger of public carrier; powers of Road Transport Corporation; traffic rules, power to limit speed, weight, use of vehicles; power to erect traffic signs; specific duties of drivers in case of accident and powers of police officers to check and penalize traffic offenders.

All vehicles used on DHP by WAPDA, Consultants and the Contractor will be subject to this Motor Vehicle Ordinance 1965 and rules 1969.

Antiquity Act, 1975

Pakistan Antiquities Act of 1975 ensures the protection of physical cultural resources in Pakistan. The Act is designed to protect especially the notified “antiquities” from destruction, theft, negligence, unlawful excavation, trade and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan (Provincial Governments after the introduction of the 18th Amendment to the Constitution of Pakistan) to prohibit excavation in any area which may contain articles of archaeological significance.

The Act describes antiquity as (i) any ancient product of human activity, movable or immovable, illustrative of art, architecture, craft, custom, literature, morals, politics, religion, warfare or science or of any aspect of civilization or culture; (ii) any ancient object or site of historical, ethnographical, anthropological, military or scientific interest; (iii) any national monument; and (iv) any other object or class of such objects declared by the Federal Government, by notification in the official Gazette. The Act also defines ‘ancient’ as an antiquity which has been in existence for a period of not less than seventy five years.

The Antiquities Act of 1975 further provides about the fate of Chance Finds, officially termed as “Accidental discovery``. In such a case the chance find is to be reported to the Director General Provincial Archaeological Department within seven days of its being discovered or found and preserve it for the period thus specified. If, within seven days of his being informed of the discovery of movable antiquity, the Director General decides to take over the antiquity for purpose of custody, preservation and protection, the person discovering or finding it shall hand it over to the Director General or a person authorized by him in writing. It further says that if Director General decides to take over the antiquity he may pay such amount as would be decided by the Advisory Committee.

Labour Laws

Labour laws in Pakistan are governed by several legislative tools. However, the principal labour rights are provided by the constitution of Pakistan. In addition to constitutional rights, Acts and Ordinances have been enforced for limiting working hours, minimum working age and conditions of employment. The laws will be applicable to the DHP construction contractors.

KP Wildlife Protection, Preservation, Conservation and Management Act, 1975

This law was enacted to protect the province’s wildlife resources directly and other natural resources indirectly. It classifies wildlife by degree of protection, i.e., animals that may be hunted on a permit or special license, and species that are protected and cannot be hunted under any circumstances. The Act specifies restrictions on hunting and trade in animals, trophies, or meat. The Act also defines various categories of wildlife protected areas, i.e., National Parks, Wildlife Sanctuaries, and Game Reserve. The project activities will have to be carried out in accordance with this Act. In particular, no activities will be carried out inside or near any protected area as defined under the Act.

Employment of Child Act, 1977

Article 11(3) of the Constitution of Pakistan prohibits employment of children below the age of 14 years in any factory, mines or any other hazardous employment. In accordance with this Article, the Employment of Child Act (ECA) 1991 disallows the child labour in the country. The ECA states that no child shall be employed or permitted to work in any of the occupation set forth in the ECA (such as transport sector, railways, construction, and ports) or in any workshop wherein any of the processes defined in the Act is carried out. The processes defined in the Act include carpet weaving, biri (kind of a cigarette) making, cement manufacturing, textile, construction and others).

Fisheries W.P. Ordinance XXX of 1961 Amended Vide NWFP Fisheries (Amendment) Ordinance 1982.

An Ordinance to amend and consolidate the law relating to fisheries in the province of West Pakistan (included KP). The ordinance was issued during West Pakistan as one unit. This was later adopted by provinces. This grants power to DG Fisheries to issue permit to catch fish. The ordinance protects the fish against 1) Destruction of fish by explosives,2) Destruction of fish by poisoning water . There are other clauses giving protection to fish.

Penalties are provided for violating the provisions of the ordinance. Fishing is prohibited as follows:

Sr. No.	Species of fish	Size Inches	Period during which taking of the fish by any net, cage, trap or fixed engine is prohibited
1.	Trout	9	10th October to 9th March.
2.	Mahaseer	12	1st June to 31st August.
3.	Rahu	12	Ist June to 31st August.
4.	Mori	12	Ist June to 31st August.
5.	Thaila	12	Ist June to 13th August.
6.	Calbans	12	1st June to 31st August

The provincial Administered Tribal Areas (Conservation and Exploitation of certain Forests) Regulation 1980

The purpose of this regulation is to provide for conservation, better exploitation and prohibition of unlawful cutting of forest in certain Provincially Administered Tribal Areas of Hazara Division.

The NWFP Power Crushers (Licensing) Ordinance 1980

This ordinance is to provide for the licensing of power crushers in the NWFP. This ordinance will extend to the whole NWFP. It will also deal with the licensing authority, registration fee of power crushers and with the penalties.

Highway Safety Ordinance, 2000

This Ordinance includes provisions for licensing and registration of vehicles and construction equipment; maintenance of road vehicles; traffic control offences, penalties and procedures; and the establishment of a police force for motorways and national highways to regulate and control the traffic as well as keep the highways clear of encroachments.

The Rivers Protection Ordinance 2001

The NWFP Local Government Ordinance (LGO) 2001 delegates substantial powers to the districts. The devolution of powers to decentralized levels of government offers potential for more effective management of natural resources that will take time to realize. New administrative structures have been superimposed on old laws, resulting in jurisdictional gaps and overlaps—for instance between district officials and development authority boards. With the exception of the Forest and the River Protection Ordinances of 2002, NWFP statutes governing natural resources were adopted prior to the LGO 2001. Such laws refer to posts and functions that are now abolished and must be read together with the LGO to understand where responsibility for natural resource management lies and how it is to be carried out.

Local Government Ordinance, 2001

This Act empowers the Government of Pakistan and provincial governments to enforce laws for land use; conservation of natural vegetation; air, water, and land pollution; disposal of solid waste and wastewater effluents; and public health and safety, including some provisions for environmental protection. Section 93 of this Ordinance pertains to environmental pollution, under which the local councils are authorized to restrict causing pollution to air, water or land. DHP will have to follow the Local Government Ordinance 2001 with regards to pollution of air, water and land.

Project Implementation and Resettlement Ordinance, 2001

The Government has proclaimed an ordinance entitled "Project Implementation and Resettlement of the Affected Persons Ordinance 2001", later referred to as the “Resettlement Ordinance". This ordinance will be used to safeguard the interests of persons/groups having to be involuntarily resettled due to land acquisition caused by a proposed project. This Ordinance establishes that the resettlement of the involuntarily displaced persons is done as a matter of right and not by way of charity or any such sentiment. In addition the Affected Persons (APs) shall be accepted as special groups who in the supreme interest of the country have accepted/undergone involuntary displacement. The proposed Ordinance shall be supplementary to the Land Acquisition Act of 1894, as well as other Laws of Pakistan, and wherever items included in the Draft Resettlement Policy.

2.1.2 National Policy Framework

2.1.2.1 The Pakistan National Conservation Strategy (NCS), 1992

The Pakistan National Conservation Strategy (NCS) is the principal policy document for environmental issues in the country and was developed and approved by the Government of Pakistan on March 1, 1992. The NCS works on a ten-year planning and implementation cycle. The NCS deals with 14 core areas which are;

- maintaining soils in cropland;
- increasing irrigation efficiency;
- protecting watersheds;
- supporting forestry and plantations;
- restoring rangelands and improving livestock;
- protecting water bodies and sustaining fisheries;
- conserving biodiversity;
- increasing energy efficiency;
- developing and deploying material for renewable energy;
- preventing/abating pollution;
- managing urban wastes;
- supporting institutions for common resources;
- integrating population and environmental programs and
- Preserving the cultural heritage.

2.1.2.2 National Environment Policy

This policy was implemented in 2005 to provide an overarching framework for addressing the environmental issues facing Pakistan. It gives directions for addressing sectorial issues and provides means for promoting conservation and environmental protection in water, air and waste management, forestry, and transport. The policy aims to promote protection of the environment, the honoring of international obligations, sustainable management of resources and economic growth.

2.1.2.3 Guidelines for the Preparation and Review of Environmental Reports, 1997

These guidelines on the preparation of environmental reports address project proponents, and specify the:

- Nature of the information to be included in environmental reports;
- Need to incorporate suitable mitigation measures into every stage of project implementation;
- Need to specify monitoring procedures; and the
- Terms of reference for the reports are to be prepared by the project proponents themselves.

2.1.2.4 Policy and Procedures for Filing, Review and Approval of Environmental Assessments, 2000

These policies and procedures define the policy context and the administrative procedures that govern the environmental assessment process, from the project prefeasibility stage to the approval of the environmental report.

2.1.2.5 Guidelines for Public Consultation, 1997

The guidelines deal with approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their concerns in impact assessment.

2.1.2.6 Guidelines for Sensitive and Critical Areas, 1997

The guidelines identify officially notified protected areas in Pakistan, including critical ecosystems, archaeological sites, etc., and present checklists for environmental assessment procedures to be carried out within or near to such sites. Environmentally sensitive areas include, among others, archaeological sites, biosphere reserves and natural parks, and wildlife sanctuaries and preserves, none of which are relevant to the Project area.

2.1.3 National Environmental Quality Standards, 2000, 2009 and 2010

NEQS were first promulgated in 1993 and were amended in 2000, 2009 and 2010. The NEQS 2000 includes Environmental Quality Standards for Municipal and Liquid Industrial Effluents (32 parameters) and Industrial Gaseous Emissions (18 parameters). NEQS 2009 provides standards for motor vehicle exhaust and noise (in use vehicle and new vehicles). NEQS 2010 provides the standards for ambient air quality (9 parameters), drinking water quality (32 parameters) and noise (four zones during day and night). The complete set of NEQS is included as Annex 2.1.

2.1.4 Environment Regulatory Authorities

The development of statutory and other instruments for environmental protection has steadily gained priority in Pakistan since the late 1970’s. The Pakistan Environmental Protection Ordinance (PEPO) 1983 was the first legislation in Pakistan designed specifically for the protection of the environment. The promulgation of this Ordinance was followed in 1984 by the creation of Pakistan Environmental Protection Council (PEPC).

2.1.4.1 Pakistan Environmental Protection Council

The PEPC is the highest inter-ministerial statutory body in the country headed by the Chief Executive and is responsible for:

- Formulating national environmental policy;
- Enforcing PEPA 1997;
- Approval of the NEQS;
- Incorporation of environmental considerations into national development plans and policies; and
- Provision of guidelines for the protection and conservation of biodiversity in general as well as conservation of renewable and non-renewable resources.

2.1.4.2 Ministry of Climate Change

The Environment Division of Ministry of Climate Change is the focal point for National Policy, Legislation, Plans, Strategies and programs with regard to Disaster Management, Climate Change including Environmental Protection and preservation. The Division also deals with other countries, international Agencies and Forums for coordination, Monitoring and Implementation of Environmental Agreements.

2.1.4.3 Pakistan Environmental Protection Agency (PAK-EPA)

The PAK-EPA is headed by a Director General and has wide ranging functions as set out in PEPA 1997. These include preparation and co-ordination of national environmental policy for approval by PEPC, administering and implementing PEPA 1997 and preparation, revision or establishment of NEQS. The PAK-EPA has issued regulations regarding the environmental assessment procedures known as Review of Initial Environmental Examination (IEE) and EIA Regulations, 2000; these provide a firm legal status to the IEEs and EIAs. The jurisdiction of the EPA is applicable to the following projects:

- On federal land;
- Military projects;
- Involving trans-country impacts; and
- Bearing trans-province impacts.

2.1.4.4 KP Environment Protection Agency

KP, along with other provinces, has its own Environmental Protection Agency (EPA) as a provincial level counterpart of the PAK-EPA. It is headed by a Director General who exercises powers delegated to him by the provincial government. The IEE and EIA reports pertaining to projects falling within KP are to be submitted to KP EPA for approval.

2.2 INTERNATIONAL TREATIES AND CONVENTIONS

Pakistan is a signatory to various international treaties and conventions on the conservation of the environment and wildlife protection. The country is thus obliged to adhere to the commitments contained in these treaties. To support the global and national environmental efforts the projects need to be environment friendly. It is incumbent for the governments and proponents to follow the international conventions. However, the implementation mechanism for most of these treaties is weak in Pakistan and institutional setup mostly nonexistent. Details of relevant international treaties and conventions ratified by Pakistan are given in Table 2.1.

Table 2.1: Major International Environmental Treaties Ratified by Pakistan

Topic	Convention/Treaty	Year of	
		Treaty	Ratification by Pakistan
Indus Water Treaty	*The Indus Water Treaty* - signed between India and Pakistan. This Treaty gave the waters of three western rivers (the Indus, Jhelum and Chenab) to Pakistan and the waters of three eastern rivers (the Ravi, Sutlej and Bias) to India. This is a landmark Treaty and has remained in force since its signature. The Indus Water Treaty gives unrestrained use of the Indus River water to Pakistan. The permanent Indus Commission, constituted under the Treaty, is responsible for implementation of the Treaty.	1960	1960
Climate change and the ozone layer	*United Nations Framework Convention on Climate Change* - the primary objective is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	1992	1994
	Kyoto Protocol to the United Nations Framework Convention on Climate Change - enabled by the above Convention on Climate Change. It has more powerful and legally binding measures. It sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas emissions.	1997	2005
	Vienna Convention for the Protection of the Ozone Layer - acts as a framework for the international efforts to protect the ozone layer with a primary objective to protect human health and the environment against adverse effects resulting from human activities that modify or are likely to modify the ozone layer.	1985	1993
	The Montreal Protocol on Substances that Deplete Ozone Layer and associated amendments - enabled by the Vienna Convention, it is designed to protect the ozone layer by phasing out the production and consumption of a number of substances believed to be responsible for ozone depletion.	1987	1993
Waste and pollution	*Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* -regulates the transboundary movement of hazardous waste and other waste with a stated purpose to protect human health and the environment against the adverse effects from generation and management of hazardous waste and other waste. The Convention provides for three sets of measures with binding obligations. These are: Strict control of transboundary movement of hazardous waste; Environmentally sound management of hazardous waste; and Enforcement and implementation of the provisions of the convention at international and national levels.	1989	1994
	International Convention on Oil Pollution Preparedness, Response and Co-operation	1990	1995
	Stockholm Convention on Persistent Organic Pollutants - seeks to protect human health and the	2001	2008

Topic	Convention/Treaty	Year of Treaty	Year of Ratification by Pakistan
	environment from Persistent Organic Pollutants, which are chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife.		
Biodiversity and the protection of plants and animals	*Convention on Biological Diversity* – covering ecosystems, species, and genetic resources and also the field of biotechnology. The objectives are: conserve of biological diversity; sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources.	1992	1994
	Cartagena Protocol on Biosafety to the Convention on Biological Diversity - addresses potential risks posed by living modified organisms resulting from modern biotechnology.	2000	2009
	Bonn Convention on the Conservation of Migratory Species of Wild Animals - aims to conserve terrestrial, marine and avian migratory species throughout their range. It is concerned with the conservation of wildlife and habitats on a global scale.	1979	1987
	Memorandum of Understanding concerning Conservation Measures for the Siberian Crane- parties undertake to provide strict protection to Siberian Cranes, and identify and conserve wetland habitats essential for their survival.	1998	1999
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) - to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	1973	1976
	International Plant Protection Convention (1997 Revised Text) -to prevent the international spread of pests and plant diseases. It requires maintenance of lists of plant pests, tracking of pest outbreaks, and coordination of technical assistance between member nations.	1951/ 52	1954
	Agreement for the Establishment of the Near East Plant Protection Organization - to establish the Near East Plant Protection Organisation (NEPPO), which promotes international co-operation with a view to implementing International Plant Protection Convention.	1993	2009
	Plant Protection Agreement for the Asia and Pacific Region and amendments – establishes the Asia and Pacific Plant Protection Commission to review and promote the region’s progress in the implementation of the Agreement. Trade in plants and plant products are regulated by certification, prohibition, inspection, disinfection, quarantine, destruction, etc., as necessary.	1955 (amendment 1967)	1958 (amendment 1969)
	Convention on Wetlands of International Importance especially as Waterfowl Habitat and associated protocols and amendments - to promote conservation and sustainable use of wetlands. The	1971 (amended 1987)	1976 (amended 1994)

Topic	Convention/Treaty	Year of Treaty	Year of Ratification by Pakistan
	Ramsar List of Wetlands of International Importance now includes almost 1,800 sites (known as Ramsar Sites). There are currently 19 Ramsar sites in Pakistan.		
Cultural heritage	*Convention concerning the Protection of the World Cultural and Natural Heritage* - requires parties to adapt a general policy on the protection of the natural and cultural heritage, to set up services for such protection, to develop scientific and technical studies, to take appropriate legal, technical, scientific and administrative measures and to foster training and education for such protection.	1972	1976

2.3 WORLD BANK SAFEGUARD POLICIES

The World Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. Developers seeking financing from the World Bank are required to comply with the applicable environmental and social safeguards, Operational Policies (OPs) and Bank Procedures (BPs). A summary of the key safeguard policies relevant to DHP and their applicability to DHP are presented in Table 2.2.

Table 2.2: World Bank Policies and their applicability to DHP

Policy	Description	Applicability to DHP
OP/BP 4.01 Environmental Assessment	Provides the framework for World Bank environmental safeguard policies and describes project screening and categorization to determine the level of environmental assessment required. The Bank classifies the proposed project into one of four categories (A, B, C or F1) depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. For a Category A project, the borrower is responsible for preparing a report, normally an EIA. For hydropower projects, this policy is triggered if modifications to river flows lead to adverse environmental risks and impacts.	Triggered. DHP is a category A project because it involves large scale construction activities and modifications to Indus River flows. An environmental assessment of the DHP has been carried out to mitigate or minimize all potential adverse environmental and social impacts. The environmental and social plans are documented in 23 volumes of EMAP and SRMP documents.
OP 4.04 Natural Habitats	Outlines the World Bank policy on biodiversity conservation taking into account ecosystem services and natural resource management and use by project affected people. Projects must assess potential impacts on biodiversity and the policy strictly limits circumstances under which	Triggered. The project has potential to cause significant conversion of aquatic habitat and impair associated ecological functions by: conversion of riverine habitat to lacustrine habitat through creation of a long reservoir (73 km); placement of a high dam (242m) on the river mainstem effectively creating a barrier to

Policy	Description	Applicability to DHP
	conversion or degradation of natural habitats can occur as well as prohibiting projects which are likely to result in significant loss of critical natural habitats. If changes in flow have the potential to cause significant loss or degradation of natural habitats, borrows must comply with this policy.	movement of biota and impairing ecological/longitudinal connectivity along the Indus River mainstem. These potential adverse impacts and possible mitigation measures are examined as part of the EIA. A standalone report on 'Aquatic Ecology is prepared. There are no protected areas, wildlife sanctuaries or critical habitats in or near to the project area.
OP 4.20/OP 4.10 Indigenous People	Recognizes that indigenous peoples may be exposed to different types of risks and impacts from development projects. The policy requires projects to identify whether indigenous peoples are affected by the project and, if so, to undertake specific consultation activities and to avoid or mitigate impacts on this potentially vulnerable group.	Not triggered. Though the project affected people are tribal, they don't fall into the Banks's category of Indigenous people. The Bank has taken a stand that only Kalash people are the only Indigenous people in Pakistan. Since no Kalash people are located in the project area, this policy is not applicable to DHP.
OP 4.11 Physical Cultural Resources	Sets out the World Bank requirement to avoid or mitigate adverse impacts resulting from project developments on cultural resources. The following projects are classified as Category A or B, and are subject to the provisions of this policy: (a) any project involving significant excavations, demolition, movement of earth, flooding, or other environmental changes; and (b) any project located in, or in the vicinity of, a physical cultural resources site recognized by the borrower.	Triggered. Two historical and beautiful decorated wooden mosques are located in the project area, one of which will be submerged and needs to disassembled and relocated in a new site. Shatihal rock carvings, a nationally designated archeological site, are located adjacent to the head of reservoir area of DHP. Though they will not be affected, they will be preserved and protected A Physical Cultural Resources Report is prepared to protect the rock carvings.
OP 4.12 Involuntary Resettlement	The World Bank aims to avoid involuntary resettlement where possible. Where necessary or acquisition of land or other assets is necessary, the policy sets out requirements for participation in resettlement planning, mandates compensation for assets at replacement cost, and expects the borrower to see that incomes and standards of living of affected persons are improved or at least restored to what they were prior to displacement.	Triggered. The project will require acquisition of about 4,643 ha of land and resettlement of about 767 households having population 6953 persons from 34 villages/hamlets. A set of documents including Resettlement Action Plan, Gender Action Plan, Public Health Action Plan, Public Consultation and Participation Plan, and Grievances Redress Plan have been prepared to address the resettlement issues.
OP/BP 4.36 Forests	This policy recognizes the need to reduce deforestation and promote sustainable forest conservation and management in reducing poverty.	Triggered. The direct impact area situated below el. 1500 m is an area consisting of steep slopes full of rubble and rocks with hardly any vegetation other than low scrubs and stunted trees. The direct impact area does not include any forests, however

Policy	Description	Applicability to DHP
		an estimated 21,000 individual trees were counted in the reservoir and resettlement area. These trees will be lost as a result of the project and a reforestation program will be created to offset the loss. The project will also have an induced impact by the expected increase in population pressure (collection of firewood, logging, and agriculture) on the high altitude forests, which are already under heavy pressure from deforestation and degradation. These forests are situated at higher elevations (2,000 -4,000 m) where the gently sloping plateaus and glacial terraces can be found.
OP/BP 4.37 Safety of Dams	This policy requires that experienced and competent professionals design and supervise construction, and that the borrower adopts and implements dam safety measures through the project cycle. It recommends, where appropriate, that Bank staff discuss with the borrowers any measures necessary to strengthen the institutional, legislative, and regulatory frameworks for dam safety programs in those countries. For large dams, the borrower must engage an independent Dam Safety Panel.	Triggered. An international panel of experts is hired by WAPDA to review the engineering designs of the dam. Dam safety monitoring equipment will be installed and regularly recorded by DHP. WAPDA's Dam Safety Organization will annually conduct investigations. WAPDA will also hire an 'independent dam safety panel' for an independent investigation on the dam safety every 3 years.
OP/BP 7.50 Projects in International Waterways	Projects on International Waterways - may affect the relations between the World Bank and its borrowers, and between riparian states. Therefore, the Bank attaches great importance to the riparian making appropriate agreements or arrangements for the entire waterway, or parts thereof, and stands ready to assist in this regard. A borrower must notify other riparian of planned projects that could affect water quality or quantity, sufficiently far in advance to allow them to review the plans and raise any concerns or objections.	Triggered. Indus River water is allocated to Pakistan under Indus Basin Treaty between India and Pakistan. The Indus Water Treaty gives unrestrained use of the Indus River water to Pakistan.
OP/BP 7.60 Projects in Disputed Areas	Projects in disputed areas may affect the relations between the Bank and its borrowers, and between the claimants to the disputed area. Therefore, the Bank will only finance projects in disputed areas when either there	Not triggered. All project facilities are located in the KP province

Policy	Description	Applicability to DHP
	is no objection from the other claimant to the disputed area, or when the special circumstances of the case support Bank financing, notwithstanding the objection.	
Policy on Access to Information	Documents (safeguard assessments and plans related to environment, resettlement) prepared or commissioned by a member country/borrow are to be made available to the public as a condition for doing business with the Bank. The borrower provides such documents to the Bank with the understanding that the Bank will make them available to the public.	EIA and RAP will be disclosed to the affected community through a public disclosure meeting. The executive summary of Independent Consultant's EIA report will be translated in to Urdu and will be made available through two Public Information Centres that will be established at the project site. The reports would be made available to public, and would be available on WAPDA website. World Bank Info Shop.

2.3.1 World Bank Group Environmental Health and Safety Guidelines

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues in specific industry sectors.

The EHS guidelines will consists of the following aspects and are given in Annex B of Volume 8: Environmental Management Plan.

1. Environmental
   - 1.1 Air Emissions and Ambient Air Quality
   - 1.2 Energy Conservation
   - 1.3 Wastewater and Ambient Water Quality
   - 1.4 Water Conservation
   - 1.5 Hazardous Materials Management
   - 1.6 Waste Management
   - 1.7 Noise
   - 1.8 Contaminated Land
2. Occupational Health and Safety
   - 2.1 General Facility Design and Operation
   - 2.2 Communication and Training
   - 2.3 Physical Hazards
   - 2.4 Chemical Hazards
   - 2.5 Biological Hazards
   - 2.6 Radiological Hazards
   - 2.7 Personal Protective Equipment (PPE)
   - 2.8 Special Hazard Environments
   - 2.9 Monitoring

3. Community Health and Safety
    3.1 Water Quality and Availability
    3.2 Structural Safety of Project Infrastructure
    3.3 Life and Fire Safety (L&FS)
    3.4 Traffic Safety
    3.5 Transport of Hazardous Materials
    3.6 Disease Prevention
    3.7 Emergency Preparedness and Response
4. Construction and Decommissioning
    4.1 Environment
    4.2 Occupational Health & Safety
    4.3 Community Health & Safety

2.4 COMPLIANCE STATUS WITH PAKISTANI AND WORLD BANK POLICIES

The present compliance status of the project with Pakistani legislation and World Bank safeguard policies is indicated in Table 2.3.

Table 2.3: Compliance of Project with GoP Legislation and WB Guidelines

	Key Legislation/Policy	Actions Taken to Comply
Government of Pakistan (GoP)	Pakistan Environmental Protection Act, 1997	WAPDA got the No Objection Certificate (NOC) for EIA from KP EPA on 23-11-2011 based on the EIA prepared in the Feasibility Study. This approval is valid for three years and is extendable for 3 more years. No further approval is required from KP EPA.
	Review of IEE and EIA regulations	EIA is prepared. The updated EIA will be again submitted to KP EPA for their review.
	International treaties	Verification of protected sites has been done, Red List and protection of vulnerable habitats considered.
	Disclosure of projects	Public information centers will be established at Dasu on both banks. Executive Summary of EIA and RAP will be prepared in Urdu and will be placed in the information centers along with other project information. A public disclosure meeting will be held in Dasu by DHP with the affected community. EIA report will be disclosed in WAPDA's website.
World Bank	Early screening and Scoping	Scoping sessions held through consultative workshops at Peshawar, Lahore, Karachi and Islamabad; and consultations at the affected villages.
	Participatory approach	Workshops, consultation meetings and focus group discussions have been held
	Integrate Environmental assessment (EA) and social assessment (SA)	Natural environment, human health, social aspects, physical cultural resources are integrated in planning documents.
	Risk assessment	Labor, health and safety risks determined Environmental Code of Practices (occupational health, labor) in tender documents contractor; Emergency Response Plan will be prepared by

	Key Legislation/Policy	Actions Taken to Comply
		contractor before commencing the construction activities.
	Climate Change and floods	Impact of increased snow-melt and climate change and effect on Indus floods studied. Regional and Strategic cumulative impacts determined
	Alternatives	Alternative sources of energy (thermal, wind power, small hydro, solar) including other large hydropower projects) are considered. Alternatives are considered for siting of the project facilities, dam and water ways; dam type; power generation equipment; construction material, WAPDA office, and construction phasing.
	Pollution	Baseline survey of environmental water, air quality, noise and soil carried out. Environmental standards applied and Environmental Code of Practices (ECPs) have been included in contract documents.
	Physical and Cultural Resources	A comprehensive study was conducted on physical and cultural resources in the project area. Chance find procedure included in contract documents.
	Gender	A gender action plan report has been prepared.
	Public Health	A comprehensive study on public health aspects has been conducted and a Public Health Action Plan is prepared
	Consultation and Information Disclosure	Consultations have been conducted in all the affected villages and with the Jirgas. Stakeholder workshops were conducted in Peshawar, Lahore, Karachi and Islamabad. EIA will be disclosed to the affected community through a public disclosure meeting. The executive summary report of Independent Consultant's EIA will be translated in to Urdu and will be made available through two Public Information Centers that will be established at the project site. The reports would be made available to public, and would be available on WAPDA website and World Bank Info Shop

Chapter 3
PROJECT DESCRIPTION

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3. PROJECT DESCRIPTION

3.1 PROJECT LOCATION

The dam site of the Dasu Hydropower Project (DHP) is located about 7 km north of Dasu town[1], the administrative headquarters of District Kohistan at geographic location N 35^o 19' 6.61", E 73^o 11' 41.33" on Indus River in Khyber Pakhtunkhwa (KP) province of Pakistan. The dam site is located about 74 km downstream of proposed Diamer Basha Dam site. Location of the Project site in Pakistan is shown in Figure 3.1. The dam site is located about 350 km north of Islamabad and can be reached by road in about 10 hours through Grand Trunk (GT) road up to Hassan Abdal and then through Karakoram Highway (KKH). The nearest railway station to the dam site is at about 240 km at Havelian that connects Karachi sea port about 1,600 km away.

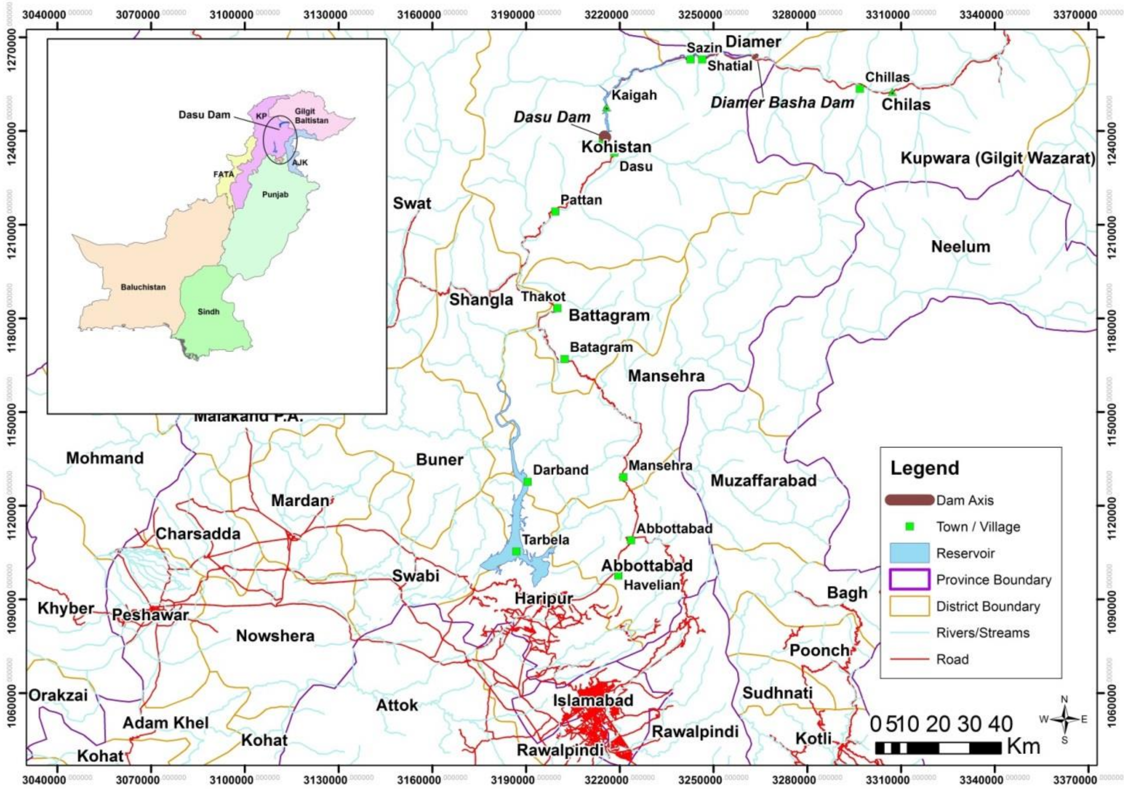


Figure 3.1: Location of DHP

3.2 SALIENT FEATURES

DHP will be comprised of a 242 m high concrete gravity dam and 73 km long reservoir behind the dam with an average width of 365m. The project will have an underground powerhouse housing 12 turbines, each of which will produce 360 MW power, and a final maximum capacity to produce 4320 MW. The salient features of the Project are given in Table 3.1. The Project also involves relocation of about 46 km of KKH that will be submerged in DHP reservoir.

[1] The distance from dam axis to Dasu bridge is 8.5 km along the Indus; and 8.8 km along KKH

Table 3.1: Salient Features of DHP

Item	Detail
General	
- Location	Near Dasu town, Kohistan District, KP
- Installed Capacity	4,320 MW
- Total Energy	18,440 GWh/annum (pre-Basha) 21,485 GWh/annum (post-Basha)
- Catchment area at dam site	158,800 km^2
- Average discharge at dam site	2,102 m^3/s
- Safety Check Flood (SCF)	51,957 m^3/s
- Basic Design Flood (BDF)	24,932 m^3/s
Water Level	
- Flood Water Level under SCF - Flood Water Level under BDF - Full Supply Level (FSL) - Minimum Operating Level (MOL)	EL. 959.46 m EL. 951.28 m EL. 950.00 m EL. 900.00 m
Reservoir	
- Gross Storage Capacity (El.950m) - Operational Storage Capacity	$1.41x\ 10^9\ m^3$ $0.82x\ 10^9\ m^3$
-Reservoir Area Full Supply El 950 m -Reservoir Area: BDF Level El 951.28m -Reservoir Area : MOL El 900 m	23.85 Km^2 24.46 Km^2 11.53 Km^2
Main Dam	
- Type	Arch-Gravity Dam in Roller Compacted Concrete (RCC)
- Maximum Height above foundation	242m
- Crest Length at EL. 957m	570m
Spillway	
- Maximum Discharge Capacity under SCF	45,097 m^3/sec
Low Level Outlet	
- Discharge Capacity under SCF	2,756 m^3/s by 2 LLO at reservoir El.959.46m 12,157 m^3/s by 9-LLO at El. 955.67 m
Flushing Tunnels	
- Discharge Capacity under SCF	1,060 m^3/s per tunnel
Power Generation	
- Generating Units and Unit Capacity	12 Francis turbines - 360 MW, 167 rpm
- Powerhouse Location	Underground, left bank
- Design Head	Approximately 179.51 m
- Rated Discharge (12 units) and Voltage	2,670 m^3/s, 16.5 kV
Tailrace Tunnel	
- Number, shape and average length	4 no, D-shaped, 2,200m in average
- Size and lining	10mW x12.5mH concrete lined
- Discharge per Tunnel	650 m^3/s
Tail Water Level	
- Flood Water Level under SCF	EL. 778.39 m
- Tail water level under 12-unit operation	EL. 762.83 m
- Tail water level under 3-unit operation	EL. 759.24 m
Power Transmission	
- Transmission Voltage	500 kV (AC)
- Powerhouse Substation &	Gas Insulated Substation (GIS) , Underground
- Transmission Substation	Air Insulated System, Surface
- Length and Location of Transmission Line	300 km, Dasu to Pathar Garh Design of transmission line and its EIA is not covered by the present study
KKH Realignment	

Item	Detail
KKH Realignment (to compensate loss of 46 km of existing KKH)	62 km
Major Ancillary Works	
Access road on right bank from Komilla to damsite	12.96 km
Right bank road from Damsite to Kandia; and Track from Kandia to Utter Gha	22.85 km 17.84 k
Bridge on Indus on the upstream of Kandia river confludence	350 m
132 kv transmission line from Dubair to Dasu	45 km
Resettlement Sites Development	30 nos.
WAPDA's colony with necessary infrastructure (water, sanitation, roads, power distribution etc.)	31.5 ha

3.3 DESCRIPTION OF PROJECT COMPONENTS

Details of various civil, mechanical and electro mechanical works (Project Components) of the Project are given in Table 3.2. A brief description of each of these components is explained in the following sections. A layout map of the Project facilities is shown in Figure 3.2. Layout of project components marked on satellite imagery is also shown in Figure 3.3.

Table 3.2: Main Civil, Mechanical and Electromechanical Works in DHP

No	Work	Quantity/Details
1	**River Diversion Works**	
1.1	Diversion Tunnel on Left Bank	
	- No. and Shape	2, D-shape shape
	- Size and Lining	17 m W x20m H, shotcrete lined
	- Length	1,261 m ~1,101m
1.2	Coffer Dams	
	- Length and Height of Upstream integrated Coffer Dam	Length 88m, height 95 m
	- Length and Height of Downstream Coffer Dam	Length 40m, height 19 m
2	**Main Dam and Associated Facilities**	
2.1	Dam	
	- Maximum Height above foundation	242m
	- Crest Length at El 957m	570m
2.2	Spillway	
	- Number of Bays	8
	- Type and Size of Gates	Radial, 16.5 m wide x 22.4m high
	- Plunge Pool	162.26 m from dam toe
2.3	Low Level Outlet	
	- Number and Size	9 no. (Circular, 6.4 m diameter, 180.23m length)
	- Type and Size of Gates	
	Service gates:	fixed wheel,8.4mWx8.4mH
	Guard gates:	fixed wheel, 5.1 m W x 6.4m H
	Regulating gates:	Radial, 5.1m W x 6.4mH
2.4	Flushing Tunnels on Right Bank	
	-No and size	2 No 9.5 m dia (L= 820 m & 680 m)
	Type & Size of Gates	Stoplogs: 4.75mW x 9.5mH

No	Work	Quantity/Details
		Guard/Regulating gates: Roller, 4.0mW x 9.5mH
3	**Power Intake**	
	- Number and Shape	4 no, D=12m, Flatbed type
	- Removal Trash rack	4 sets,
	- Intake service gates	4 no,9.5 m W x 12.5m H
	- Intake maintenance gates	2,9.5m W x 12.5m H
4	**Tunnels (Water Ways)**	
4.1	Power Tunnel	
	- Number and Shape	4 no, circular
	- Size and Lining	D=12.5~5.5m dia, concrete lined
	- Average Length	450m
4.2	Tailrace Tunnel	
	- Number and shape	4 no, D-shaped
	- Size and lining	10mW x12.5mH concrete lined
	- Average Length	2,152m in average
	- Surge Chamber	4 no, D=37m, H=56m
	- Surge Chamber Stoplogs	4, 6.2m W x 7.8m H gantry crane
	- Tailrace Outlet Gates	8 no, 9.0m W x 8 m high
5	**Power Generation**	
5.1	Generating Units	12 no, Francis turbines (360 MW), 166.7 rpm
5.2	Powerhouse	
	- Powerhouse Cavern L × W × H	424m × 31m × 62m
	- Transformer Cavern L × W × H	424m × 22m × 33.5m

3.3.1 River Diversion Works

The purpose of the diversion works is to divert the river water from the upstream side of the dam to the downstream side of the dam in a controlled manner and help create a dry working area during the construction phase. The upstream diversion works include a dewatering dyke (EL 775.5m) with rock fill enwrapped by 2m thick conventional concrete, an upstream starter dam, a coffer dam (which will be part of the future main dam) and 2 diversion tunnels. The sketch of the river diversion system at both upstream and downstream is shown in Figure 3.4.

The diversion system at downstream area, such as the dewatering dyke (EL.765m) to be embanked by rock fill, the starter dam (EL.768m) by conventional vibrated concrete (CVC) retaining wall and the cofferdam (EL.778m) to be constructed by the cemented sand and gravel (CSG).

3.3.1.1 Diversion Tunnels

There will be two D shaped diversion tunnels on left bank of the Indus River with lengths 1,260 m and 1,101 m. The diversion structures include inlet and outlet. The invert elevations of inlet structure are provided at different elevations of EL 768m for first tunnels and E. 773 m for the second tunnel to reduce the construction risks during diversion and gate closure. The tunnels will be shotcrete concrete lined and be 17 m wide and 20 m high. The design discharge for river diversion tunnels is 10,308 m^3/s (equivalent of the peak discharge of 5-year probable flood).

After completion of the main dam, and before the first reservoir fill these tunnels will be plugged with concrete on permanent basis.

Coffer dams are small dams constructed to divert and control Indus River flow through the diversion tunnels to provide a dry area for construction of the main dam. Two such dams, one on upstream and other one on downstream, will be constructed. The details are:

1. The upstream integrated coffer dam (that will be later used as part of the main dam) will have same design of the main dam (RCC) with 95 m height (El, 715m to EL.810m). To facilitate the construction of cofferdam an up stream dewatering dyke and starter dam will be constructed.
2. The downstream coffer dam will be located 530m downstream of the main dam. The height of the dam will be 19 m founded on the riverbed rock after removal of a few meter thickness of river deposit material. To facilitate the construction of downstream coffer dam, a starter dam will be constructed just above the coffer dam.

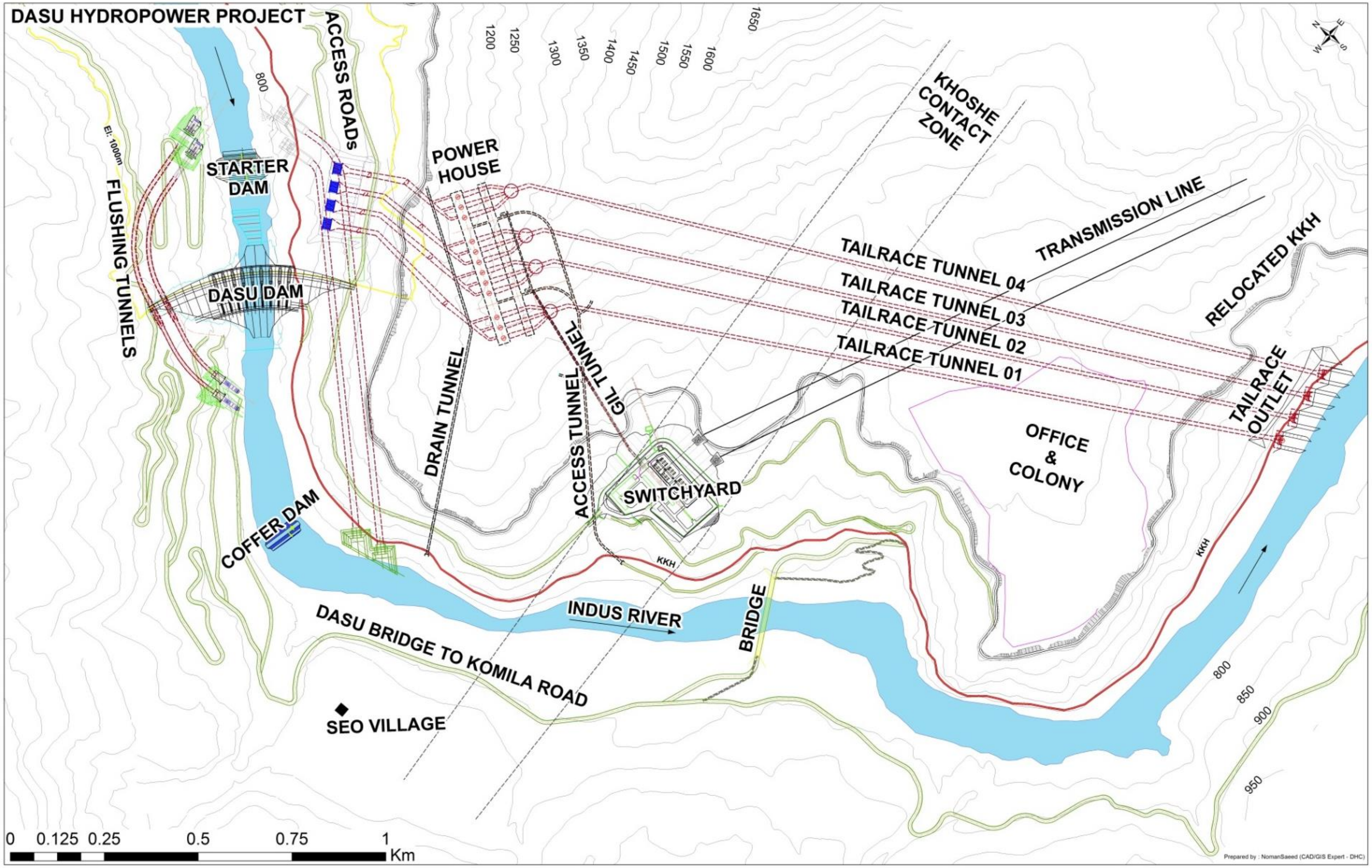


Figure 3.2: Layout Plan of Project Components

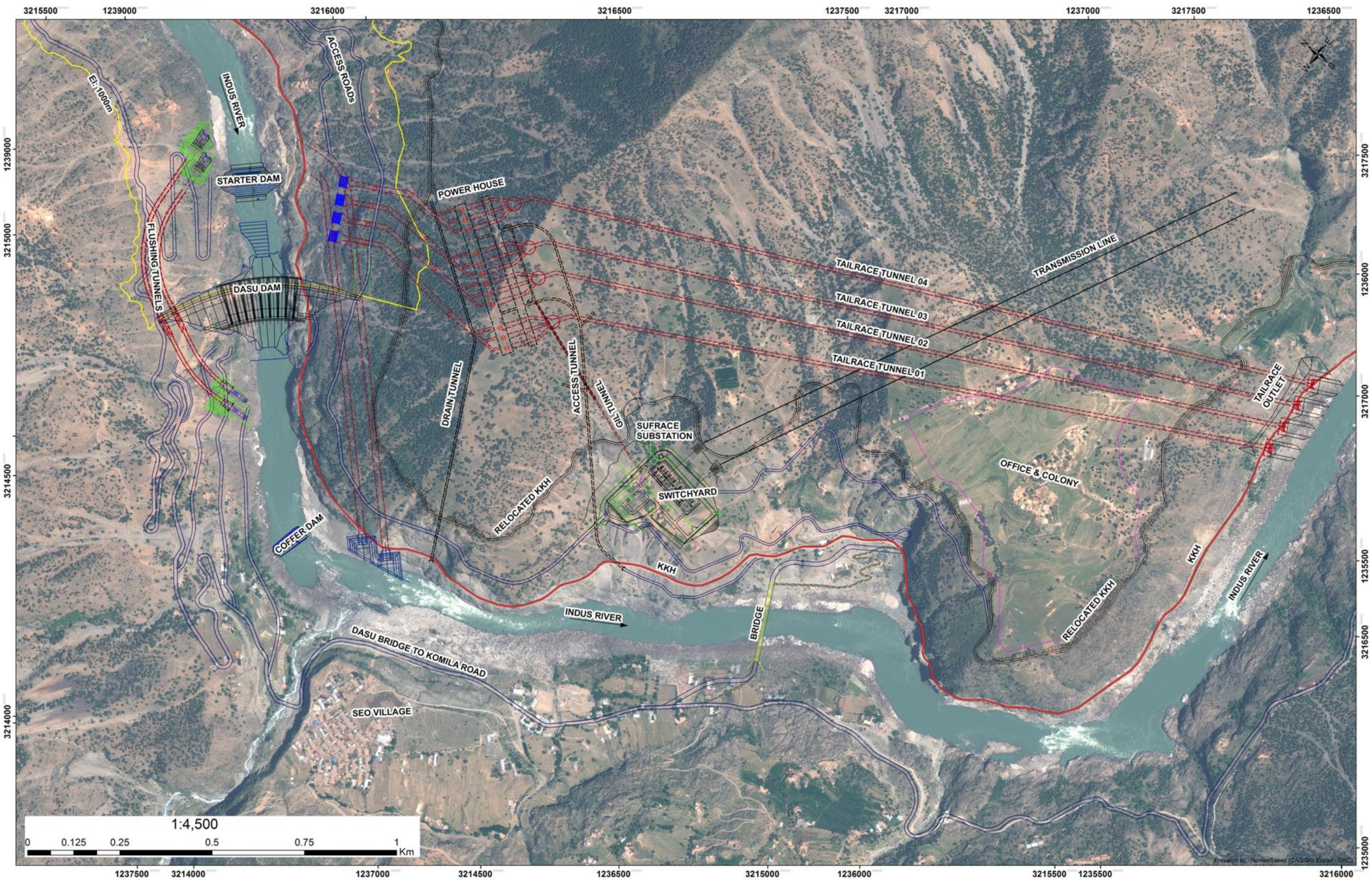


Figure 3.3: Layout Plan of Project Components marked on Satellite Imagery

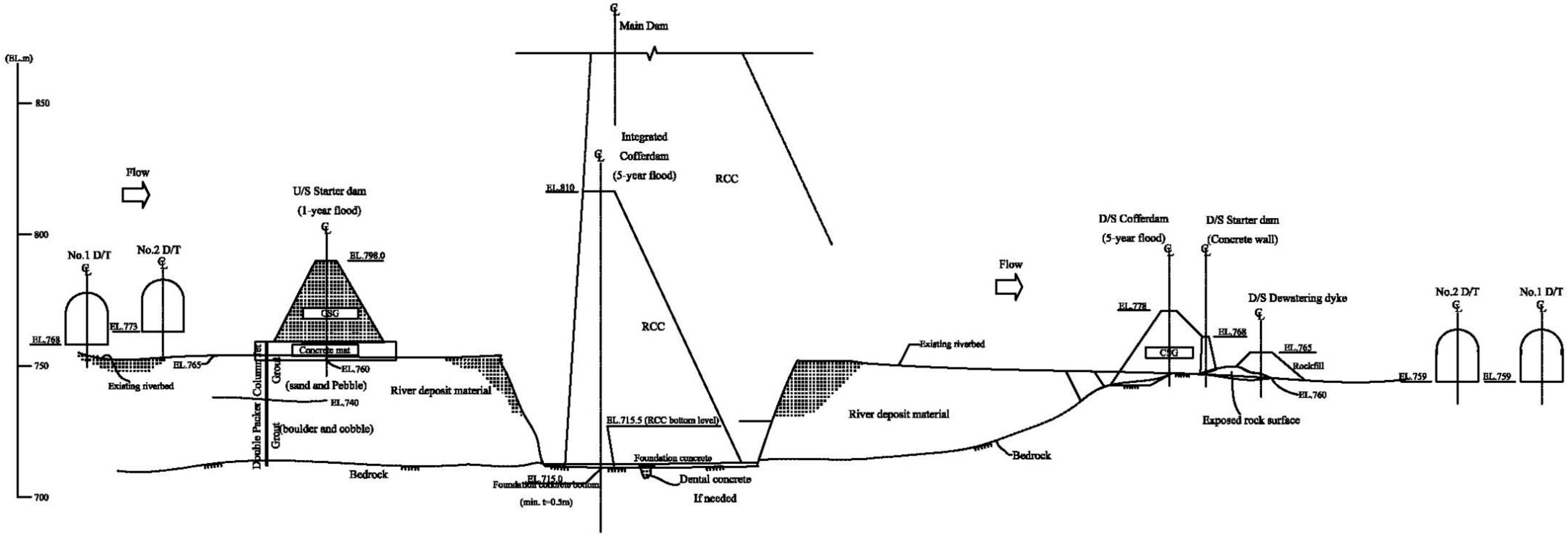


Figure 3.4: Sketch: Cross-section of River Diversion System at Upstream/Downstream Area along Center Line of River

3.3.2 Main Dam and Associated Facilities

3.3.2.1 Dam

The main structure is an Arch Gravity Dam. The maximum height of the dam above bedrock is 242 m. The construction shall use Roller Compacted Concrete (RCC). The design uses a flip bucket to toss excess water flow not used by generation into the air which then free falls into a plunge pool to minimize the potential and kinetic energy of the water. The base of the dam is kept at El 715 m when the river bed is at El 765 m (thus 50 m below the river bed).

3.3.2.2 Spillway and Plunge Pool

A view of spillway from downstream end is shown in Figure 3.5. Spillway is a structure which houses the water flow control gates and has a special shape to deliver water along its slope. The water is delivered to the flip bucket at lowest elevation of spillway for tossing water into the air.

The spillway equipped with eight radial gates, 16.5 m wide x 22.4 m high each, shall release floods from Basic Design Flood (BDF) with full opening of 7 gates. In case of floods from SCF, the surplus discharge will be overtopped with 1.4 m depth on the 1.1 m high parapet wall when all 8 gates are open (along with two lanes of low level outlets). The gates will be operated by using hydraulic hoists while the stoplog is by a gantry crane

Plunge pool is an excavated area in the river on the downstream of the dam (162 m from dam toe). The purpose of the plunge pool is to dissipate the unwanted water energy from the spillway slope and avoid damage to dam toe. This energy dissipation takes place by internal friction and formation of eddies.

3.3.2.3 Low Level Outlet

Low level outlets (LLO) are tunnel like structures in the body of the main dam and have gates for the control of water flow. The main purpose of LLO is to flush sediments and discharge flood. A total of 9 circular LLO having 6.4 m diameter, 180 m long have been provided (see Figure 3.5).

Each LLO is operated by three types of gates: fixed-roller-typed maintenance gate (8.4m widex8.4m high), steel conduit of 80m long, fixed-roller-typed guard gate (5.1m widex6.4m high) and radial-typed regulating gate (5.1m widex6.4m high). When an inflow excesses the plant discharge during high flow seasons, first LLO will be opened to flush the sediment as much possible.

3.3.2.4 Sediment Flushing Tunnels on Right Bank

Sediment build-up in the reservoir will be major threat to the life of reservoir. To meet the discharge requirement of sediment flushing, in addition to low level outlets, two sediment flushing tunnels have been proposed on right bank of Indus River. The sill level will be similar to LLO. These will be gated structures. During high flow period it will be preferable to operate this tunnel rather than to allow the spillway to work. Each tunnel will have a discharge capacity of 1,060 m^3/s under free flow conditions.

The tunnel size will be 4.75m width and 9.5 m height. Lengths of tunnels are 820 m and 680 m. The tunnels are concrete lined with 500 mm concrete and further with stainless steel.

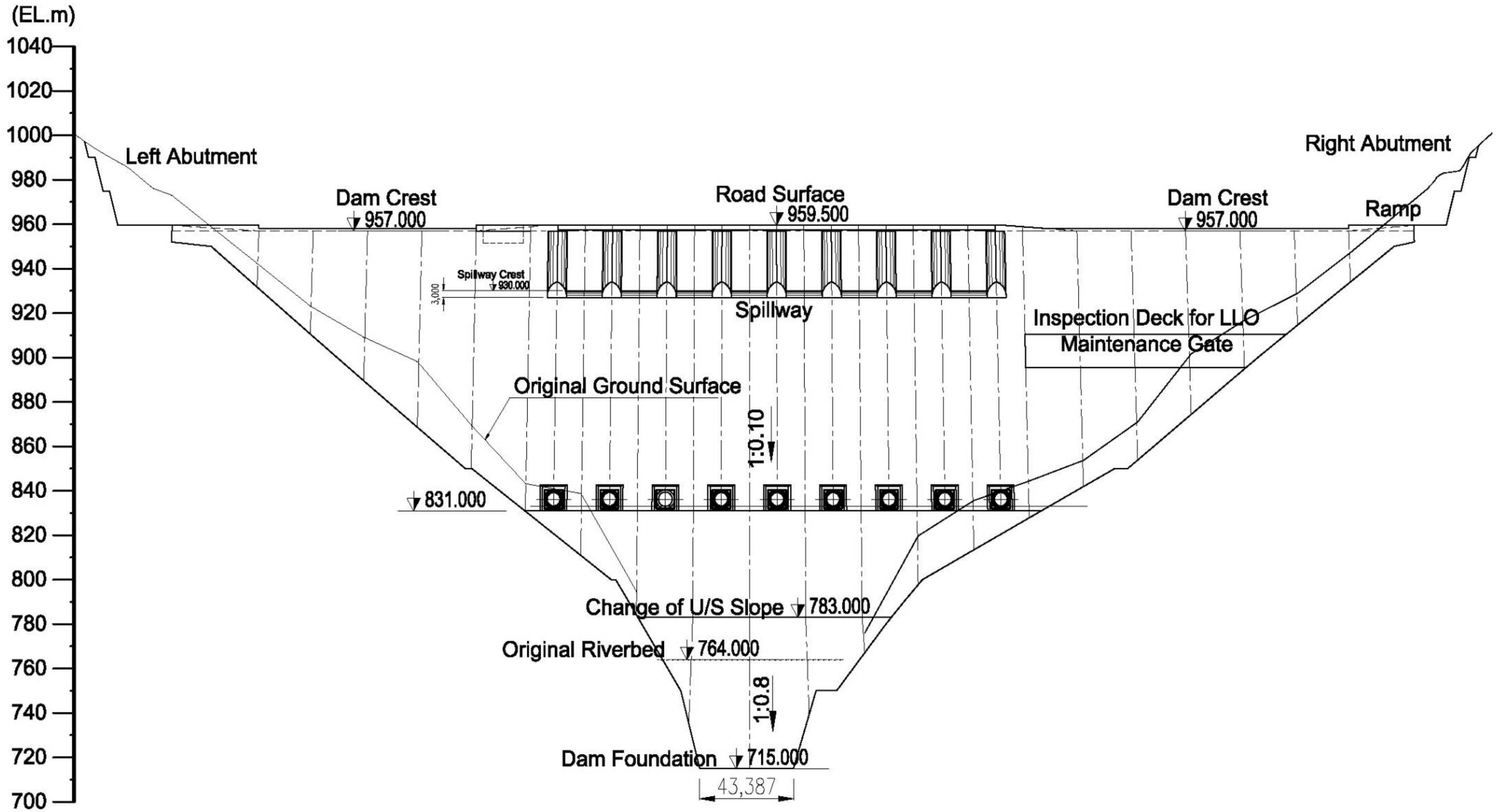


Figure 3.5: Downstream view of Spillway and LLO

3.3.2.5 Power Intake

Power Intake structure located at the upstream of the dam axis, on the left bank. Four intakes will be constructed. The orientation of the intake has been arranged according to the topography and the general joint system of the bedrock.

Entrance of the power intake is covered by removable type trash racks for preventing debris entering into to the pressure tunnel. An inclined concrete platform will be provided along each intake so that raking machine can clean the trash racks one by one. After trash racks, intake continue till the entrance of the power tunnel.

3.3.3 Water Ways (Tunnels)

The waterways are the tunnels that carry water from reservoir to power house (power tunnels or pressure tunnels) and tunnels that carry water from turbines to deliver back to the river (tail race tunnels). Vertical profile of tunnels and powerhouse is shown in Figure 3.6.

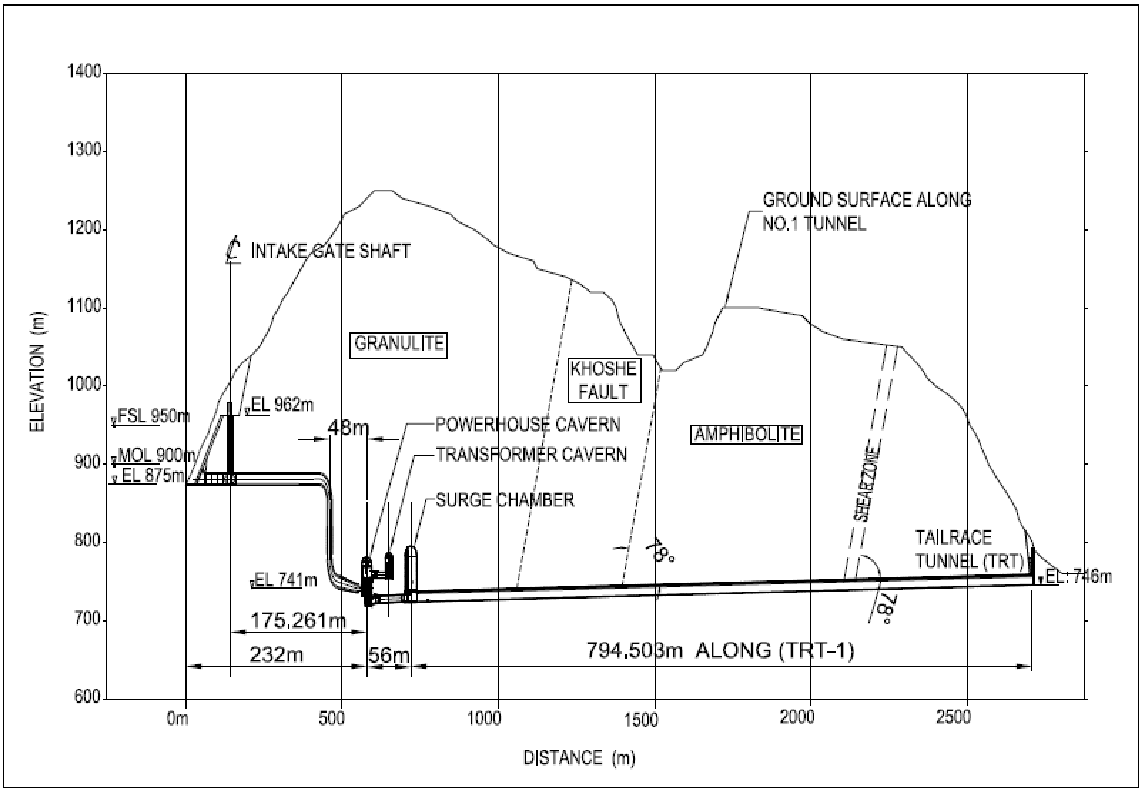


Figure 3.6: Profile of Tunnels and Power House

3.3.3.1 Power Tunnel (Pressure Tunnel)

Four tunnels (each 12 m in diameter, 450 m length, circular and concrete lined) will be constructed. The tunnels follow different routes until they reach vertical pressure shafts. Each tunnel is connected to 3 turbines in the power house.

All the tunnels, in general, continue for 50m and then make a turn to reach the shaft. At the shaft, tunnel turns down 90° with a radius of 36m. It continues in shaft form approximately for 131 m until it reaches elevation 750 m. It then becomes nearly horizontal with a slope of 4% in N-S direction with a bend of radius 36m until it reaches to the beginning of the trifurcation to further connect to the powerhouse.

3.3.3.2 Tailrace Tunnel

Tailrace is underground tunnel structures on left bank of Indus River. The purpose of tail race tunnel is to receive discharge outflow from the turbines and deliver it back to the Indus River. The layout and profile of tail race tunnels are shown in Figure 3.2. There will be four, D-shaped concrete lined tunnels with dimensions 10 m x 12.5 m . Each tailrace tunnel will have discharge capacity of 668 m^3/s. Each tail Race tunnel will be connected at its upstream start point to a 37 m diameter surge chamber that is 45.5 m in height.

The discharge from each 3 turbine units set will be conveyed into a common tailrace tunnel of approximately 2200 m. The surge chamber acts to protect the turbines (in case there is a sudden stop in power generation which results in a water hammer phenomenon). The surge chamber connects with the main access tunnel at a high level. This arrangement will provide a route into the tailrace tunnel for inspection and maintenance. The tailrace outfall structure will be equipped with gates so that the tunnel can be isolated from the river for de-watering. Water level in the river at discharge point will be El. 778 m under SCF. If 12 units work water level will be El.762.38 m. In case of three units operation the water level will be El. 759.2 m.

3.3.4 Power House and Underground Tunnels

The powerhouse complex comprises three major underground caverns, the powerhouse cavern (PH cavern), transformer/GIS cavern (TR cavern) and tailrace surge chambers. The PH cavern accommodates twelve 360 MW generating units. The TR cavern houses main step-up transformers and gas-insulated switchgears (GISs) for all units. The surge chambers are four large cylindrical caverns, one surge chamber serves for three turbine units. The powerhouse complex is located in the left bank abutment of the main dam.

3.3.5 Transmission Line

Injection of power generated at Dasu Hydropower to the National grid requires construction of high voltage transmission lines for which a feasible line route corridor has yet to be explored in detail. The environmental assessment of the transmission route is being carried out through a separate study by National Transmission and Dispatch Company (NTDC).

Two 500 kV transmission lines have been planned from Dasu to Pathar Garh (near Hasan Abdal), where a new 500 kv grid station will be established. The alignment of the transmission line passes through the districts of Kohistan, Battagram, Mansehra, Abbotabad, Haripur and Attock districts. Length of the transmission line is approximately 250 km.

3.3.6 KKH Realignment and Access Roads

3.3.6.1 KKH Realignment

The existing KKH in a stretch of about 46 km will be submerged in Dasu reservoir requiring its relocation at a higher level. To compensate, a new KKH of 61.7 km will have to be rebuilt downstream of Dasu dam site to join the existing KKH located at the lower level with the new road relocated at the higher level upstream of the Dasu dam site. In addition two link roads, each of 3 km length, will be constructed from realigned KKH to existing KKH (one joining the upstream of damsite at Barseen, and other one joining at Kaigah).

The relocated KKH length of 61.7 km is divided in two sections i.e. KKH-01 and KKH-02. The first section is comprised of 15.575 km of relocated KKH plus a link road of 3.028 km length from existing KKH at lower level and jointing with relocated KKH at higher altitude. Section KKH-01 will serve as a By Pass to avoid interference in the construction activities at dam site. Section 2 will be of length 46.1 km.

Design parameters used in KKH relocation are given in Table 3.3. The pavement is asphalt.

Table 3.3: Geometric Standards for Relocated KKH

No.	Description	Parameters at Designed Speed		
	Terrain	Rugged mountainous	Hilly to mountainous	Hilly
1	Design Speed	30 Km/h	40 km/h	50 Km/h
2	Lane width	3.65m x 2	3.65 m x 2	3.65 x 2 m
3	Treated shoulder width outer/inner	1.0m/1.0m	1.0m/1.0m	1.0m/1.0m
4	Pavement cross slope	2.0%	2.0%	2.0%
5	Shoulder Cross Slope	2.0%	2.0%	2.0%
6	Cut Slope	0.5:1 vertical	0.5:1 vertical	0.5:1 vertical
7	Minimum Radius of curve	21 m	43m	79 m
8	Minimum length of Horizontal Curve	30 m	40 m	50 m
9	Minimum stopping sight distance	35 m	50 m	65 m
10	Maximum rate of Super elevation	6%	6%	6%
11	Maximum super elevation Run off	29	31	33
12	Maximum Tangent Run out	0	7	9
13	Maximum grade	6%	6%	6%
14	Vertical curvature: K value for sag curve	2	4	7
15	Vertical Curvature: K-value for sag curve	6	9	13
16	Minimum Length of vertical curve	18	24	30

The full extent of relocation of KKH plan is shown in Figure 3.7. This figure also shows the right bank access road proposed from Komela.

The construction of 15.6 Km bypass to the construction- area will be constructed on priority to enable project construction activity to start.

In addition to the road, the structures on realigned KKH include:

- Section KKH-01 involves construction of 4 box culverts, eight bridges of each 20 to 35 m length, 25 causeways and 3.7 l km retaining walls.
- Section KKH-02, detail design of which is ongoing, is likely to include construction of 23 causeways, 6 bridges, 11 box culverts, and 9.02 km of retaining wall

3.3.6.2 Access road along Right Bank

About 45 km of access road from Komela to Damsite and then to Kandia will be constructed along right bank. Length of the road from Komela to damsite is 11.96 km and the length from damsite to Kandia is about 23km road, whose design is still under progress. The access road will pass through the built-up area at Komela. The road junction with KKH will be modified and will be widened. After passing through the buildup area at Komela the road will leave Seo road and take independent route to dam site. From Komela junction, From Komela to Seo, the access road will be shared by the Project with public traffic and thereafter the roads will follow separate routes. The first section of the road, from Komela to damsite, will have 2 bridges of 16 and 30 m length; 8 box culverts, 2 causeways and 1,220 m long retaining walls.

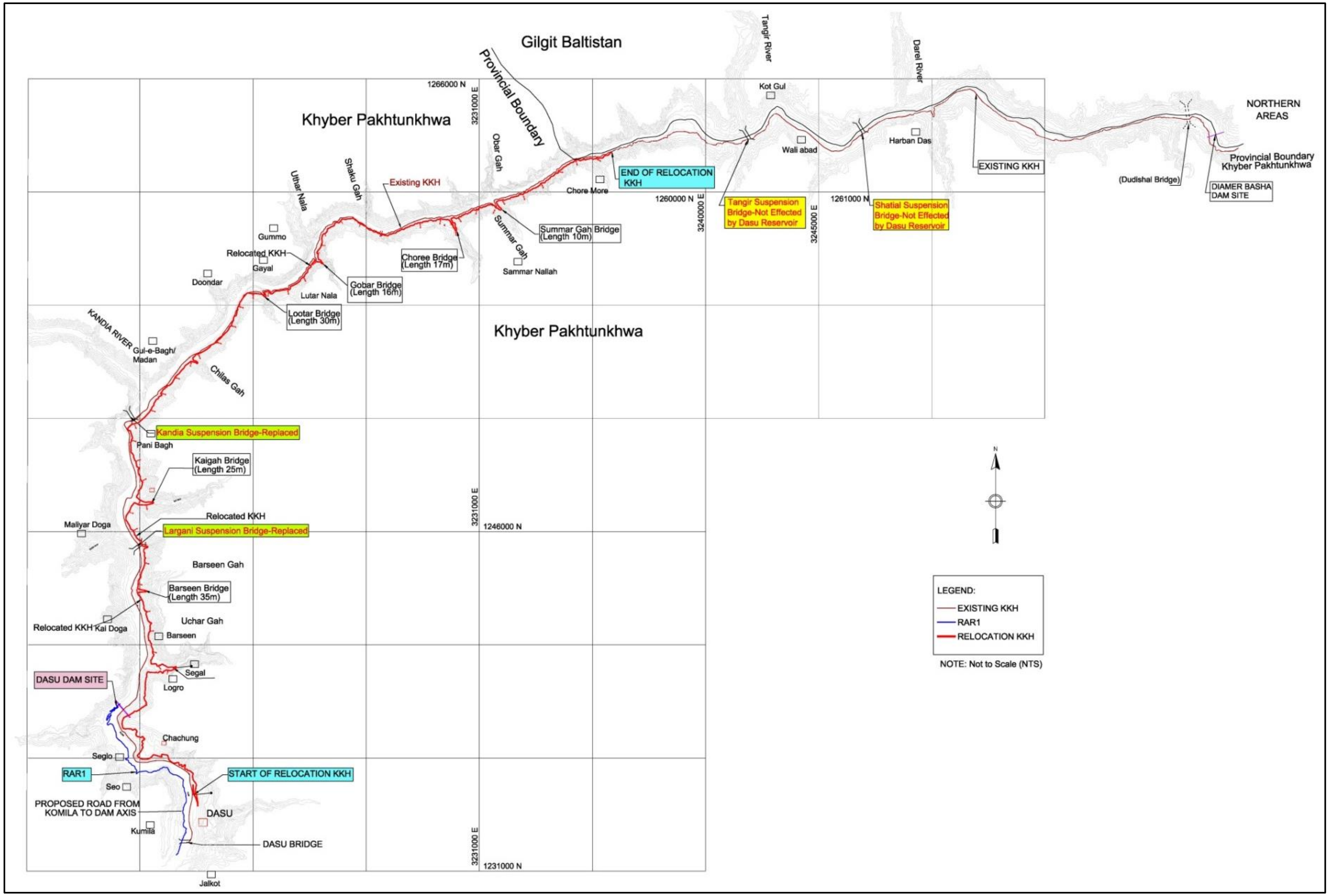


Figure 3.7: Proposed Relocation Plan of KKH and Right Bank Access Road Komela to Dam Site and to Kandia

3.3.6.3 WAPDA Offices and Colonies

The residences and office buildings for WAPDA's staff will be constructed at Choochang, on the left bank on the downstream of the dam site, on approximately 32 ha. The facilities in the WAPDA's colony are given in Table 3.4. During construction these facilities will be used by the Consultants and WAPDA's supervision staff.

Table 3.4: Facilities in WAPDA Colony

S No	Description	No. of Units	Land Area (m^2)
1	Project Office 1	1	7,556
2	Project Office 2	1	6,705
3	Consultant's Office	1	4,849
4	Information Canter & Aquarium	1	3,934
5	Main Security Office	1	1,615
6	Category 1 Residences	08	4,941
7	Category 2 Residences	51	17,181
8	Category 3 Residences	78	10,900
9	Category 4 Residences	136	10,751
10	Category 5 Residences	296	14,443
11	Sr. Officer's Hostel Category 2	4	11,602
12	Jr. Officer's Hostel Category 3	2	9,360
13	Rest House	1	3,440
14	WAPDA Hospital	1	4,872
15	High School for Girls	1	6,700
16	High School for Boys	1	6,700
17	Primary Schools	2	6,896
18	WAPDA Club	1	5,040
19	Community Centre	1	4,150
20	Jamia Mosque + Neighbourhood Mosque	1+1	4,893
21	Market / Shopping Centre	1	4,629
22	Banks (Plots Only)	3	1,288
23	Post Office, Fire Station & PABX	1+1+1	2,779
24	Water Supply Treatment Tanks Area	--	7,542
25	Grave Yard	1	6,000
26	Parks and Play Grounds	06	15,499
27	Roads	-	70,077
28	Cut Slopes	-	23,070
29	Open / Steep / Unused Land areas	-	38,155
TOTAL:-			**315,567**

Water supply system will be constructed for the office and colony. The source of water supply is Dasu nullah, a perennial tributary to Indus. The water supply system will include water extraction, raw water tank, slow sand filter, treatment by chlorination, and transmission and distribution system. The facilities are designed for 6,200 people (staff and their families) considering an average domestic demand of 227 liters per capita per day. The total daily water demand is estimated to be 3515 m^3/day (including institutional, commercial, firefighting, gardening and transmission losses).

Sewage system will consists of collection of sewages through concrete pipes and treatment of sewage by septicization. About 1700 m3/day of sewage flows (80% of the domestic and 90 percent of commercial water supply) are considered for the design sewage facilities. A surface drainage system with a disposal system will also be constructed. The surface drainage will consists of cement concrete covered drains cum footpaths.

Solid waste management system will include segregation of waste, storage and collection, storage depots, waste processing and disposal. A sanitary landfilling facility will be constructed (with appropriate landfill liners) for non-degradable, inert waste and other waste that are not suitable for recycling or biological processing. Total solid waste generation is estimated as 1860 kg/day (at the rate of 0.3 kg/capacity/day).

3.3.7 Temporary Facilities

The Project will also construct some temporary facilities such as construction yards, construction camps, and other temporary areas used during construction; Details of these temporary facilities required during construction stage are given in Figure 3.8 and Figure 3.9.

3.3.8 Construction Materials

The construction materials required for the DHP are summarized in Table 3.5 for the major items and their approximate quantities. This detail pertains to the dam, tunnels, powerhouse etc.

Table 3.5: Construction Material Requirement

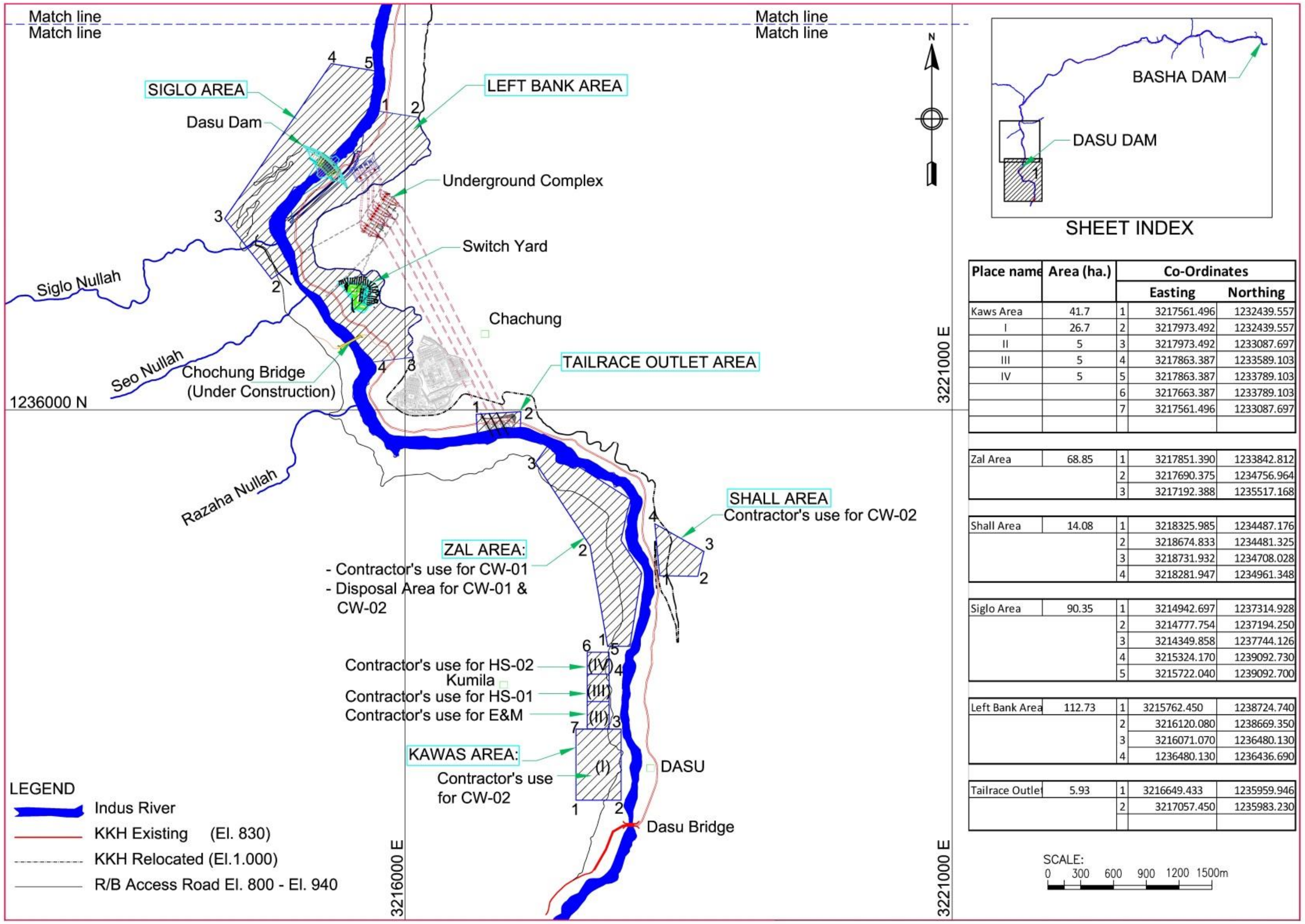
Sr. No.	Materials	Dam & Appurtenant structures	Underground Power structures	Quantity, tons
1	Aggregate Coarse (stones)	7,200,000 t	2,000,000 t	9,200,000 t
2	Aggregate Fine (Manufactured sand)	4,000,000 t 600,000 t	1,000,000 t	5,000,000 t
3	Cement	400,000 t	200,000 t	800,000 t
4	Pozzolan	400,000 t	100,000 t	500,000 t
5	Reinforcement steel	40,000 t	60,000 t	100,000 t
6	Structural steel	20,000 t	30,000 t	50,000 t
7	Fuel	150,000 kl	150,000 kl	300,000 kl
8	Explosives	10,000 t	10,000 t	20,000 t
9	Asphalt			116,000 m^3

Note: Units of material in the table: t – metric ton; kl – kilo liters

3.3.8.1 Aggregates

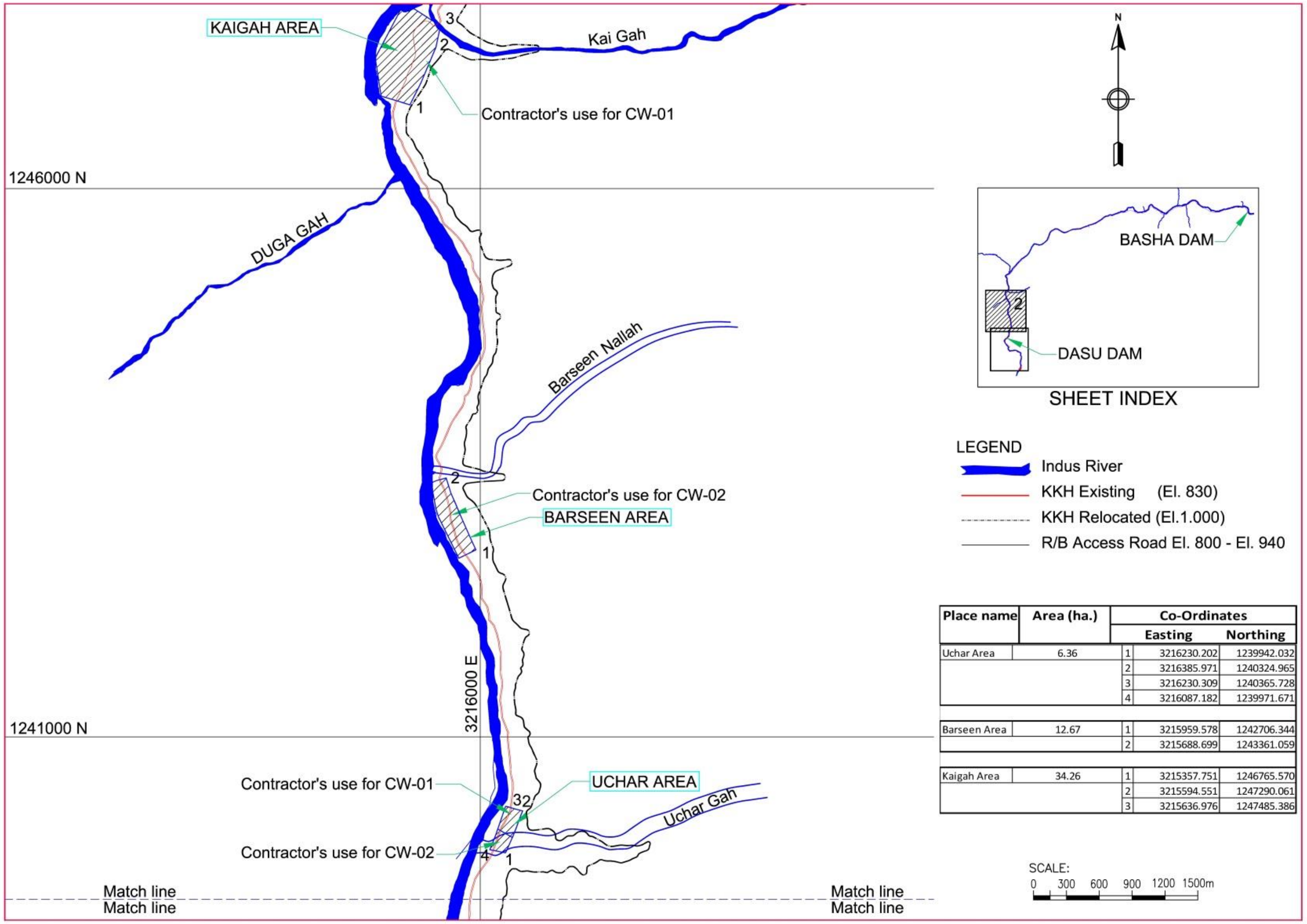
Concrete aggregates (including manufactured sand) required for the project are planned to be obtained by exploiting local rock quarries. However, the excavated rocks from the construction under the Dam and Underground Powerhouse Contracts may also be used as aggregate raw materials, if these excavated materials meet the required quality and specifications for conventional concrete and RCC.

Potential source of aggregates is identified near Kaigah, in the reservoir submergence area (Figure 3.10), which is located about 10km upstream of the damsite. Quarrying at Kaigah will be carried out by bench cut method with necessary drilling and blasting. Crushing plant also will be established near the quarry site. The produced aggregates at Kaigah will be transported by belt conveyor system to the stock pile in the right bank of the dam site. Length of this conveyor belt will be about 10km. Capacity of the conveyor belt will be 930 tons per hour.



Place name	Area (ha.)	Co-Ordinates		
			Easting	Northing
Kaws Area	41.7	1	3217561.496	1232439.557
I	26.7	2	3217973.492	1232439.557
II	5	3	3217973.492	1233087.697
III	5	4	3217863.387	1233589.103
IV	5	5	3217863.387	1233789.103
		6	3217663.387	1233789.103
		7	3217561.496	1233087.697
Zal Area	68.85	1	3217851.390	1233842.812
		2	3217690.375	1234756.964
		3	3217192.388	1235517.168
Shall Area	14.08	1	3218325.985	1234487.176
		2	3218674.833	1234481.325
		3	3218731.932	1234708.028
		4	3218281.947	1234961.348
Siglo Area	90.35	1	3214942.697	1237314.928
		2	3214777.754	1237194.250
		3	3214349.858	1237744.126
		4	3215324.170	1239092.730
		5	3215722.040	1239092.700
Left Bank Area	112.73	1	3215762.450	1238724.740
		2	3216120.080	1238669.350
		3	3216071.070	1236480.130
		4	1236480.130	1236436.690
Tailrace Outlet	5.93	1	3216649.433	1235959.946
		2	3217057.450	1235983.230

Figure 3.8: Locations and Details of Temporary Facilities - 1



Place name	Area (ha.)	Co-Ordinates		
			Easting	Northing
Uchar Area	6.36	1	3216230.202	1239942.032
		2	3216385.971	1240324.965
		3	3216230.309	1240365.728
		4	3216087.182	1239971.671
Barseen Area	12.67	1	3215959.578	1242706.344
		2	3215688.699	1243361.059
Kaigah Area	34.26	1	3215357.751	1246765.570
		2	3215594.551	1247290.061
		3	3215636.976	1247485.386

Figure 3.9: Locations and Details of Temporary Facilities – 2

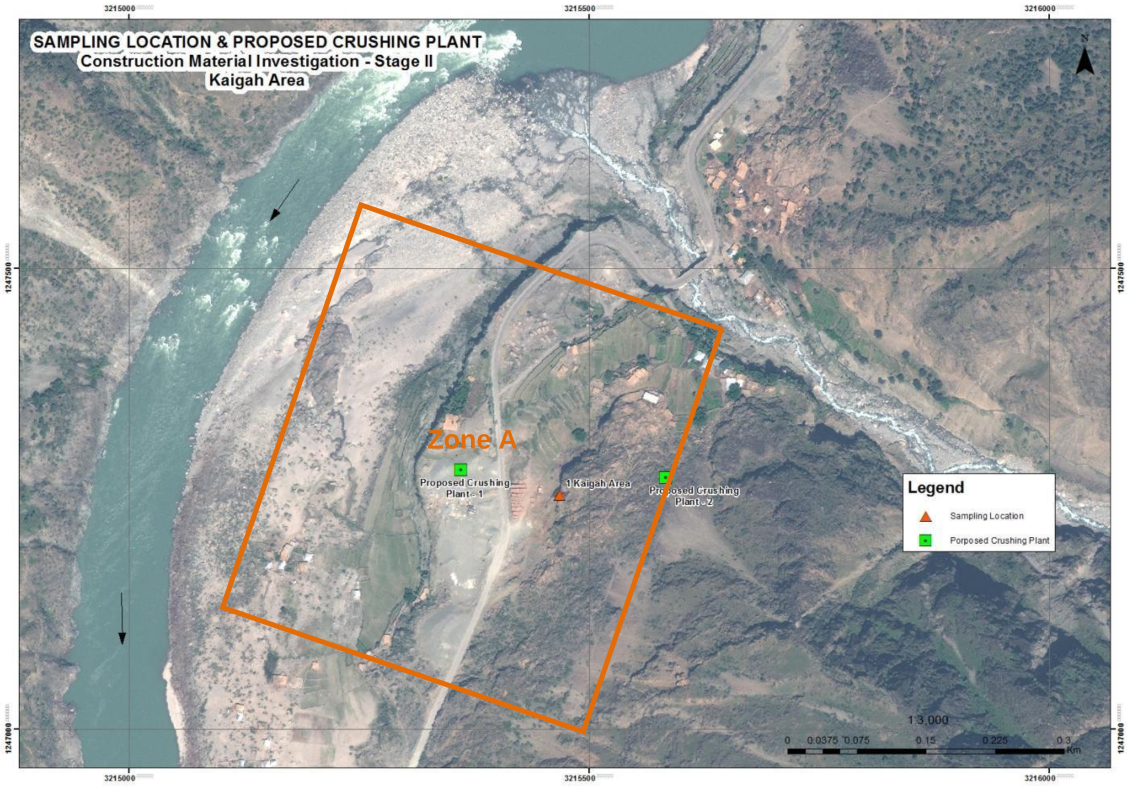


Figure 3.10: Quarry and Aggregate Crushing Plant Site at Kaigah

3.3.8.2 Pozzolan Materials

Pozzolan material required for the project will be about 500,000 tons, with a monthly average consumption of about 17,000 tons. This can be manufactured in the cement factories or can be borrowed from natural deposits. A prospective area of natural pozzolan material (10 ha) is identified at Gini (Figure 3.11), located about 10 km north of Chilas and 128 km upstream of the damsite. These surface moraine deposits will be excavated through bull dozers. A milling plant of natural pozzolan will be established at the identified site with 700 t/day capacity. To ensure continuity of operations there will be need to maintain sufficient storage of pozzolan materials, at least 1-month RCC works, at the site. Since the transportation capacity of KKH is critical to construction activities, efficient supply and transportation by long truck trailers will be adopted. Alternatives of using aggregates (from excavated material or proposed quarry site at Kaigah) are being still studied by the engineering team. However, the contractor can also make his own arrangements for procurement and/or manufacture and supply of pozzolan material according to the requirement of technical specifications. The contractor can also import material with the permission of WAPDA, if suitable material of sufficient quantity is not available. About 35 vehicle trips per day are required to transport the pozzolan from the milling site to the damsite.

3.3.8.3 Spoil Disposal Sites

The excavation activities carried out for dam, power house, tunnel and KKH construction will generate about 20 million cubic meters of excess rock material. A site of 68.85 ha, located 3 km downstream of the damsite, is allotted for disposal of excess spoils. Location of the disposal site is shown Figure 3.12.

3.3.8.4 Cement

It has been assessed that good quality cement is available in Pakistan and haulage of cement material using the KKH is feasible. Sufficient production capacity, approximately 30,000 tons per day, is available with the existing cement factories near

Islamabad, and can be transported to the site using normal trucks of long trailers. Average monthly cement requirement for the project has been estimated to be 15,000 tons. To ensure continuity of operations there will be need to maintain sufficient storage, for at least one-months concreting works, at the site. Cement will be transported using long trailers or normal trucks to the site via KKH.

Figure 3.11: Potential Source of Pozzolan Material Site at Gini (inlet Photograph of site)

Figure 3.12: Location of Spoil Disposal Area

3.3.8.5 Reinforcement steel bar

Required reinforcing steel bar is approximately 100,000 tons in total for the RCC dam and underground powerhouse complex. It is confirmed that several factories in the country produce small quantities of reinforcing steel, in the form of both plain and deformed bars. There is no factory producing or re-rolling reinforcing steel bars in the near vicinity of the dam site. The nearest location from where the reinforcing steel bars of the desired specification are available is Islamabad (also Hassanabdal). Both hot and cold rolled reinforcing steel bars are available in desired quantity from Islamabad about 340 km from the dam site. The other main source is Pakistan Steel in Karachi. Alternatively, steel item can be imported from neighboring countries.

Transportation of reinforcing steel bars will be by trucks with long bodies via KKH. Sufficient quantities will have to be stocked under taking rust prevention of steel bars.

3.3.8.6 Petroleum products

Required fuel will be procured from Islamabad by using large fuel tanks. In the site fuel supply depot system will be provided having sufficient capacity for one month’s operation at least.

3.3.8.7 Steel plates and steel formwork

It is confirmed that steel sheets of various thickness are produced at the Steel Mills at Karachi, which can be used to fabricate steel formwork. These can also be used for fabricating small to middle size of steel liners and other miscellaneous items required in connection with the construction activities. Alternatively, steel items can be imported from abroad.

3.3.8.8 Power Supply

About 30 MW of power supply is required for whole construction site. The required power will be supplied from Dubair Khawar (located 45 km from Dasu) through a new 132 kv transmission line along the existing KKH. About 7 km of new distribution line will be constructed from the grid station to work areas. The, Peshawar Electric Supply Company (PESCO) will operate and control this power.

3.3.9 Construction Machinery

The following type of constructional plant and equipment will be required for the implementation of the project, as major items:

Table 3.6: Required Major Plant & Equipment (Approximate)

Plant & Equipment	Capacity	Number
Concrete mixing plant at Siglo for RCC	600 m^3/h	2 sets
Concrete mixing plant at Siglo for CVC	200-250 $m^{3/}$h	1 set
Belt conveyor system for RCC *(Batcher plant → Dam)*	1,200 m^3/h	1 set
Aggregate plant at Kaigah	250 t/h	1 set
Aggregate plant at Kaigah	500 t/h	2 sets
Belt conveyor system for aggregates *(Transportation (Kaigah → Siglo))*	930 t/h	1 set
Belt conveyor system for excavated Material *(dam site → disposal site)*	1,700 m^3/h	1 set
Pozzolan milling plant	200 m^3/h	1 set
Tower crane	5 txR75m	3 sets
Power supply system		1 lot

Plant & Equipment	Capacity	Number
Water supply system		2 lots
Cooling plant for aggregates		1 lot
Aggregate bin	1,500 m^3	4 sets
Cement silo	1,000 t	2 sets
Pozzolan silo	300 t	1 set
Winch system	50 t	1 set
Tower crane	5 t x R75m	3 sets
Crawler crane	55 t	1 set
Crawler drill	150 kg drifter	2 units
Giant breaker	600 kg breaker	2 units
Crawler loader	2. 0 m3	4 units
Dump truck	20 t	30 units
Drill jumbo, 2 booms	150 kg drifter	4 units
Grout machine	70 m	5 sets
Road header	110 kW	2 units
Wheel loader	2.0 m^3	4 units
Bulldozer	30 t	6 units
Vibrating roller	12 t	4 units
Motor grader	3.7 m	2 units
Vibration joint cutter		2 units
Immersion vibrator		2 units
Concrete pump	90 m^3/hr	1 unit
Mixer truck	6 m^3	6 units
Crawler crane	80 t	2 unit

The working time for the equipment will be 26 days per month or 10 months per year. The usage of the equipment will be based on the daily shifts as given below:

- Above-ground earthmoving — 2-shift of 10 hours each
- Underground excavations — 2-shift of 10 hours each
- CVC concrete works — 1-shift above ground, & 2-shift for underground
- RCC production & placement — To apply continuous process under 3-shift of 24 hours

3.3.10 Manpower Requirements

Skilled and semi-skilled construction labourers will be needed to construct the RCC dam and underground structures. Technicians, foremen and supervisors will be utilised for specialist works for RCC placement, drilling, blasting, and operators for plant and equipment especially for aggregate plant, batching plant, pozzolan milling plant, long span belt conveyors and so on. A mix of expatriate and local technicians/supervisors will be employed on these requirements. It is expected that non-skilled labours will have to be employed from the surrounding local area the dam site.

The number of workers to be involved in the project activities on contract basis including staff from WAPDA and Consultants are given in the Table 3.7. These figures indicate the peak time requirement.

Table 3.7: Manpower Requirement for Project Implementation

Year	Personnel Required
2014	1,100
2015	1,800
2016	1,700
2017	2,400
2018	2,700
2019	2,400
2020 onward	1,500

Estimated peak personnel deployment during operation and maintenance (O&M) stage is given in Table 3.8:

Table 3.8: Manpower Requirement during O&M

Sr. No.	Staff category	Personnel Required
Technical/Professional		
1	E & M Works	125
2	Power House Operation & Protection	90
3	Civil Works	40
4	Engineering & Administration	20
	Sub Total	**275**
Support Staff		
Other Staff including staff for Colony Maintenance		1100
	Total	**1375**

3.3.11 Construction Schedule

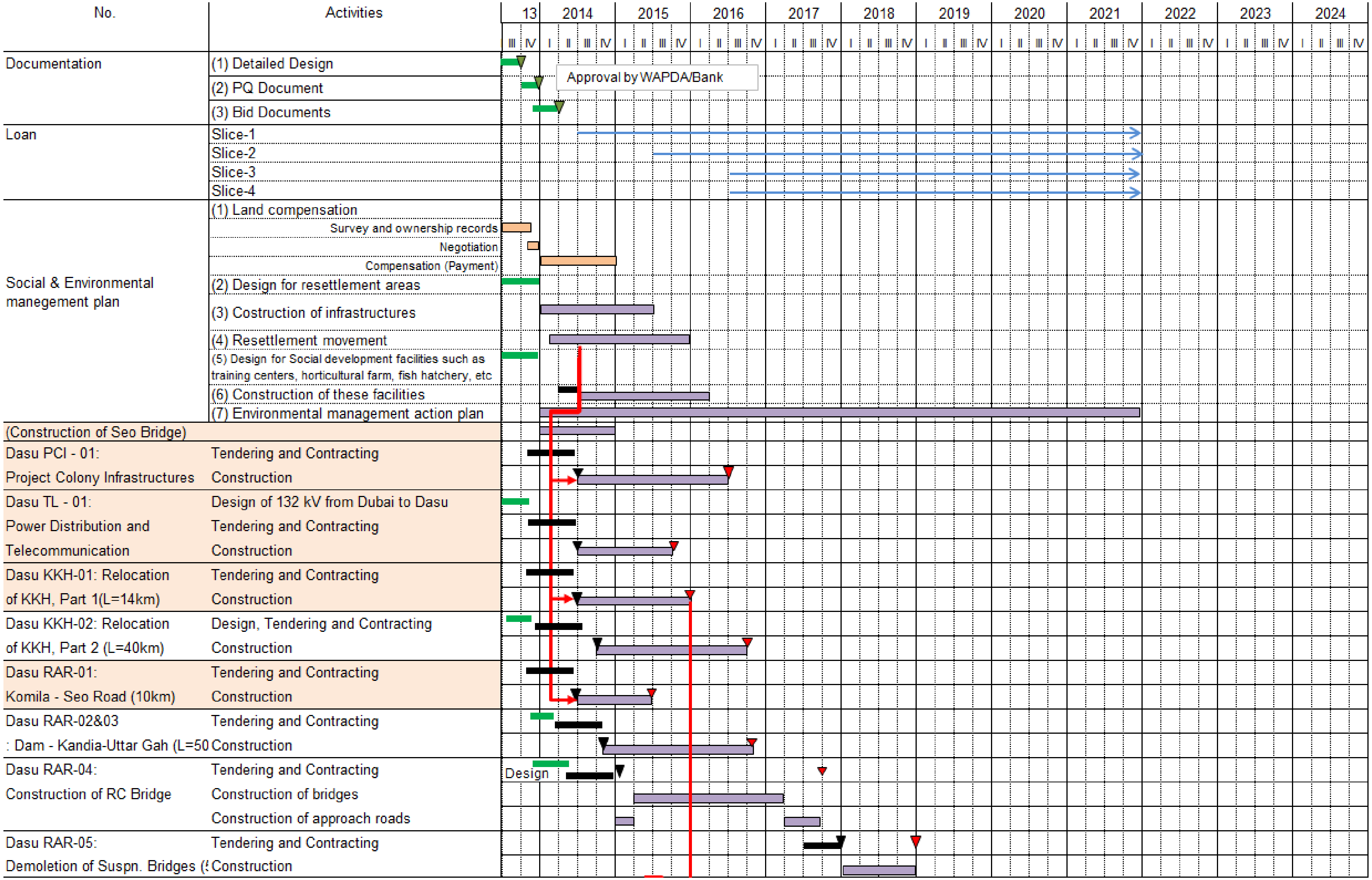
The DHP requires huge and committed investment. A staged development is the practical way to achieve earlier power generation with the minimum investment cost (committed finance from the World Bank) and to deal with uncertainties in future investment. It was agreed with WAPDA and World Bank that a two staged approach will be followed for DHP with each stage divided into two phases as shown in Table 3.9. The stage 2 development is assumed to be implemented after Basha project construction, which has some implications on the sediment load to DHP and thereby operations of DHP. During each phase additional power generating capacity of 1,080 MW (three turbines of 360 MW) will be installed. During Phase-1 (5 years, 2015-2020) the major hydraulic structures and related infrastructure will be constructed and one power tunnel including generating facilities for 1,080 MW of installed capacity. Another tunnel would be constructed during Phase-2, together with power generating facilities for another 1080 MW. Both phases of Stage 1 will be implemented simultaneously (2015 -2022). The Second Stage will include the construction of a third power tunnel and generating facilities for an additional 1,080 MW. Phase-3 and 4 would preferably be carried out after the development of Diamer-Basha dam.

Table 3.9: Staged Development of DHP

	Stage I		Stage II	
	Phase-I	**Phase-II**	**Phase-III**	**Phase-IV**
Works	Full dam & Three Turbines	Three Turbines	Three Turbines	Three Turbines
Cumulative Installed Capacity MW	1,080	2,160	3,240	4,320
Generation GWh under each Phase	8056	12,255	15,544 (18,730 post Basha)	18,440(21,485 post Basha)
Start	2015		To be initiated after the completion of Basha	
Completion	2022 (first unit will start generating form 2020)		4 years after commencement	

Note: Diamer Basha project implementation is expected to be completed in 15 years

The proposed construction schedule is given in Figure 3.13.


No.
Activities
13
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
III IV I II III IV
Approval by WAPDA/Bank
Documentation
(1) Detailed Design
(2) PQ Document
(3) Bid Documents
Loan
Slice-1
Slice-2
Slice-3
Slice-4
Social & Environmental managemenet plan
(1) Land compensation
Survey and ownership records
Negotiation
Compensation (Payment)
(2) Design for resettlement areas
(3) Costruction of infrastructures
(4) Resettlement movement
(5) Design for Social development facilities such as training centers, horticultural farm, fish hatchery, etc
(6) Construction of these facilities
(7) Environmental management action plan
(Construction of Seo Bridge)
Dasu PCI - 01: Project Colony Infrastructures
Tendering and Contracting
Construction
Dasu TL - 01: Power Distribution and Telecommunication
Design of 132 kV from Dubai to Dasu
Tendering and Contracting
Construction
Dasu KKH-01: Relocation of KKH, Part 1(L=14km)
Tendering and Contracting
Construction
Dasu KKH-02: Relocation of KKH, Part 2 (L=40km)
Design, Tendering and Contracting
Construction
Dasu RAR-01: Komila - Seo Road (10km)
Tendering and Contracting
Construction
Dasu RAR-02&03 : Dam - Kandia-Uttar Gah (L=50
Tendering and Contracting
Construction
Dasu RAR-04: Construction of RC Bridge
Design
Tendering and Contracting
Construction of bridges
Construction of approach roads
Dasu RAR-05: Demoletion of Suspn. Bridges (
Tendering and Contracting
Construction

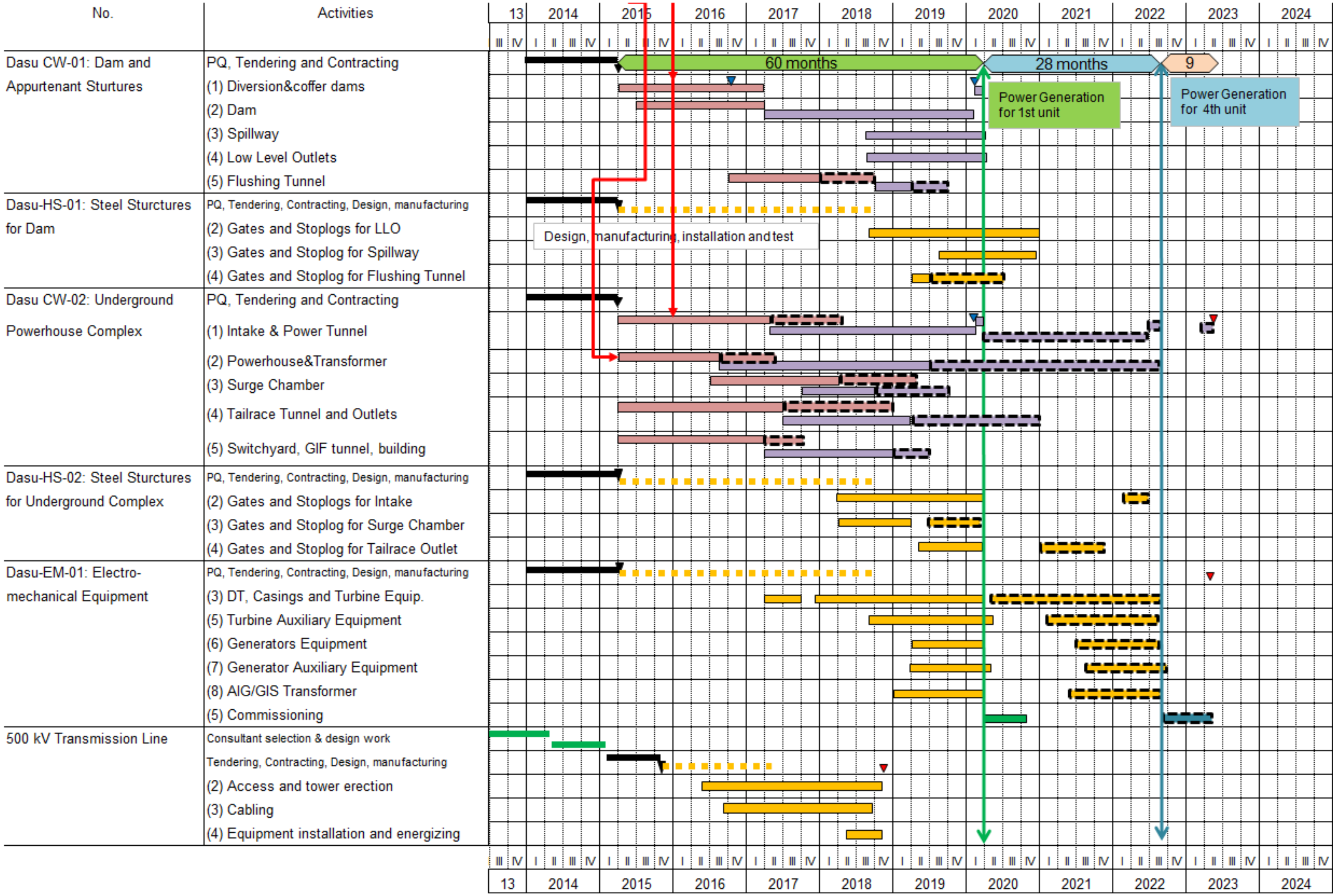


Figure 3.13: Project Construction Schedule

3.4 OPERATION AND MAINTENANCE OF THE PROJECT

3.4.1 Reservoir Impounding

Once the dam construction is completed, water will be allowed to store behind the dam. First reservoir water filling will be an important milestone in the project and requires lot of preparation and careful monitoring for landslides in the identified landslide prone areas.

The first impounding will start around mid-June. The area between river bed elevation (765m) and crest of starter dam (798m) will be already filled with water during construction. From crest of starter dam to LLO (833m), the filling rate will be done in a few hours. A filing rate of 2m/day will be followed to gradually rise the reservoir level from 833 to 950 m, by releasing the excess flow through LLOs. Once the level 950 m is reached, LLOs will be completely closed. It will take about 60 days for impounding the reservoir (Table 3.10). About 215 m^3/s of flow is required to achieve this filling rate, and the remaining flows (above 4,000 m^3/s will be released through LLOs)

Table 3.10: Reservoir Impounding

Elevation, masl	Location	Height (H) & Volume (V) (V in million cubic meters, MCM)	Days
950	FSL	H = 20m (950-930) V= 392 MCM	10 days (2m/day)
930	Crest of Spillway	H = 97 m (930-833) V = 909 MCM	49 days (2m/day)
833	Sill of LLO	H = 35 m (833-798) V = 90 MCM	few hours
798	Crest of starter dam		

3.4.2 Operational Concepts in Stage 1 (ROR or Base Load Operation Prior to Commissioning of Basha Project)

The water level in the reservoir will always be maintained at 950m, and whatever additional water coming into the reservoir will be diverted through intake and to the power house. This means the reservoir and power house will be operated as a run of river (ROR) type power generation (base load plant).

During the high flow season (May to October) water will mainly enter the reservoir at a rate greater than water released through the powerhouse intakes and excess will pass over the spillway.

During Low Flow Season (November to April) also water will be maintained in the reservoir at 950m and additional water will be diverted through power house intake.

The runoff river operation of the project is schematically shown in Figure 3.14 and this type of operation is expected to continue in the Stage 1 (first two phases – Phase 1 operation starts from 2019 and Phase 2 operation starts from 2022) of the project until commissioning of Basha Project.

3.4.3 Operational Concepts In Stage 2 (after Commissioning of Basha Hydropower Project

In Stage 2, after completion of Basha project, there is a potential that Dasu could be used as peaking plant due to guaranteed water releases from Basha reservoir. However, peaking operation produces about 1000 Gwh of less power annually compered to ROR (base load) operation. Hence in Stage 2 also it is recommended to use Dasu for base load operations.. In the peaking plant operation, water will be stored and released on a daily cycle of approximately 18-20 hours storage followed by 4-6 hours release for power production (expected to take place approximately from 4 to 5pm to 8 to 11pm to meet the peak time requirement of grid).

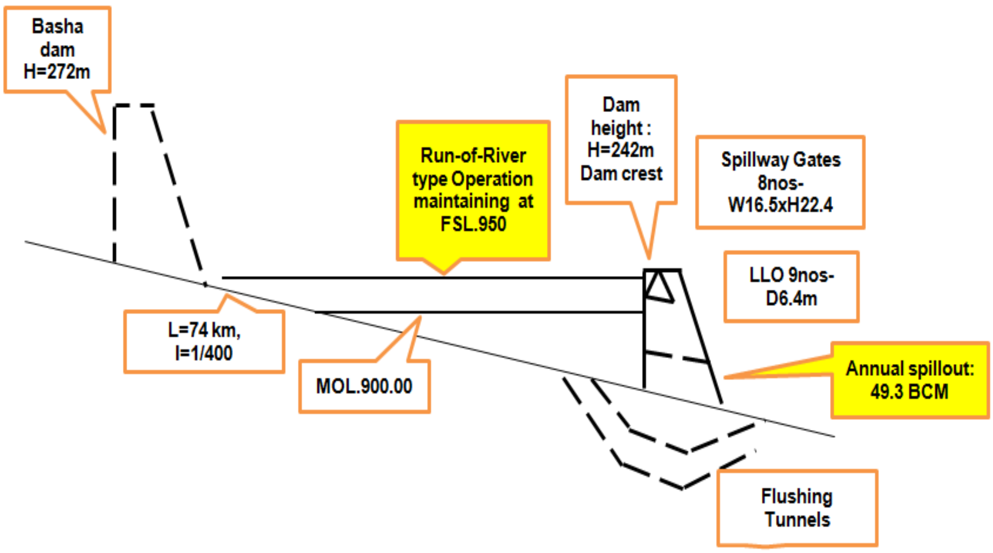


Figure 3.14: Operational concepts of DHP as Run of River Type

Peaking plant operation (reservoir storage) is schematically shown in the Figure 3.15. Though the Project is recommended to ROR throughout its life, peaking operation is feasible in the Stage 2 (second and third phases – Phase 3 operation starts from 2031 and Phase 2 operation starts from 2037) of the project after commissioning of Basha Project.

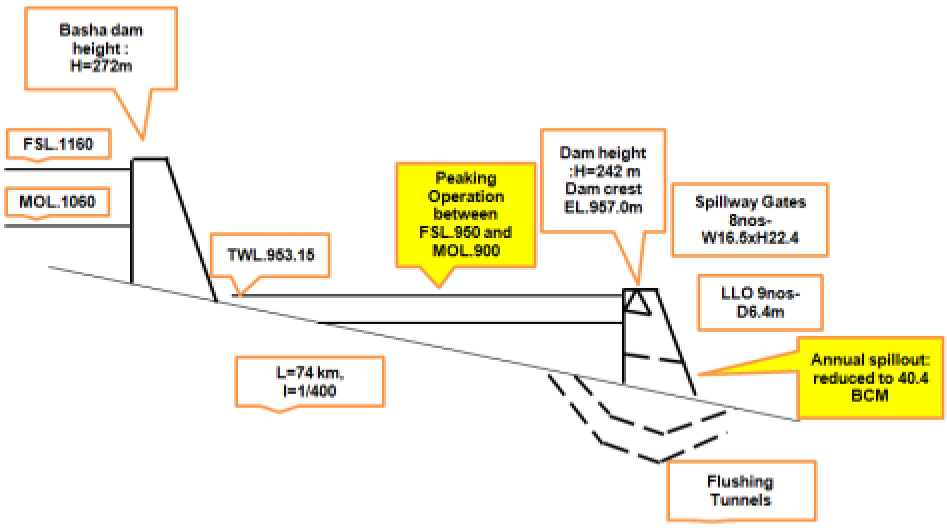


Figure 3.15: Operational concepts of DHP as Peaking Plant (Reservoir Storage Type)

Reservoir water level (RWL) in both ROR and peaking type is shown in Figure 3.16. As shown in this figure, the water level in the ROR type is completely kept at 950 m, while for reservoir storage type, the RWL shows the drawdown from FSL towards the MOL over 4 months from beginning of December up to beginning of April due to low flows. The reservoir water levels under the storage peaking type operation are controlled annually with the periods of 66.7% at FSL.950.00m, 8.4% at the transition between FSL and MOL, and 24.9% at MOL.900.00m.

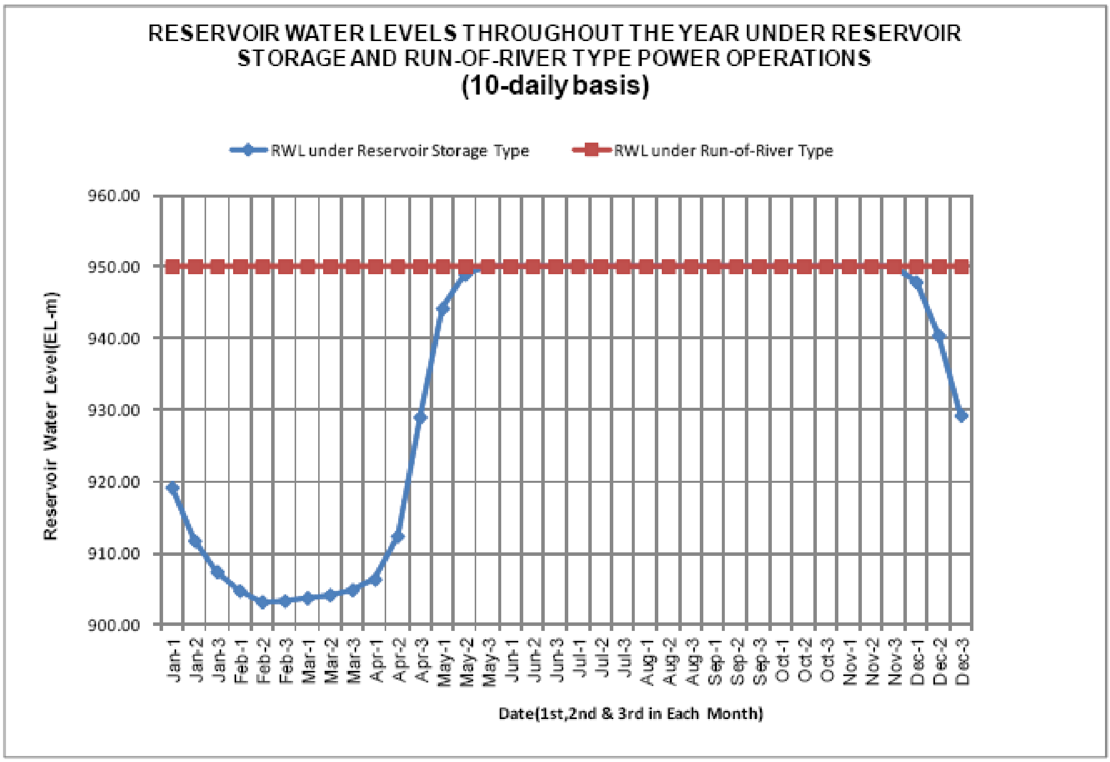


Figure 3.16: Reservoir Water Levels throughout the Year under Reservoir Storage Type and Run-of-River Type Power Generation Operations

Peaking Operation in Pre-Basha Scenario: Peaking operation is more feasible after commission of Basha dam than before commissioning of Basha dam. The required 95% dependable flow for peaking operation is 445 m^3/s[2]. During pre-Basha (Stage 1), the 95% dependable flow is 351 m^3/s, which is less than required flow 445 m^3/s and hence peaking flow is not feasible in Stage 1. While in post-Basha scenario (Stage 2), the 95% dependable flow will be 661 m^3/s, which is higher than required flow for peaking operation and hence peaking operation is feasible in post-Basha. The power generation in pre-Basha scenario is about 1,000 GWh is higher for ROR operation than peaking operation[3]. Hence the design team recommended that the ROR type operation should be adopted for the Dasu project under “Pre-Basha” in view of increasing of financial viability for the power generation instead of peaking power generation operation.

3.4.4 Sediment Flushing

About 200 million tons of sediment passes every year at the dam site. Hence there will be reduction of reservoir storage over the years due to sedimentation and it is expected that the inlets for LLO and power intake will be filled within 20 to 25 years if there is no flushing of sediments.

The reservoir periodically will be flushed to remove accumulated sediment. The frequency of flushing is yet to be finalized. However, the current plans are to flush the

[2] Assuming that the total turbine discharge at 12 units is 2,670 m^3/s(=12 units x 222.5m^3/s) and the peaking operation hours are 4 hrs, the minimum inflow discharge is calculated as 445m^3/s(=2,670x4/24).

[3] Annual Energy Generation for ROR and Peaking Types in Pre-Basha (Source: Design Report of DHP)

Reservoir operation methods	Annual energy (GWh)	Firm energy (GWh)	Secondary energy (GWh)	Peak energy (GWh)	95% dependable (MW)
ROR type	18,432	17,903	529	2,659	1,821
Peaking type	17,531	16,895	636	4,367	2,991
Difference to ROR type	901	1,008	107	-1,708	-1,170
	4.88%	5.63%	-20.22%	-64.23%	-64.25%

reservoir once per year (after 15 years of operation if Basha is not constructed by that time or after 40 years if Basha is constructed within 15 years) for one month from 21st May to 20th June. Tentative lowering and rising program of the reservoir to undertake drawdown flushing under free flow condition is shown in Figure 3.17 and specified below.

- Beginning date of lowering the reservoir water from FSL.950.00m: 15th of April
- End date of drawdown to RWL.842.55 m: 20th May
- Lowering rate:3m/day(120m in 40 days)
- Flushing period under free flow : 1 month from 21st of May up to 20th of June
- Beginning date of rising the reservoir water up to FSL.950.00m:21st of June
- End date recovered up to FSL.950.00m: 20th of July
- Rising rate: 4m/day (120m in 30 days)

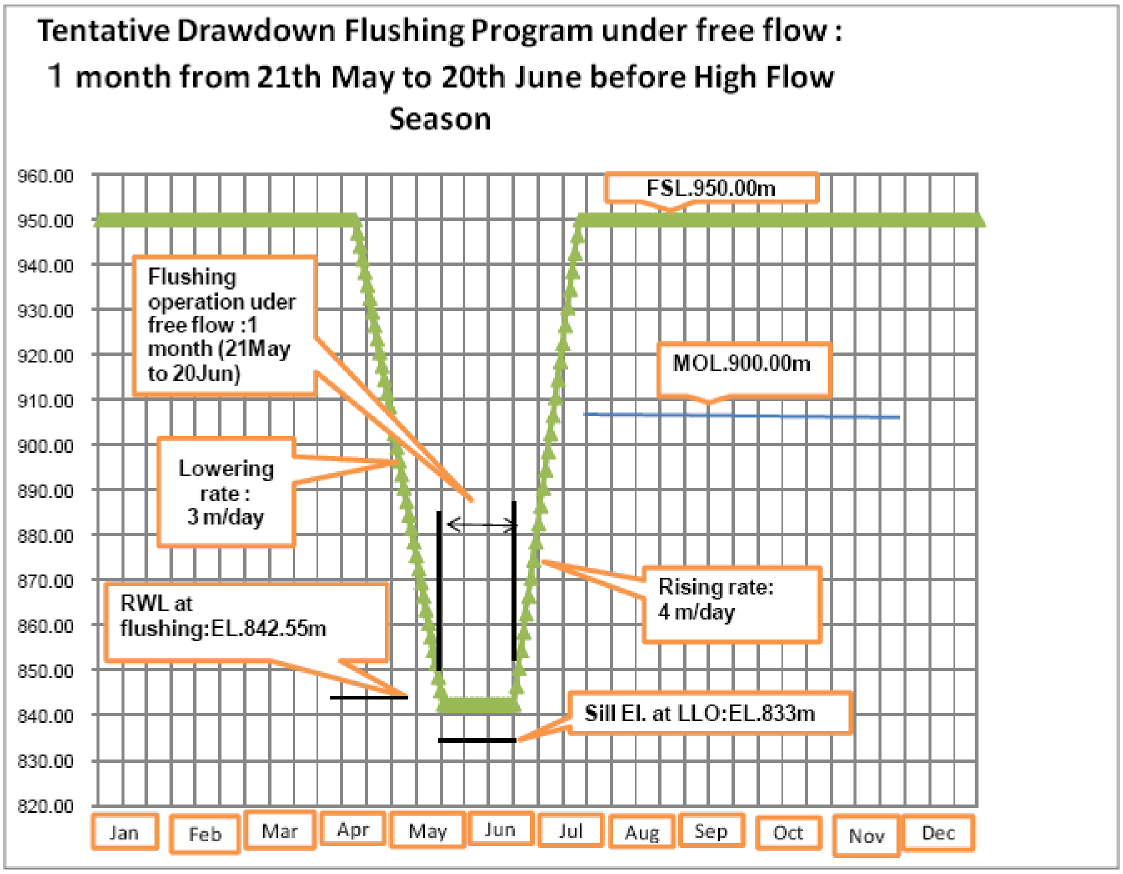


Figure 3.17: Tentative Reservoir Flushing Program

3.5 PROJECT COST ESTIMATES

The estimated cost of the project for Phase I to Phase IV is U.S. $7,658.6 million. The foreign currency component is 48.8% of the total cost, while local component will be 51.2 % in Pakistan Rupees.

The IRR for phase I of the Project is 28.8%.

The cost breakdown of Project components by phases is presented in Table 3.11.

Table 3.11: Financial Cost of Dasu HPP, Dam, Underground Powerhouse (Phase 1 to 4) and related Infrastructures – Detailed Design

Item No.		Cost Items	Cost (million)														
			Total Phase 1 to 4			Phase 1			Phase 2			Phase 3			Phase 4		
			FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
			(US$)	(PKR)	(US$)	(US$)	(PKR)	(US$)	(US$)	(PKR)	(US$)	(US$)	(PKR)	(US$)	(US$)	(PKR)	(US$)
I	**Direct Cost**																
	I.1	Dam and appurtenant structures	487.6	44,510.0	956.1	487.6	44,510.0	956.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	I.2	Underground powerhouse complex	405.1	52,898.0	961.9	160.4	22,857.0	401.0	81.7	8,552.0	171.7	86.0	13,629.0	229.5	77.0	7,860.0	159.7
	I.3	Hydraulic steel structures - dam	238.3	2,515.6	264.8	238.3	2,515.6	264.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	I.4	Hydraulic steel structures - powerhouse	81.4	858.8	90.4	28.3	298.3	31.4	18.0	190.0	20.0	17.6	185.3	19.5	17.6	185.3	19.5
	I.5	Hydro-mechanical & electrical equipment	850.8	8,660.2	941.9	237.6	2,508.0	264.0	205.2	2,059.1	226.9	227.6	2,283.8	251.7	180.3	1,809.3	199.4
	I.6	500kV Transmission line	303.6	19,228.0	506.0	176.4	11,172.0	294.0				127.2	8,056.0	212.0			
	Sub total, I.1 to I.6		2,366.8	128,670.6	3,721.2	1,328.6	83,860.9	2,211.3	304.9	10,801.1	418.6	458.4	24,154.1	712.6	274.9	9,854.6	378.6
	I.7	Direct cost related the Project	0.0	27,360.0	288.0	0.0	27,360.0	288.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sub total, I.1 to I.7		**2,366.8**	**156,030.6**	**4,009.2**	**1,328.6**	**111,220.9**	**2,499.3**	**304.9**	**10,801.1**	**418.6**	**458.4**	**24,154.1**	**712.6**	**274.9**	**9,854.6**	**378.6**
II	**Social and Environment Management Cost**																
	II.1	Social Management Plan<1+	0.0	44,664.0	470.1	0.0	44,664.0	470.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	II.2	Environmental Management Plan	0.0	2,309.0	24.3		2,309.0	24.3									
	Sub total of I to II		**0.0**	**46,973.0**	**494.5**	**0.0**	**46,973.0**	**494.5**									
III	Administration Cost of Executing Agency <2		0.0	6,435.9	67.7	0.0	2,850.0	30.0	0.0	994.2	10.5	0.0	1,692.5	17.8	0.0	899.2	9.5
IV	Engineering Services Cost <3		68.5	2,433.0	94.1	26.5	1,032.0	37.4	14.0	467.0	18.9	14.0	467.0	18.9	14.0	467.0	18.9
	Sub total of I to IV		**2,435.3**	**211,872.5**	**4,665.5**	**1,355.1**	**162,075.9**	**3,061.2**	**318.9**	**12,262.3**	**448.0**	**472.4**	**26,313.5**	**749.4**	**288.9**	**11,220.8**	**407.0**
V	Physical Contingency <4		111.0	12,351.3	241.0	66.2	9,564.9	166.9	12.4	668.3	19.5	21.0	1,504.7	36.8	11.4	613.4	17.9
	Total as Base Cost of Project		**2,546.3**	**224,223.8**	**4,906.5**	**1,421.3**	**171,640.8**	**3,228.0**	**331.4**	**12,930.6**	**467.5**	**493.4**	**27,818.3**	**786.2**	**300.3**	**11,834.2**	**424.8**
VI	Price Escalation <5		480.8	148,244.8	2,041.2	117.0	56,564.1	712.4	69.8	12,532.9	201.7	159.7	47,236.4	656.9	134.3	31,911.4	470.2
	Total of I to VI		**3,027.1**	**372,468.7**	**6,947.8**	**1,538.3**	**228,204.9**	**3,940.4**	**401.2**	**25,463.5**	**669.2**	**653.0**	**75,054.7**	**1,443.1**	**434.5**	**43,745.5**	**895.0**
VII	Interest During Construction <6		710.8	0.0	710.8	459.9	0.0	459.9	56.0	0.0	56.0	120.3	0.0	120.3	74.7	0.0	74.7
VIII	Tax																
G. TOTAL			3,737.9	372,468.7	7,658.6	**1,998.2**	**228,204.9**	**4,400.3**	**457.2**	**25,463.5**	**725.2**	**773.3**	**75,054.7**	**1,563.4**	**509.2**	**43,745.5**	**969.7**

*	Price Level: October 2012
**	FC: Foreign currency portion. LC: Local currency portion
<1	Land compensation is included
<2	2.50% of total direct cost and incorporated into LC portion, but for Phase-1 the figure indicated in PC-I is taken.
<3	FC 1,592 MM, LC 5,597 MM for Phase 1 to 4
<4	6% for civil and 3% for E&M are considered against Subto0tal of I to V
<5	1.80% for FC against Sub-total of I to V 6.50% for LC against Sub-total of I to V
<6	2.50%
<8	95.0 PKR=1.0 US$

Item No.	No. of contract package	
I.1	Dasu-CW-01	Main dam and appurtenant structures
I.2	Dasu-CW-02	Underground powerhouse complex
I.3	Dasu-HS-01	Hydraulic steel structures for dam including diversion gates
I.4	Dasu-HS-02	Hydraulic steel structures for underground powerhouse complex
I.5	Dasu-EM-01	Hydro-mechanical and electrical equipment
I.6	Dasu-PCI-01, PCI-02	EMR-01, KKH-01&02, RAR-01 to 04, EWC-01, EWC-02, EWH-01, EWH-02, EWH-03 & 04 (15-package)

Source: PC1 Estimates, Dasu Hydropower Project, October 2012.

3.6 EFFECTED ENVIRONMENTAL FEATURES OF THE PROJECT

Environmental features of the reservoir and affected resources in the project area including land acquisition and resettlement are given in the Table 3.12. Details of these impacts are further described in Chapters 7 and 8. The reservoir area is shown in Figure 3.18. Satellite image of the reservoir area is shown in Annex 3.1. Detailed satellite maps of 1:5,000 scale are available as a part of detailed design documentation.

Table 3.12: Effected Environmental Features

I	**Reservoir Features**	
1.	Length and Average Width	73 Km length and 365 m average width
2.	Reservoir Surface Area Total Flooded Area	23.85 km^2 18.14 km^2
3.	Reservoir volume	1410 MCM
4.	Reservoir Sediment Trap Capacity	60%
5.	Maximum Depth	185 m
II	**Reservoir Flow Features**	
6.	Maximum flows from tail race	222.5 m^3/s
7.	Minimum flows in low from tail race	2.670 m^3/s
8.	Average residence of time of water in reservoir	1 to 6 days in high flow season) and 19 days in low flow season
II	**Affected Terrestrial Environment**	
9.	Trees and Shrubs	21,000 numbers
10.	Grasses and herbs (grazing area)	280 ha
11.	Forests	None
12.	Wildlife habitats	None
III	**Affected Aquatic Environment**	
13.	Dry river bed during construction (between two cofferdams)	0.98 km
14.	Distance from dam axis to tailrace discharge point that will experience reduced flows during winter	4.8 km
15.	Conversion riverine system to lacustrine system	73 km
IV	**Land Acquisition and Resettlement**	
16.	Villages	34 Nos
17.	Land Acquisition (Total, excluding River)	3576 ha
18.	Agriculture Land	143 ha
19.	Grazing Area	280 ha
20.	Barren land	3,126 ha
21.	Residential area (with structures)	27 ha
22.	Affected Households	767 Nos.
23.	Total Population	6953 Nos.
24.	Affected HHs by Agricultural Land	600 Nos.
25.	Affected Sonilwals (gold extractors from sand)	13 Nos.

26.	Total Structures	923 Nos.
27.	Residential Structures	573 Nos.
28.	Commercial Structures	76 Nos.
V	**Community Structures to be submerged**	
29.	Physical Cultural Resources	A 400 year old mosque at Seer Gayal
30.	KKH	52 Km
31.	Bridges on Indus	2 bridges (Largani, Kandia,);
32.	Schools	7 Nos.
33.	Health Center (BHUs)	2 Nos.
34.	Mosques	31 Nos.
35.	Micro Hydro Power Plant	10 Nos.
36.	Police Check Post	6 Nos.
37.	Mechanical Timber Cable	4 Nos.
38.	Water Mill	2 Nos.
39.	Graveyards	17 Nos.
40.	Hotel	1 No.
VI	**Emissions and Wastes**	
41.	Spoils (Excavated Waste)	14.2 MCM
42.	Greenhouse gases from Construction	0.13 million tons
43.	Greenhouse gases from Reservoir	0.0055 million tons per year
44.	Construction Traffic on KKH	200 to 300 vehicles per day

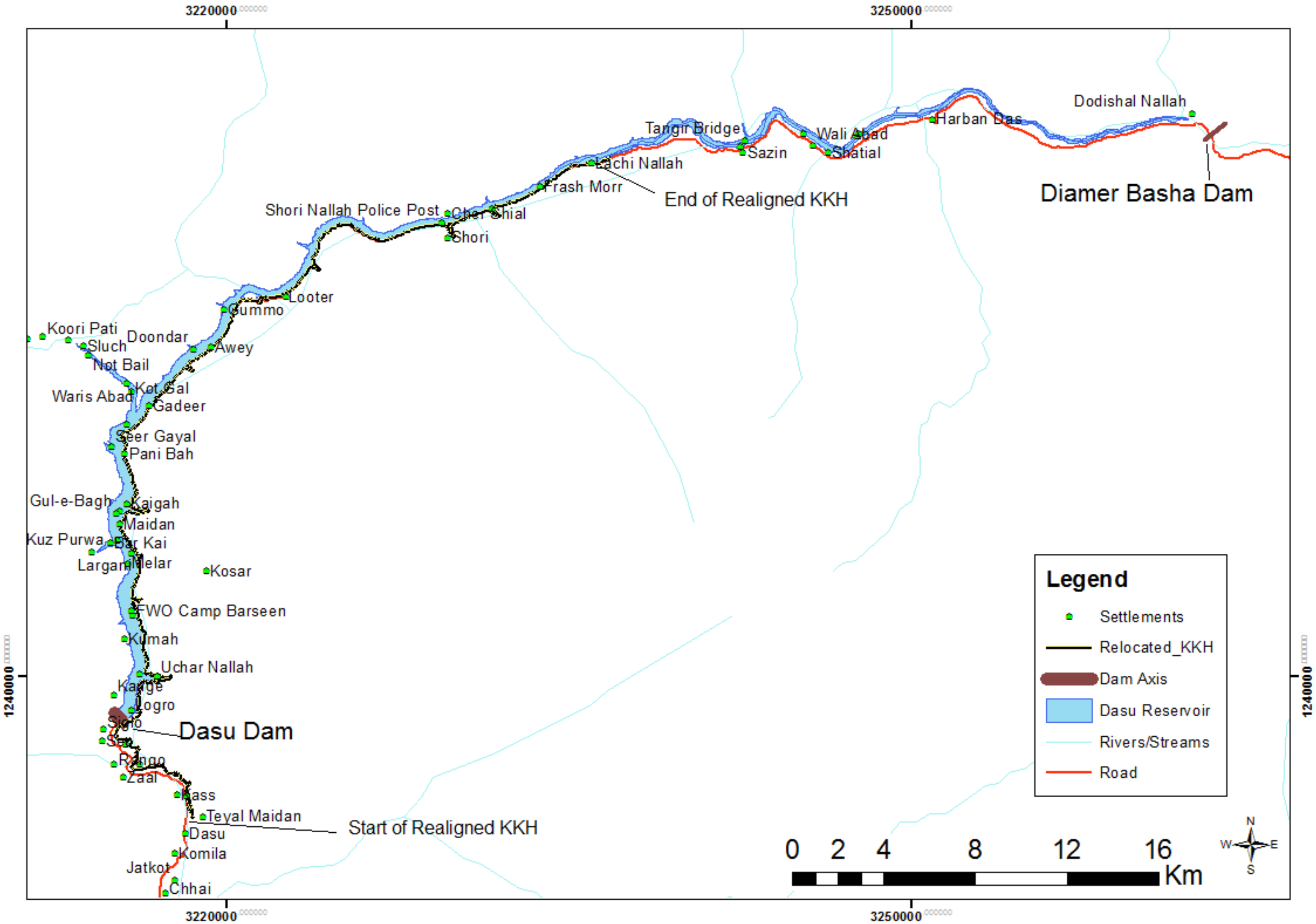


Figure 3.18: DHP Reservoir Area

Chapter 4
BASELINE DESCRIPTION

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4. BASELINE DESCRIPTION

4.1 STUDY AREA

The study area for environmental assessment is selected to cover both direct and indirect influence area of the Project. The study area is divided into two categories: permanent study area and temporary study area (Figure 4.1). The permanent study area consists of:

- Direct impact areas of the Project, which include
    - Project footprints (dam and other project facilities that will be permanently located)
    - Reservoir/inundated area (950 masl on upstream of dam up to Basha dam site)
    - Relocated villages of the affected community
    - Relocated portion of KKH along reservoir and access roads
- Both sides of the reservoir up to summits of immediate mountains (covering summit, slopes and valley) to cover the migration pattern of population and wildlife, and forests
- Indus downstream up to Tarbela

While the temporary study area consists of:

- Access roads to the construction sites including KKH from Havelian (110 km north of Islamabad) to Gini (10 km north of Chilas). The reason for selecting Havelian as the starting point of KKH is due to beyond Havelian there is no other access to KKH. The reason for selecting Gini is due to location of prospective quarry site for natural pozzolan.
- Construction yards, quarry areas, material storage sites, workers areas etc.
- Indus from Gini to Basha (due to potential of water pollution by Gini quarry).

4.2 PHYSICAL ENVIRONMENT

4.2.1 Topography

The Project area is located in the narrow Indus River valley of Hindu Kush – Karakoram - Himalayan (HKH) mountain ranges. Lower Himalayas are located on the left bank and Offshoots of Hindus Kush are located on the right bank of the river. These two mountain ranges join Karakoram Mountains near Gilgit. HKH contain twelve of the thirty highest mountain peaks in the world, with heights greater than 8,500 m. The mountain peaks show typical glacial and pre-glacial geomorphic features, characterized by steep slopes, occasionally covered by sparse vegetation. Digital elevation map of Upper Indus Basin (Tarbela catchment) is shown in Figure 4.2 and a schematic three-dimensional view of the Project area is shown in Figure 4.3.

The Indus River originates from a spring called Singikabad near Manasarovar Lake on the north side of great Himalayan Range (Kailas Parbat) in Tibet at an altitude of 5,500 masl. The river flows in north westerly to westerly direction for about 950 km up to Diamer Basha Dam site. From there on, the river flows in a deep narrow gorge and continue in westerly direction with southernly dip till it reaches Kandia. It is here the Indus River takes totally south-westerly direction and continues that way and reaches Dasu. From Dasu the river continue to take a southernly direction.

The river stretch between Basha dam and Dasu dam is a narrow gorge of limited capacity with a slope of 2.1m/km in average, which would form a reservoir without much storage. The river valley at dam axis, about 80 m wide, is generally symmetrical and deep V-shaped. The valley or abutment slopes at the both sides have an average slope of about 60 degrees at the lower part and of about 40 degrees at the upper part.

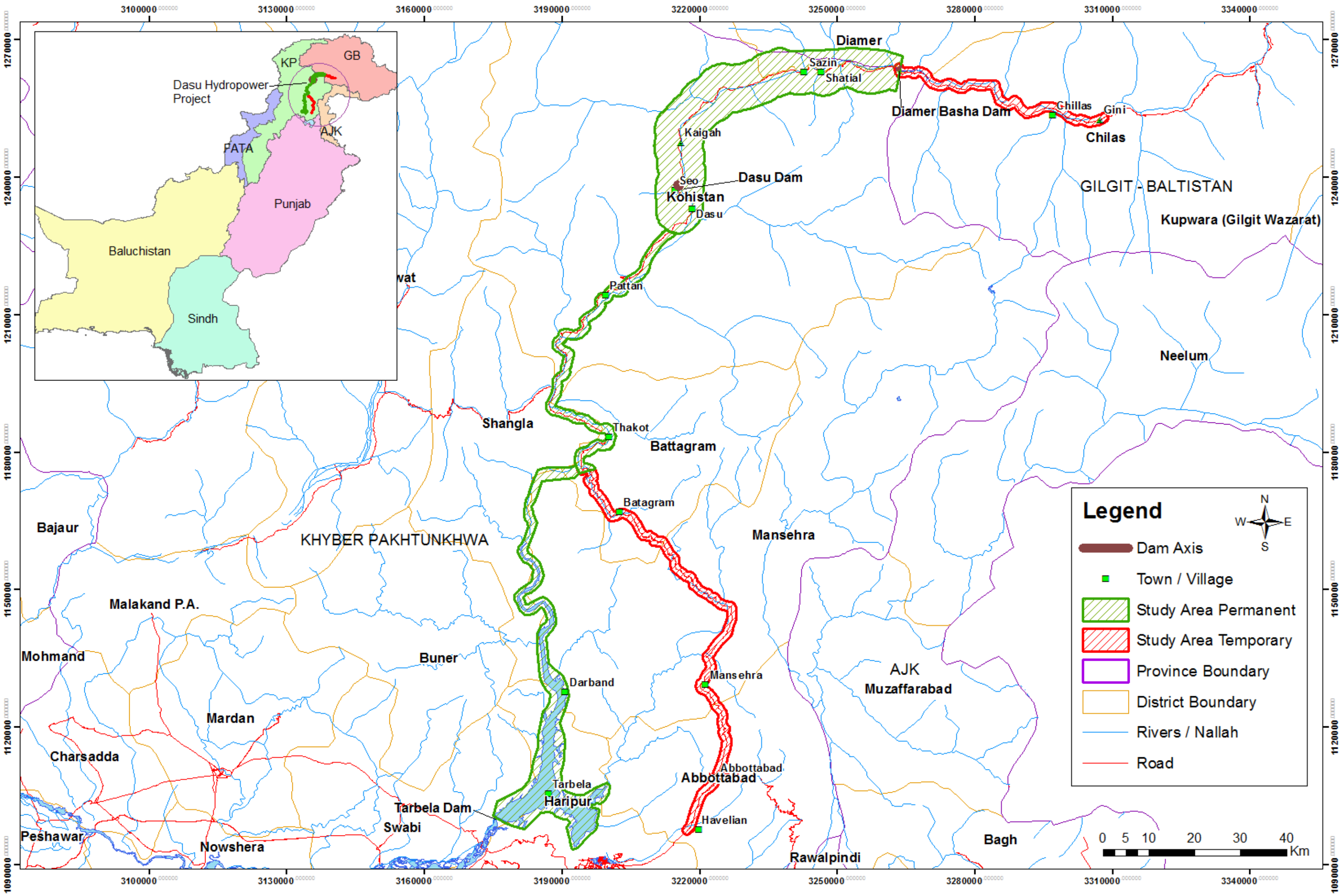


Figure 4.1: Study Area of DHP

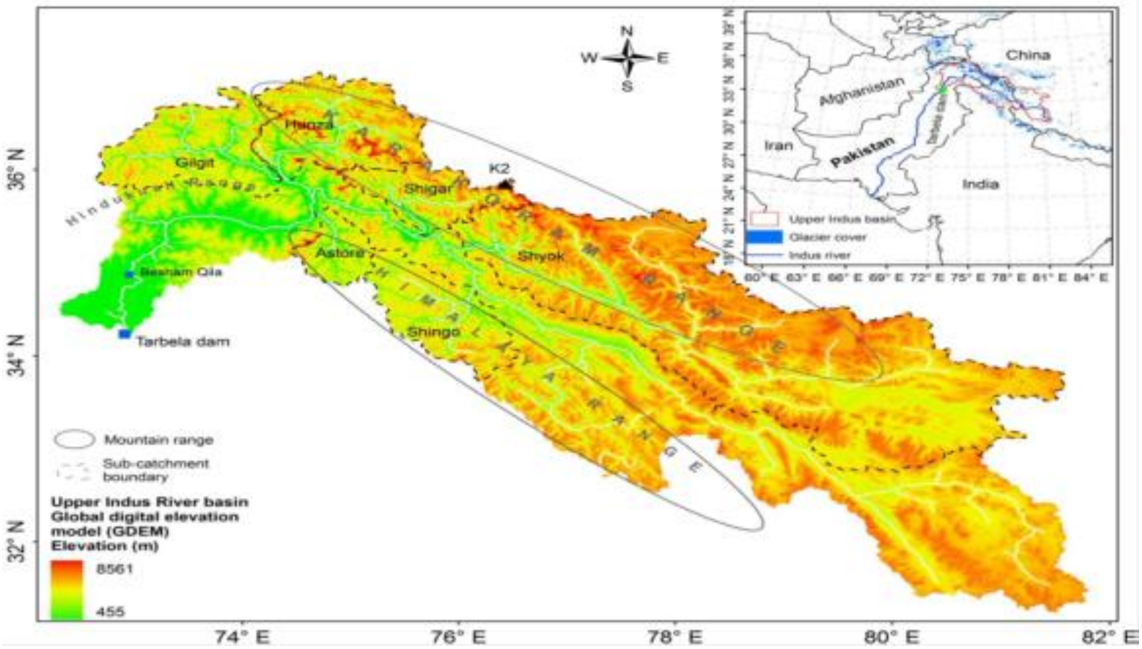


Figure 4.2: Topography of Upper Indus Basin

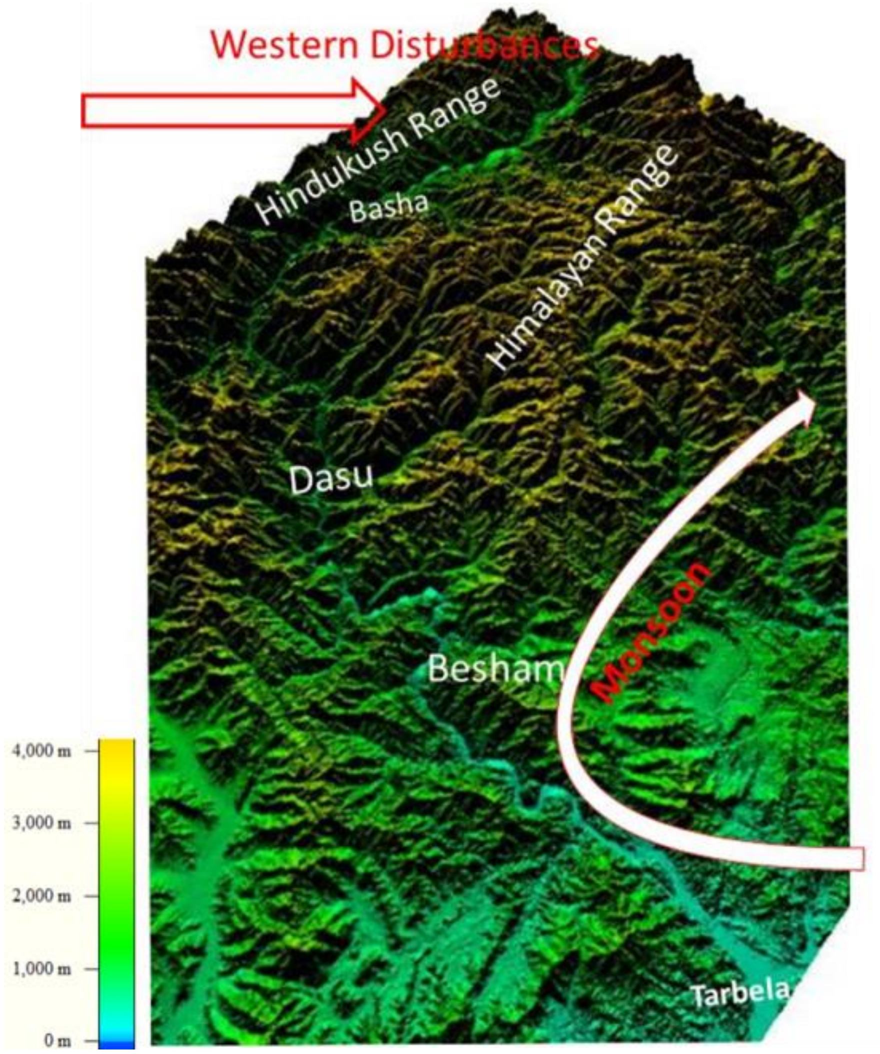


Figure 4.3: Terrain View of the Project Areas

The topography on each abutment is irregular with alternating scraps and natural benches. Table 4.1 shows the gradient of the Indus River bed every 10km in the project area. Photographs of the Project area shown below to understand the topography of the area.

River Indus at Kandia

Dasu Town

Photographs describing the topography of the Project Area

Table 4.1: River bed slopes in the project area

Sr. No.	Distance from Dam Axis	Bed Elevation (masl)	Slope in percentage
1.	0.0 km	765	-
2.	10 km	770	0.05
3.	20 km	795	0.25
4.	30 km	825	0.30
5.	40 km	860	035
6.	50 km	890	0.30
7.	60 km	920	0.30
8.	70 km	930	0.10
9.	80 km	935	0.05

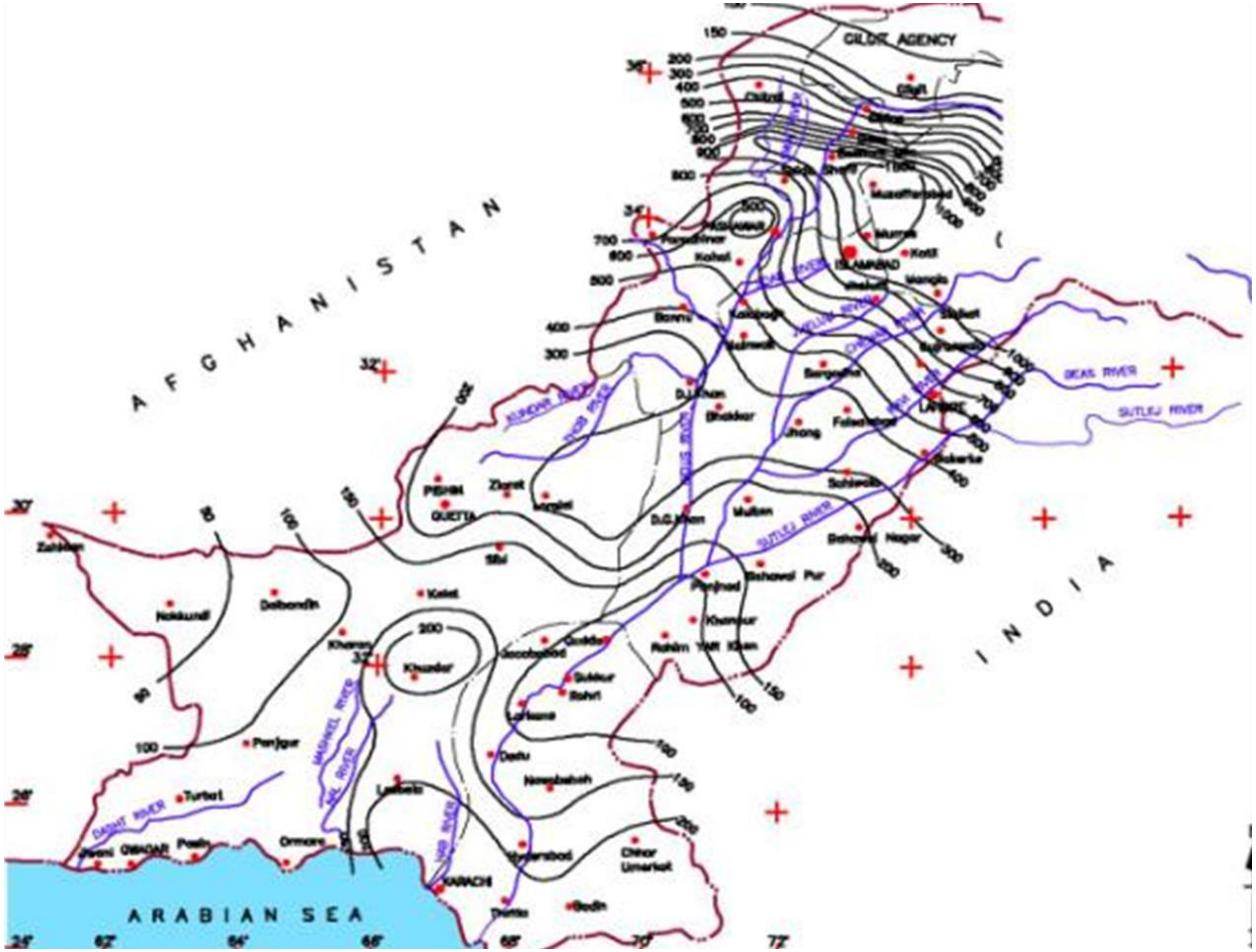
Source: Hydrology Report DHC 2012.

4.2.2 Climate

The climate of Project area is generally influenced by the presence of high mountain system which creates rain shadows in some places and high precipitation in other. The climate in the project area can be classified as dry subtropical (below 1500 masl) to temperate (above 1500 masl) climate. In Dasu, the summers are generally hot with temperatures over 35 ^{o}C and winters are cold with temperatures up to 5 ^{o}C. The annual normal isohyetal map of Pakistan is shown in Figure 4.4. Himalayas act as barrier to the monsoon movement and hence most part of the study area above Besham is located in monsoon shadow (Figure 4.3). The average annual rainfall in the monsoon shadow area is generally less than 300mm and in the monsoon influence area the rainfall is more than 1000mm. Annual rainfall at major gauging stations (at the bottom of valleys) along with their elevations is given in the Table 4.2. Precipitation in the northern part of the project mainly occurs through westerly winds originating from Mediterranean Sea.

Table 4.2: Annual Rainfall in UIB

Station	Elevation, masl	Annual rainfall mm
Besham Qila	480	1,100
Kandia	840	332
Chilas	1,251	170
Partab, Bunji	1,372	150



(ISOHYETS IN MILLIMETERS)
Source: Pakistan Meteorological Department National Flood Forecasting Bureau, Lahore.

Figure 4.4: Annual Isohyetal Map

Within the gorges of the upper part of the Project area, the climate varies between lowlands and valleys and mountains. The valleys are dry with annual precipitation of around 200mm, but totals can go up as high as 600 mm at elevations above 4000 masl. Glacial studies above 5000 masl suggest precipitation in the order of 2000 mm annually in the form of snow (Kreutzmann, 2000).

The nearest meteorological station at dam site is located at Kandia (14 km upstream of dam site established in 2005). The station measures precipitation, maximum and minimum air temperatures, maximum and minimum water temperatures, wind movement, and maximum/minimum pan evaporation. Average monthly climatic data at Kandia station is given in Table 4.3.

Table 4.3: Climate Data at Kandia Site (2006 to 2009)

Date	Rain-fall, mm (2006-2010)	Temperature C^o				Relative Humidity %		Wind Velocity (km/day)		Pan Evaporation (mm)		
		Air		Water								
		Max	Min	Max	Min	Max.	Min.	Max	Min	Max	Min	Mean
January	40.33	11.5	-6	3.5	2.7	81.2	9.9	82.1	67.7	61.5	10.9	34.2
February	62.03	15.1	-3.9	3.8	3.3	78	39.2	95.6	5.3	61.5	22.1	37.4
March	29.08	20.3	7.8	8.5	8	79.2	66.5	107.3	65.1	397	110.2	215.1
April	40.19	26.7	12	6.3	6.3	83.9	58.3	115.6	48.5	202.9	89.9	146.9
May	27.2	34.7	15.1	12.8	11.8	75.8	57.5	122.5	27.6	468.4	309.1	399.7
June	4.92	36.2	18.3	17.4	13.9	75.8	38.3	182.1	34.5	499.9	316.7	382.6
July	19.62	35.5	24.5	18.5	14.3	91.7	57.6	217.3	27.6	566.7	440.7	508
August	26.68	35.7	23.5	22.3	14.7	82.6	44.6	156.5	79.7	610.9	329.9	477.4
September	10.72	34.1	20.3	20.9	11.4	70.1	47.4	119.3	24.9	336.6	287	306.3
October	24.18	32	6.6	19.5	8.2	71.5	29.8	63.9	19.7	325.4	259.8	285.4
November	9.51	20.6	1.9	13	7.6	75.4	44.4	77.8	32.9	108.7	77	92.2
December	38.62	10.9	-1.8	3.5	3.5	65.5	23.8	98.8	37.2	34.3	30.7	32.3
Annual	332.7									3673	2284	2917
Maximum	62	36.17		22.3		91.68		217.3		610.8		508
Minimum	49		-6		2.7		9.9		5.3		10.9	32.3

Monthly maximum air temperature at Kandia station has been recorded as 36.17 °C in August while minimum of -6 °C in January. Temperatures from January to February in 2008 were exceptionally low. Excluding these extreme values, the average temperature might exceed 35 °C in summer and will drop to 5 °C in winter. Monthly maximum and minimum water temperature at Kandia station is 22.3°C in August and 2.7°C in January.

Monthly maximum and minimum relative humidity at Kandia station recorded is 91.68% in July and 9.9% in January.

Maximum and minimum wind speed ranges from 217.3 km/day (60.4 m/sec) in July and 5.3 km/day (1.5 m/sec) in February.

Maximum pan evaporation at Kandia station has been recorded as 610 mm in the month of August while minimum of 10.9 mm in January and mean annual of 2,917 mm with maximum of 508 mm in July and minimum of 32.3 mm in December.

Wind speed and directions were measured (24 hours) at the project sites during July 2012 and presented as wind roses in Figure 4.5. Wind direction at Seo was from north to north/east and speed was 0 m/sec to 3 m/sec with an average value 1 m/sec. At dam axis wind direction was from south to west and wind speed was 3 m/sec to 6 m/sec with an average value 4 m/sec. Wind direction at Gini was from south/west and wind speed was 0 m/sec to 3 m/sec with an average value 1 m/sec and at Besham the direction of wind was from west to south/west and wind speed was 0 m/sec to 5 m/sec with an average value 2 m/sec. Wind speed and directions were also measured during December 2012 and results of these measurements are presented in Volume 6: Environmental Quality.

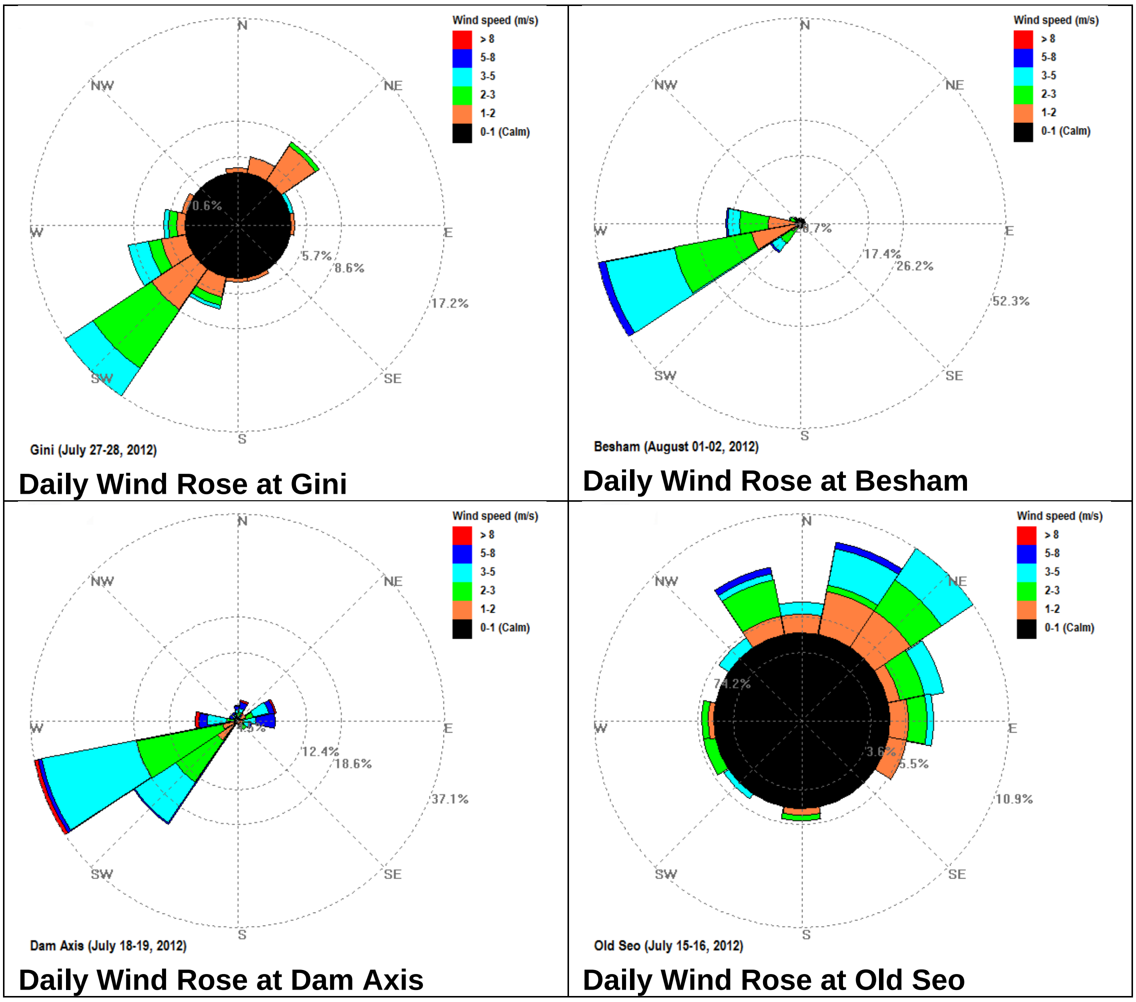


Figure 4.5: Daily Wind Roses at Project Area

4.2.3 Geology

Geologically, the northern Pakistan region is divided into three blocks: Karakoram Block, Kohistan Island Arc and Indian plate from north to south. The project area is located in the southern part of the Kohistan Island Arc bounded by the Main Karakoram Thrust (MKT) in the north and west (Northern Suture) and by the Main Mantle Thrust (MMT) to the south and east (Southern Suture) as shown in Figure 4.6.

The project area is underlain mainly by two types of rocks, granulite distributed in the upper reach (in the dam area) and amphibolite in the lower reach, with a contact zone having 300m wide. This contact is called Koshe contact and during the feasibility study it was assessed as a fault zone, however during drillings carried out in detailed design stage it was found to be a just contact. The stratigraphic/lithological sequence of the rocks exposed in the project area is shown in Figure 4.7 and summarized in Table 4.4.

The rock formations are in principle suitable for high dam and large surface and underground excavations provided proper attention is given to joint systems, and local faults and weak areas.

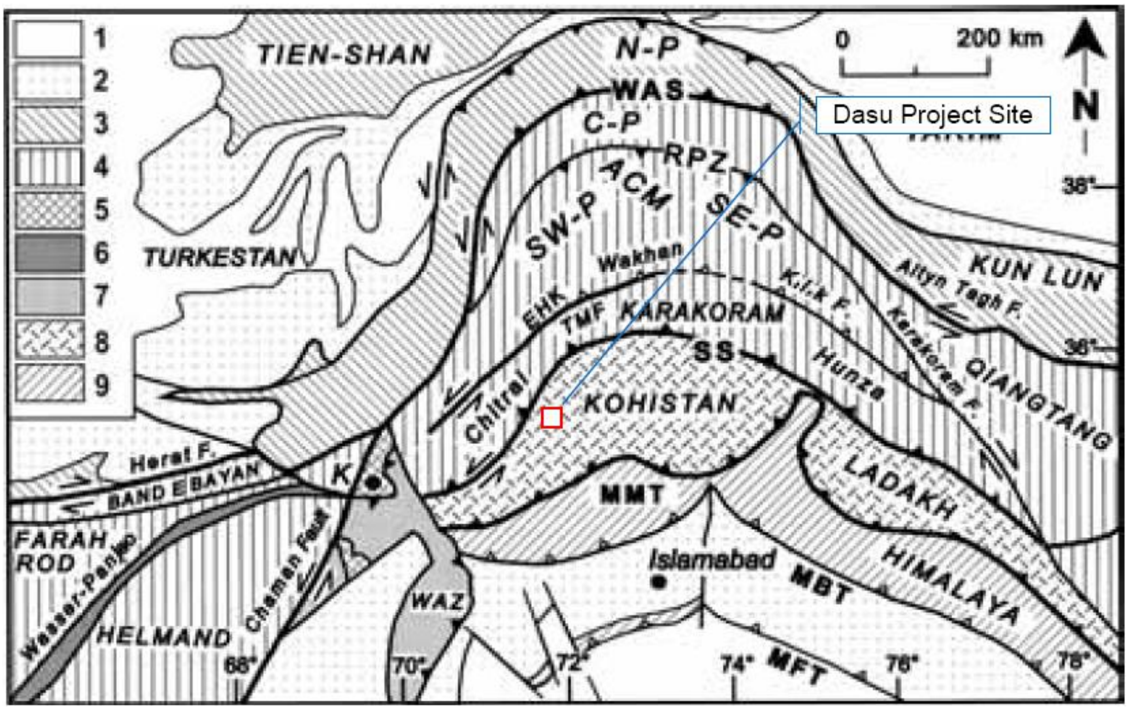


Figure 4.6: Geological and Tectonic Sketch Maps of Northern Pakistan and Surrounding Regions (after Zanchi et al., 2000)

Note:

MFT: Main Frontal Thrust, MBT: Main Boundary Thrust, MMT: Main Mantle Thrust, SS: Shyok Suture, TMF: Tirich Mir Fault Zone, EHK: East Hindu Kush, ACM: Alitchur mountains, RPZ: Rushan-Pshart Zone; WAS: Wanch-Akbaital Suture, N-P: North Pamir, C-P: Central Pamir, SE-P: SE Pamir, SW-P: SW Pamir, WAZ: Waziristan, K: Kabul.

1: Quaternary, 2: Tertiary foredeeps, 3: Paleozoic belts, 4: Terranes of Gondwanan affinity, 5: Kabul Block, 6: Wasser-Panjao Suture, 7: Waziristan ophiolitic complex, 8: Kohistan-Ladakh arc terranes, 9: Himalayas.

Block lines represent main sutures.

Table 4.4: Stratigraphic/Lithological Sequence of the Project Area

Age	Geological Group/Fault	Symbol and Lithological Features	
Quaternary	Colluvium Deposits	Cs	Scree/talus deposits
		Cl	Landslide and rock fall materials
	Alluvium Deposits	Af	Fan alluvium, recent channel and river deposits
		At	Terrace deposits (Khoshe, Seo, etc.)
	Glacial Deposits	Gf	Glacio-fluvial deposits
		Gm	Moraine deposits
Tertiary (?)	Khoshe Contact	-	Mylonized amphibolite (Khoshe Fault)
Cretaceous	Kohistan amphibolite sequence	G	Granulite
		Hn	Hornblendite
		Amp	Amphibolite
		Dt	Diorite
		N	Norite/Gabbronorite

Source: Basic Design Report, DHC, 2012.

(1) Surficial Deposits

Quaternary surficial deposits occur as unconsolidated moraine deposits at high elevation locations, glacio-fluvial deposits, terrace deposits, talus cone/scree and landslide materials throughout most parts of the project area. Thickness and characters of the deposits are highly variable, depending on the location and origin.

(2) Khoshe Contact

The Khoshe contact was defined to be inactive fault with a deformation zone of about 300 m in width. The fault strikes east-west and dips 70 degrees towards north. At most outcrops of the fault zone, the bedrocks were brecciated. However, below the brecciated rocks the rocks were observed to be mylonized garnet amphibolite through petrographic analysis, and become medium weak to strong rock at depth. At the outcrops of the left bank within the Khoshe fault the mylonized garnet amphibolites are highly to intensely jointed or fractured, and moderately foliated, but these joints, generally non-persistent, are very tight and in part are healed. Geological investigations at the detailed design stage, together with review of the feasibility study (FS) have revealed that the Khoshe fault inferred at the FS is a normal contact of rock types or an inactive fault with limited displacement. The contact has a deformation zone of about 300 m in width.

(3) Granulite

In the project area the granulites are exposed on the both sides of the Indus River around the proposed dam site and in the lower half of the reservoir area.

The granulites, homogeneous and massive crystalline, are generally light grey to dark grey, medium-grained, very strong and generally less foliated in outcrop and core observation. The rock mass is moderately to widely jointed or fractured, locally massive, and slightly weathered in outcrop, with a weathering depth of few meters around the left bank and 10 meters around the right bank. The rock mass is in general slightly weathered to fresh below this top weathered zone.

(4) Amphibolite

The amphibolite is distributed in the downstream of the dam site below the Khoshe terrace. The rocks are light to medium grey with dark grey banding, coarsely crystalline, strong to very strong, moderately foliated, and fresh to slightly weathered in outcrops with a weathering depth of a few meters.

In addition, hornblendite is locally exposed within the amphibolite. The hornblendite is generally dark grey, coarsely crystalline, medium strong and less weathered. In general, the hornblendite is more massive and blocky than the amphibolite.

The geological map of the project area is given in Figure 4.7.

4.2.3.1 Site Specific Geology at Project Components

Damsite: The bedrock at the damsite is composed of mainly granulite and covered with about 50 m of recent river deposits on the riverbed, and 5 to 10 m of scree deposits on gentle slopes on the right and left abutments. Three sets of joints were identified around the damsite. They are 1) moderate to high dipping joint set, almost parallel to the river course, 2) relatively high dipping joint set, almost parallel to the dam axis, and 3) relatively low dipping joint set, almost parallel to the dam axis.

Diversion Tunnels: The tunnels will encounter granulite and does not cross any faults. The granulite bedrocks along the tunnel route are typically massive to blocky, strong to very strong, slightly weathered to fresh. Shears or shear zones of 5 cm to 50 cm in width are locally encountered in the tunnel route. In addition, the inlet portal is in massive to blocky granulite while the outlet is in closely to moderately fractured granulite.

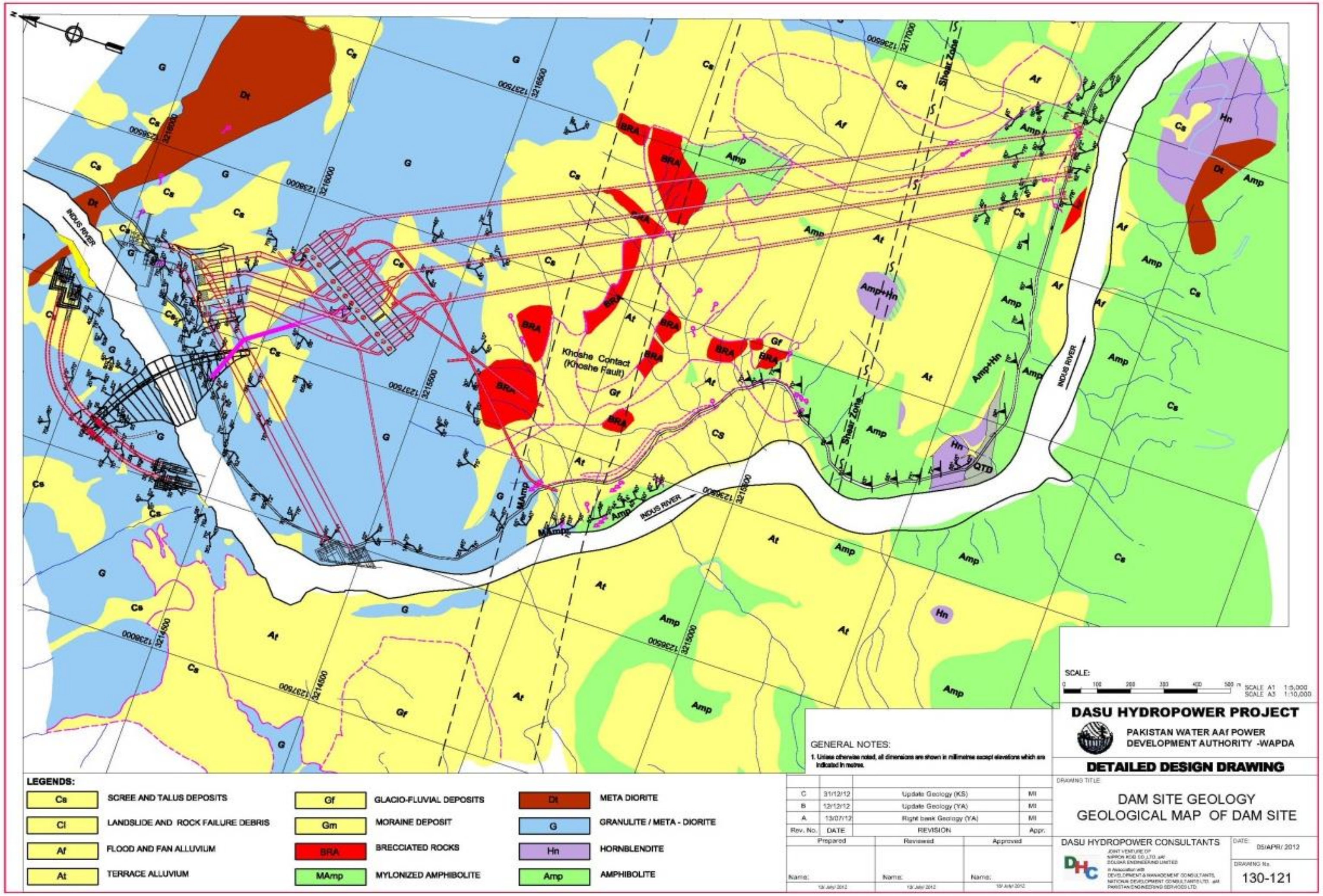


Figure 4.7: Geological Map of Project Area

Flushing Tunnels: The geology of the tunnel consists of granulite. The granulite bedrocks along the tunnel route are typically massive to blocky, strong to very strong, slightly weathered to fresh. The tunnel would perpendicularly or sub-perpendicularly cross some shear zones of 1 to 5 m in width. These shear zones are generally highly fractured to coarsely fragmented without clay-rich gouge.

Underground Powerhouse Complex: The underground powerhouse complex is located in a coarsely crystalline dioritic granulite. The granulite rocks are generally massive to blocky, slightly foliated and strong to very strong. The rocks are generally fresh and occasionally slightly weathered.

Tailrace Tunnel: Geologically, the tailrace tunnel route is underlain in part by the granulite bedrock to the north and in part by the amphibolite bedrock to the south. The contact between the two rock units is the Khoshe fault, which is a local inactive fault. The granulite rock along the tailrace tunnel route is basically the same as that observed around the powerhouse complex area. The amphibolite bedrocks at outcrops are typically fresh to slightly weathered, very strong, and locally highly foliated with a tabular to blocky structure.

4.2.4 Seismology

The Project area is located in in an active seismic and earth quake zone area. According to seismic zoning map of Geological Survey of Pakistan, the Project area is located Seismic Zone 3 with peak horizontal ground acceleration of 0.24 to 0.32 g. The seismicity of the northern Pakistan is shown in Figure 4.8.

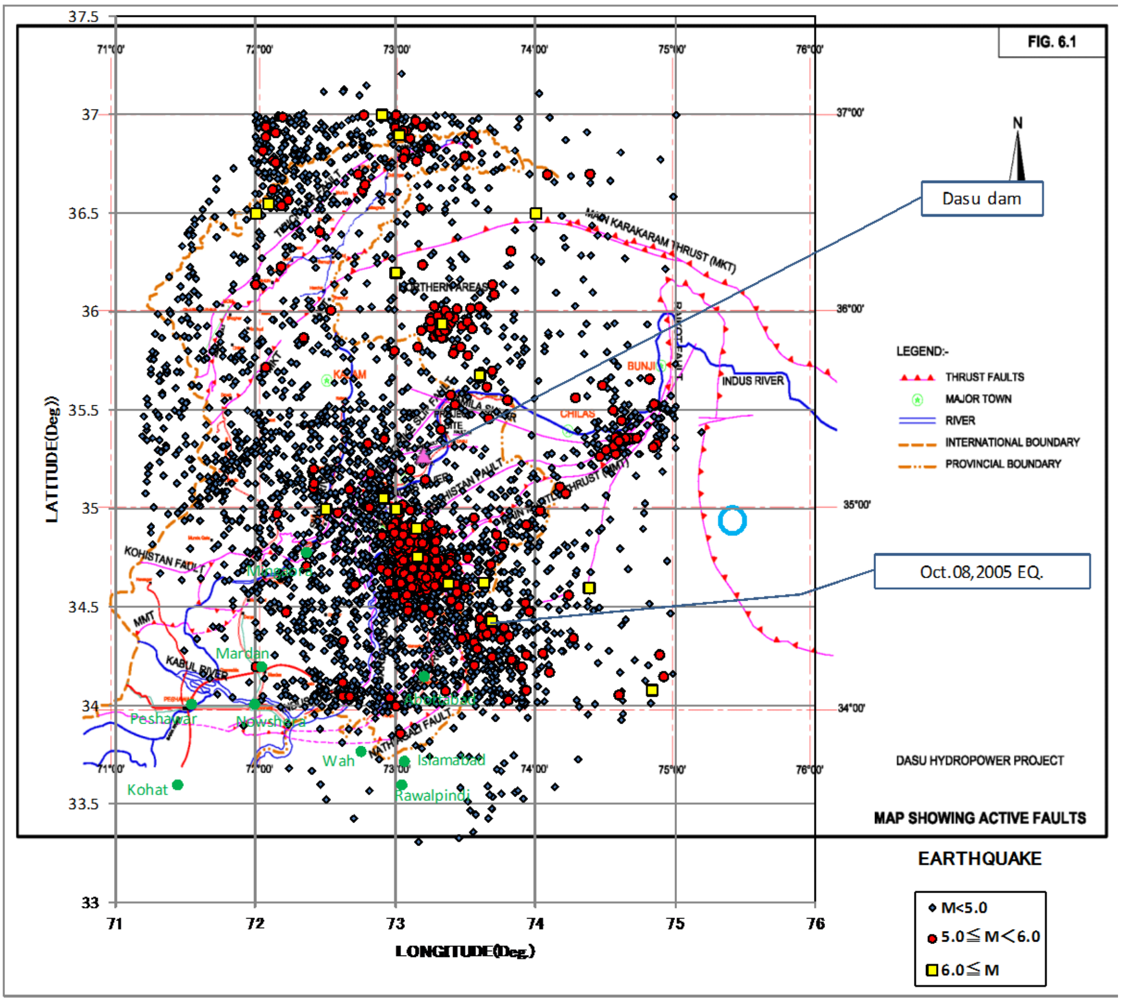


Figure 4.8: Seismicity of Project Region and Active Faults

The important tremors in northern Pakistan for which damage data is available are as follows:

- On March 25, 1869, a large earthquake occurred in the Hindu Kush region, strongly felt at Kohat, Peshawar, Lahore, and at Khodjend and Tashkent, the shaking lasting 20 seconds;
- On May 22, 1871, a damaging shock was recorded at Gilgit with many aftershocks. This earthquake was strong enough to be felt as far as Meerut and Agra in India;
- On January 20, 1902, a large earthquake caused damage in the Chitral area and was felt widely in the Punjab and up to Shimla;
- On July 8, 1909 an earthquake caused destruction in the region of Mankial and Kalam in the Swat valley where Lady Minot's Hospital was damaged and many houses collapsed, killing 10 people and cattle. Damage area extends to Dir, Karori and Alipurai and was felt in Gilgit, Besham, and to the north up to Tashkent; and
- The epicentral intensity of all these earthquakes is estimated to be not greater than VIII on the Modified Mercalli (MM) intensity scale.

For detailed design, the instrumental record of earthquakes within about 150-km-radius of the dam was obtained mainly from International Seismological Centre (ISC) England, National Earthquake Information Centre (NEIC) of the U.S. Geological Survey, Geophysical Centre, Quetta and Tarbela Seismic Observatory, WAPDA. A composite catalogue of instrumentally recorded earthquakes was prepared by combining these earthquake listings comprising 2115 events having magnitude greater than 3.0. For seismic data to be used in seismic hazard analysis, the magnitudes given in different scales were converted into a uniform magnitude-scale i.e. M_W (Moment magnitude).

The epicenters of three well-studied earthquakes of magnitude 5.9 or above have been recorded near dam site. These earthquakes are:

- Pattan earthquake (28 December 1974); magnitude (Mb) 5.9; 90 km southwest of the dam site; close to the surface expression of MMT;
- Hamran earthquake (3 September 1972); magnitude (Mb) 6.3; 55 km northwest of the dam site; within the Kohistan Island Arc; and
- Darel earthquake (12 September 1981); magnitude (Mb) 6.1; 20 km northwest of the dam site; within the Kohistan Island Arc.

Other major recent earth quakes are:

- Near Raikhot area on the western flank of the Nanga Parbat-Haramosh structure. The main shocks include earthquakes of 1st November, 2002 with magnitude (Mw) 5.5 and 20 November, 2002 with magnitude (Mw) 5.9.

- The Kashmir earthquake of magnitude M_W =7.6 struck the northern part of Pakistan on October 08, 2005, causing widespread damage and casualties in Azad Kashmir and adjoining areas of KP. The epicentre was at a distance of 90-100 km from the project. The earthquake was followed by a series of more than thousand aftershocks.

4.2.5 Geomorphology and Landslides

The project area is geomorphologically characterized by rugged terrain and high relief. The relief of the area ranges from 740 masl to 2600 masl on the left bank and some 2,800 m on the right bank . The most important topographical features in the project area are the distribution of the N-S trending ranges on both sides of the Indus River.

The project area is located in vertical or sub-vertical rocky slopes and is associated with granulite and amphibolite rocks. The rocks at outcrops is variably jointed and slightly weathered. The rock slopes would be susceptible to rock fall and block toppling along steeply inclined foliation discontinuities and occasional wedge sliding along various combination of moderately to steeply inclined Joints and shears.

The stability of rock slopes depends largely on rock mass properties, structural discontinuities, groundwater and earthquake. Specially, these structural discontinuities within the rock mass, such as fault, shear/shear zone, joint, foliations, random crack and so on, control the type and size of rock slope failures. As shown in Table 4.5, rock slope failures probably occurring in this project site can be classified into four categories according chiefly to their occurrence mechanism and the nature of structural discontinuities within the rock mass.

Table 4.5: Types of Rock Slope Failures and Their Characteristics

Type		Geological setting	Morphological setting	Controlling factor	Trigger
Fall	Rock fall	Granulite, amphibolite and other jointed rocks	Mid-and upper-slope cliffs, steep dipping slopes	Sub-vertical and vertical joist, cracks	Earthquake, rainfall, snowmelt, weathering, excavation and so on
	Block failure				
Slide	Planar slide		Flat ridge, gentle to steep dipping slopes	Fault, shear, contact, joints	
	Wedge slide		Cliffs, rock wall, steep slope with intersecting discontinuities	Shear, joint	
	Rational slide		Flat ridge, gentle slope with well-developed discontinuities	Joints	
	Complex slide			Fault, shear, joint	
Toppling failure			Cliffs, rock wall, steep high opposite-dip slope	Vertical joint, crack	

Huge moraine deposits occur on either side of Indus River with nearly vertical slopes. In the Project are these deposits occur near Kandia, Seo, Tial Medan and Gini. Moraine material is mostly silty sand with some gravel and boulders of glacier origin embedded in main deposit. These deposits are also responsible for frequent landslides during rainy season.

4.2.6 Hydrogeology

During the geological investigations, the groundwater table in the valleys was found to be deep and was also limited to deeper aquifers. Groundwater is not even noticed in some of the test borewells. Low precipitation, steep slopes, little over burden and vegetation, and low permeability of rocks are probably reasons for low groundwater. Groundwater levels at different project sites are given below.

Damsite: The groundwater depth at dam axis on the right abutment ranges between 50 m to 68 m and on the left abutment between 48 m to 68 m. Groundwater level at damsite is shown in Figure 4.9.

Diversion Tunnels: Groundwater level along the tunnel alignment is generally above the level of the tunnel invert, groundwater inflow would be expected at tunneling. However, because of generally low groundwater table, the potential for water inflow will be limited and quantity of water flow will be around 200 l/min according to the seepage measurements during excavations.

Flushing Tunnels: Groundwater level along the tunnel alignment is generally above the level of the tunnel invert. Some shear zones cross the tunnels at high angle with a spring amount of about 5 l/min at ground surface. A limited groundwater inflow would be expected at tunneling.

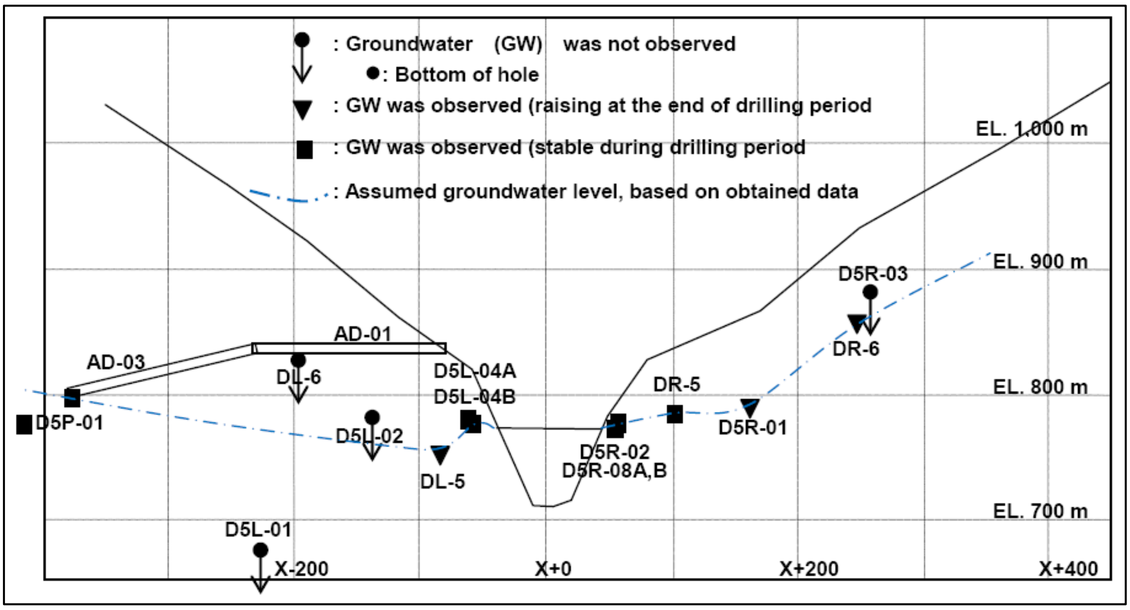


Figure 4.9: Schematic Section at Damsite showing Groundwater Condition

Power Intake and Pressure Tunnel: Groundwater level at the power shaft and pressure tunnel exists at a depth of about 260 to 280m, below the ground surface, lower that the level of proposed power intake and pressure tunnel.

Underground Power House: Groundwater level in the vicinity of the underground power house complex exists 250 to 300 m deep below the ground surface, probably above the level of proposed power house cavern. In addition, springs are observed at ground surface. Estimated inflow amount of groundwater during construction will be 30 to 200 l/min based pump discharges of trail borewells.

Tailrace Tunnels: Groundwater along tailrace ranges from 100 m above power house cavern roof within granulite bedrock to about 40m above the tail race tunnel within the amphibolite bedrock (around the portal area). Many springs are also found to be distributed along and around the waterway. Permeability of the groundwater bearing strata along the tunnel alignment found to be 1 to 10^{-7}m/s.

4.2.7 Soils

Physiologically the project area consists of mountain terraces and piedmont plains. The mountains are rugged with high relief amplitude and strong/sharp slopes. Geological erosion in these mountain areas is substantial. The rock debris is generally found at the toe of mountain. Generally accessible slopes with soil covers are terraced for arable farming. The gravelly fans/terraces are of limited extent and mostly located at the bottom of mountain slopes. These are characterized by gravelly moderately coarse to medium textured soils. In general, the infiltration rate in these soils is rapid. Water holding and nutrient holding capacity is low. These are mainly in narrow strips below the mountain slopes. The soil material is mainly loam and silty loam.

The cultivated areas have been mainly developed on alluvial fans and to the lesser extent from reclamation of old river terraces. The soils are generally low in clay contents and high in silt and sand with low organic matter. These soils are used for cultivation of wheat, maize and fodder etc. The soils are in general, poor in plant nutrient.

The soils of the lower altitude zone are shallow to moderately calcareous and in some part of the project area well drained. The soil colour varies from brown to dark brown and sandy loam in nature.

4.2.8 Hydrology

The Catchment of Indus River at Dasu covers 158,800 km^2. The catchment area of Dasu is shown in Fig 4.12. The major tributaries of Indus in Upper Indus Basin (UIB) are: Astor, Gilgit, Shyok and Shigar.

The river flows in UIB are characterized generally by two seasons: high flow season from May to September (summer) and low flow season from October to April (mostly winter). The river is fed largely by the snows and glaciers of the Himalaya, Karakorum and Hindu Kush mountains. The mountain ranges are seat of major glaciers such as Baltoro, Biafo, Hispar, Siachin and Batura. During summer, the flows are higher (1,015 m^3/s to 6,580 m^3/s) due to melting of snow, and during winter the flows are low (380 to 620 m^3/s). Total annual mean flow at Dasu dam site is 2,116 m^3/s and total annual run off is 66.7 BCM (billion cubic meters), 78 percent of annual run off comes from June to September.

Unregulated mean annual flows at different hydrological stations are presented in Table 4.6. Monthly mean flow in the project area is shown in Figure 4.11 (Diamer Basha damsite), Figure 4.12 (Dasu damsite) and Figure 4.13 (flows from sources in the intervening area between Diamer Basha and Dasu dam site).

Table 4.6: Mean Annual Flow at various Hydrological stations

Sr. No.	Name of Station	Mean Annual Flow (m^3/s)	
		Feasibility Study 2009	Updated up to 2011
1.	Indus river at Bunji	1784	1,796
2.	Indus river at Shatial Bridge	2005	2,034
3.	Indus at Diamer Basha dams site	1978	2,005
4.	Indus at Dasu dam site	2081	2,116
5.	Area between Dasu & Diamer Basha	103	111
6.	Indus river at Besham Qila	Not concluded	2,425

Source: DHP Engineering Design Report 2012.

The mean annual flow at Dasu damsite is 2116 m^3/s and the lowest 10-day mean flow is 291 m^3/s. The average lowest discharge over the winter low flow period (Feb-Mar) is 377 m^3/s.

Details of tributaries on the upstream side of the dam site (with in the reservoir area) are given in Table 4.7, and downstream of the dam are given in Table 4.8. Major tributaries in the Project area with higher annual flows are Kandia on the upstream side of the dam; and Goshali and Palas on the downstream side of the dam.

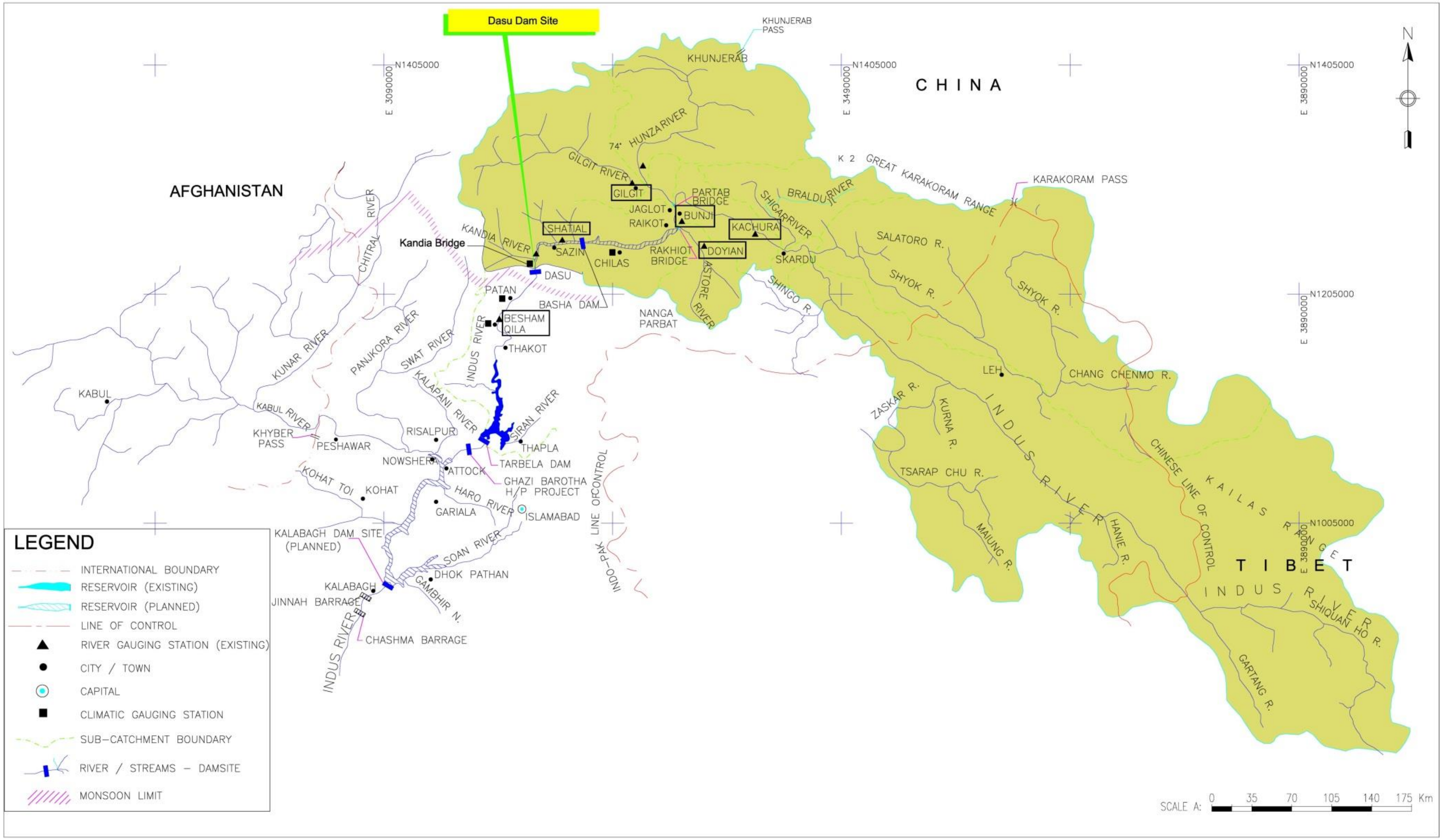


Figure 4.10: DHPCatchment Area and Location of Gauging Stations

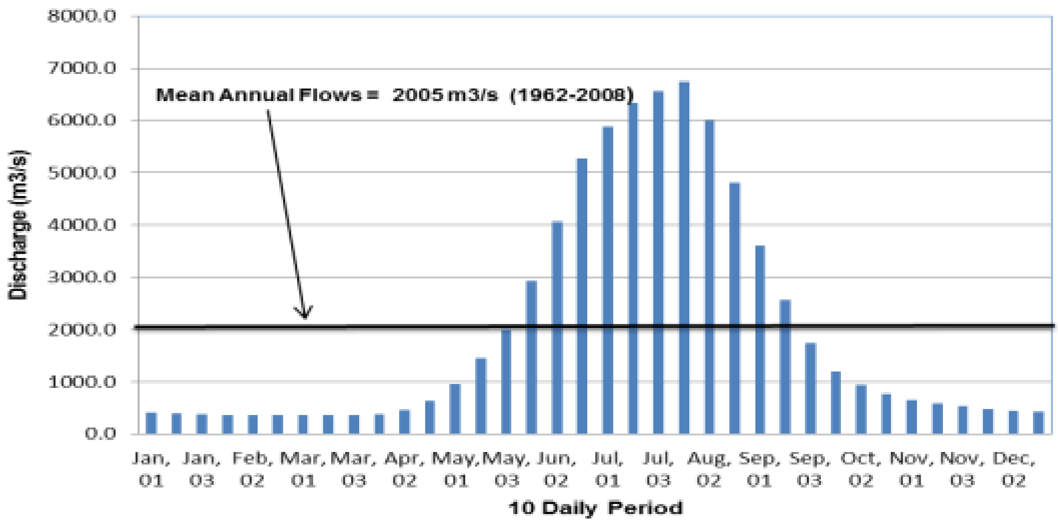


Figure 4.11: 10-daily mean and mean annual flows of Indus at Diamer Basha damsite (1962-2008)

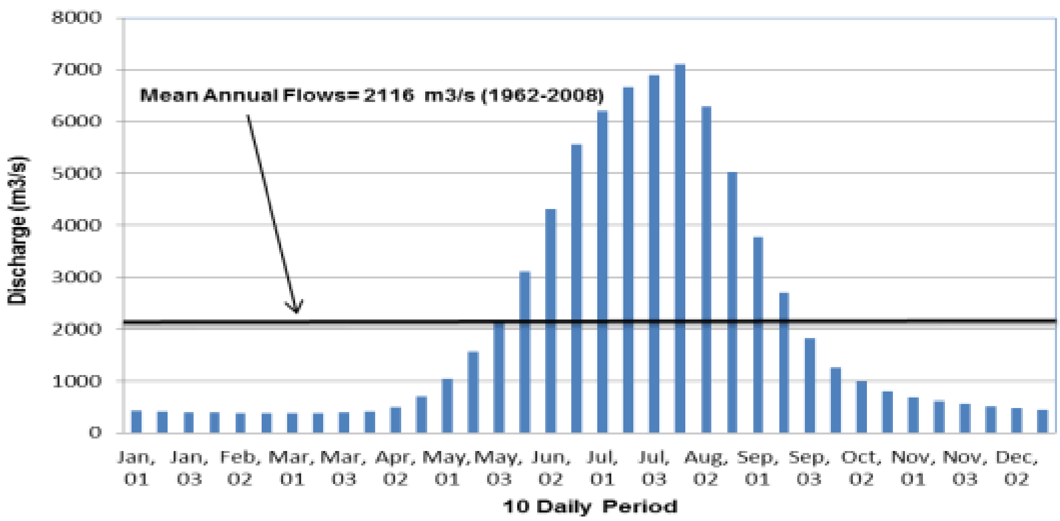


Figure 4.12: Natural unregulated 10-daily mean and mean annual flows of Indus at Dasu damsite (1962-2008)

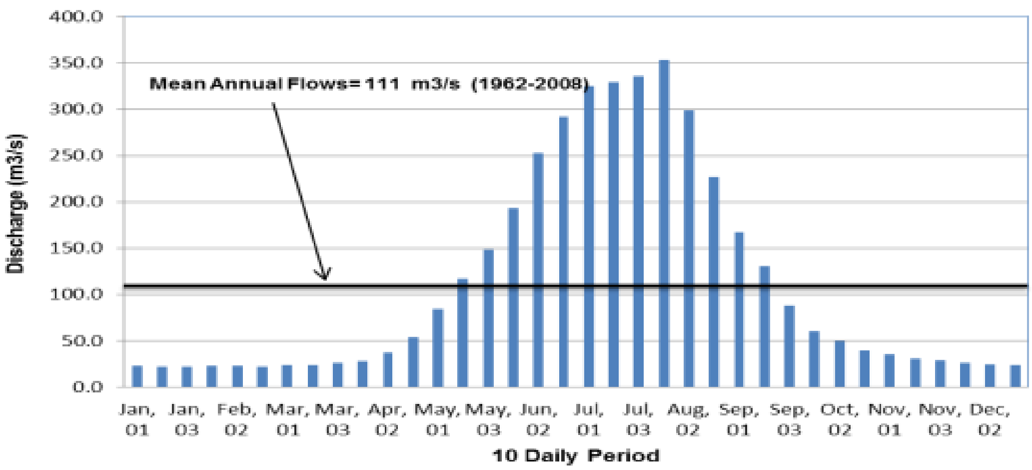


Figure 4.13: Natural unregulated 10-daily mean and mean annual flows of Indus River from intervening areas between Dasu and Basha damsite (1962-2008)

Table 4.7: Tributaries in the Study Area located On the Upstream of Dam

Sr. No.	Tributary	Catchment Area (Km^2)	Length (m)	Mean Annual Flow (m^3/s)
Left Bank Tributaries				
1.	Uchar	70.568	-	2.57
2.	Barseen	15.342	2902	0.59
3.	Kaigah	42.964	13166	1.65
4.	Lutter	09.505	8723	0.36
5.	Summar	82.627	22640	2.21
6.	Shatial	09.162	7736	0.35
Right Bank Tributaries				
7.	Duga	-	12993	-
8.	Kandia	22420.024	84334	79.92
9.	Utar Gah	28.036	10763	1.08
10.	Tangir	62.460	46798	2.39
11.	Darel	95.590	37585	2.56

Table 4.8: Tributaries in the Study Area Located on the Downstream of Dam

Sr. No.	Tributary	Catchment Area (km^2)	Length (m)	Mean Annual Flow (m^3/s)
1.	Sieglo	4559	12.419	1.73
2.	Jalkot	247.7	30.353	-
3.	Goshali	1491.5	80.993	53.17
4.	Palas	1238	75.197	44.12
5.	Keyal	15059	22.708	4.09
6.	Dubair	514	35.702	18.32

4.2.9 Floods

The floods in the upper Indus catchment area occur due to natural dam formation and then their failure. Natural dam formations are of two types. One form blocks the passage of Indus or its tributaries due to: landslide (s), while other form causes creation of lake behind the glacier and sudden and large river flow caused due to overtopping or bursting of an ice dam is known as glacial lake outburst flood (GLOF). Nearly 60 GLOF events have been reported since 1830. Such dam break floods are characterised by a very rapid flood rise. Dams created by massive landslides are rare but glacier dams are numerous. Other causes of floods are storm runoff and glacier and snowmelt. The important and well recoded flood events are described below.

a. 1841 Flood

The landslide dam burst flood of June 1841 resulted from the sudden failure of a dam in the main stem of Indus River near Raikot. The landslide occurred on left bank of Indus River at Lichar Gah below Bunji and close to the head of the proposed periphery of the Diamer Basha reservoir. The Indus Valley is about 75m wide at this location and a landslide dam of some 200m high totally blocked the river for six to seven months. There was another landslide, a few km upstream of the previous landslide after about seven months, but on the right side of Indus River. The landslide dam therefore failed due to high velocity wave and over topping in such a way that it drained the entire contents of the lake within 24 hours. The volume of the lake behind the landslide dam was estimated as 4.6 BCM. This brought lot of sediments into reaches downstream.

b. 1858 Flood

The flood of August 1858 is the flood event that resulted from the failure of a landslide dam above Baltit in Hunza Valley. This landslide dam blocked the Hunza River for some seven months before it suddenly failed. This dam break produced a flood wave with a peak of 17,000 m^3/s and an estimated volume of 1.85 BCM and brought lot of sediments downstream.

c. 1929 Flood

In August 1929 there was a GLOF in Shyok River, a tributary of Indus River. This had a peak discharge of 23,710 m^3 /s including a base flow of 5350 m^3 /s and a 2 – day volume of 2.3 BCM as constituted for the site of Partab Bridge and was assumed to occur at Diamer Basha Dam Site and has been termed as Basic Design Flood (BDF).

d. 1974 Flood

In 1974 Hunza River was obstructed by a huge landslide which blocked the river and resulted in creation of lake about 8 km x 10 km behind the blockage. The bursting of this lake left significant sediments on the valley floor and caused severe erosion of the downstream valley.

e. Recent Flood of 2010

In 2010 there was a huge landslide in the Hunza Valley, which blocked Hunza River and eroded away a considerable length of Karakoram Highway near Ata – Abad and also created a lake which is still existing and causing great hurdles and problems for the locals and is affecting trade with China. On 27 February 2012 the artificial blockage was blasted to release 50,000 ft^3 /s (about 1416 m^3 /s) to lower down the lake water level and ease the situation to some extent. This has resulted in to rise of about 2.44 meter (8 feet) at gauge –II near the proposed Dasu Damsite on 29 February 2012.

4.2.10 Sedimentation

Indus carries lot of sediments and sediment flow at the Dasu damsite is estimated to be about 200 million tons per annum. The river derives sediments from vast alluvial fields and moraine deposits formed along its banks. The poor vegetative cover on riverside slopes, steep slopes, easily erodes able soils and rocks, glacial erosion, landslides and weathering of rock (due to extreme changes in day and night temperature) are also mainly responsible for high yield of sediments in river flow. Tributaries also bring high sediment inflows to the river.

There is a strong correlation between high flows and sediment concentrations in Indus. About 78.6 percent of annual runoff occurs in June to September, and 97 percent of sediment flow also occurs in June to September. The graph in Fig 4.16 shows the average monthly inflow discharge and monthly sediment inflow. Annual sediment inflow from to Dasu damsite after construction of Basha Project is estimated to be 45.6 million tons.

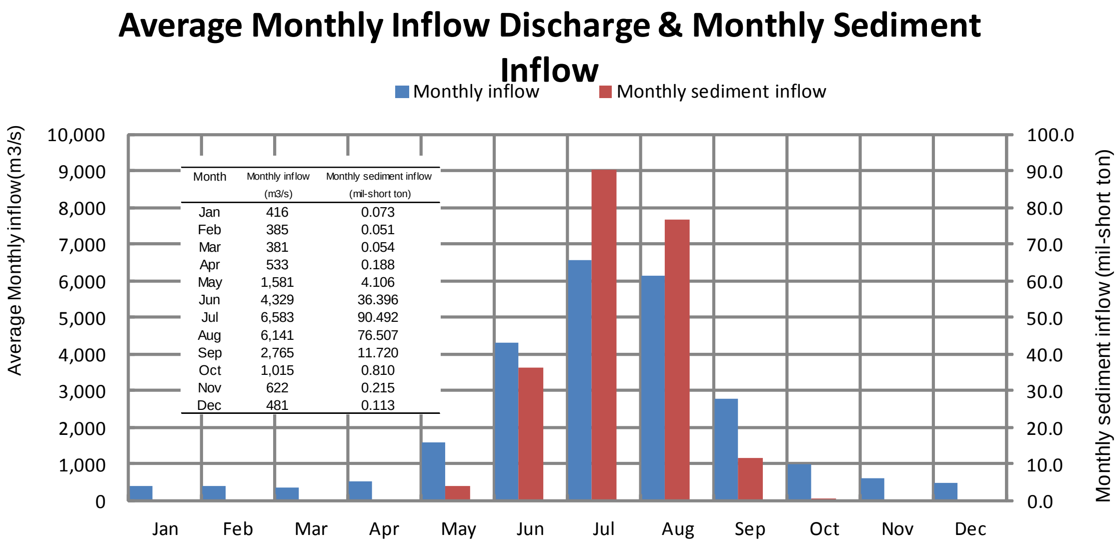


Figure 4.14: Sediment Load at Dasu Damsite

Particle size distribution of sediment entering Dasu reservoir is given in Table 4.9.

Table 4.9: Particle Size Distribution of Sediment

Sediment class (with diameter, d)	1,400m^3/s	2,800m^3/s	4,200m^3/s	5,600m^3/s	11,200m^3/s
Sand (0.062mm≤d<2mm)	28.8%	44.68%	48.82%	51.33%	44.23%
Silt (0.004mm≤d<0.062mm)	63.15%	43.84%	45.93%	42.08%	48.40%
Clay (d<0.004mm)	8.05%	11.48%	5.25%	6.59%	7.37%

4.3 QUALITY OF ENVIRONMENT

Water, air and noise quality monitoring was taken up in the entire project area during high flow (summer months of June and July) of 2012 and low flow (winter months of December and January) of 2012 and 2013. The sampling and analysis was carried out by Space and Upper Atmosphere Research Commission (SUPARCO) of GOP. 'EMAP Volume 6: Baseline Environmental Quality' provides complete results of this study, while a summary of these results are presented in this section. 20 sampling sites for water quality and 18 sampling sites for air and noise quality were selected to cover all the project areas and the areas that can be potentially affected by the Project. Meteorological conditions viz. ambient air temperature, pressure, relative humidity, wind speed and wind direction were also monitored along with ambient air quality monitoring at the same sites. Locations of the sampling sites for water are shown in Figure 4.15 and locations for air and noise are shown in Figure 4.16.

4.3.1 Water Quality

Water Quality sampling of Indus and its tributaries in the project area is conducted during high flow season (July/Aug 2012) and low flow season (Nov/ Dec 2012). Fifteen (15) sites were tested during high flow season, while 5 more sites were added to low flow season to increase the sampling sites. Water sampling sites in Indus are located between Gini and Tarbela. Water quality sampling sites are also located in the tributaries of both upstream and downstream areas of damsite.

Summary of water quality results are given in Table 4.10 and detailed results are given in Annex 4.1 (including the results of water quality carried out in 2007 and 2008 during feasibility study). Water quality in general is in compliance with the NEQS drinking water standards except turbidity. Water quality is also compared with National Surface Water Classification criteria proposed by WWF (2007).

Water quality of Indus and its tributaries are characterized by:

- Changes in physic-chemical conditions in high flow and low flow seasons
- high water temperatures in high flow season (15 to 21 ^{o}C) and low temperatures in low flow season (6 to 15 ^{o}C);
- alkaline with pH above 7;
- high dissolved oxygen (above 6.5 mg/l and Figure 4.17);
- High turbidity up to 70 NTU in high flow season; and up to 32 NTU in low flow season;
- low total dissolved solids (less than 150 mg/l) and low conductivity (325 µS/cm);
- nitrate concentrations vary from 0.6 to 3.5 mg/l; and
- nickel concentration is slightly exceeding the national drinking water standards

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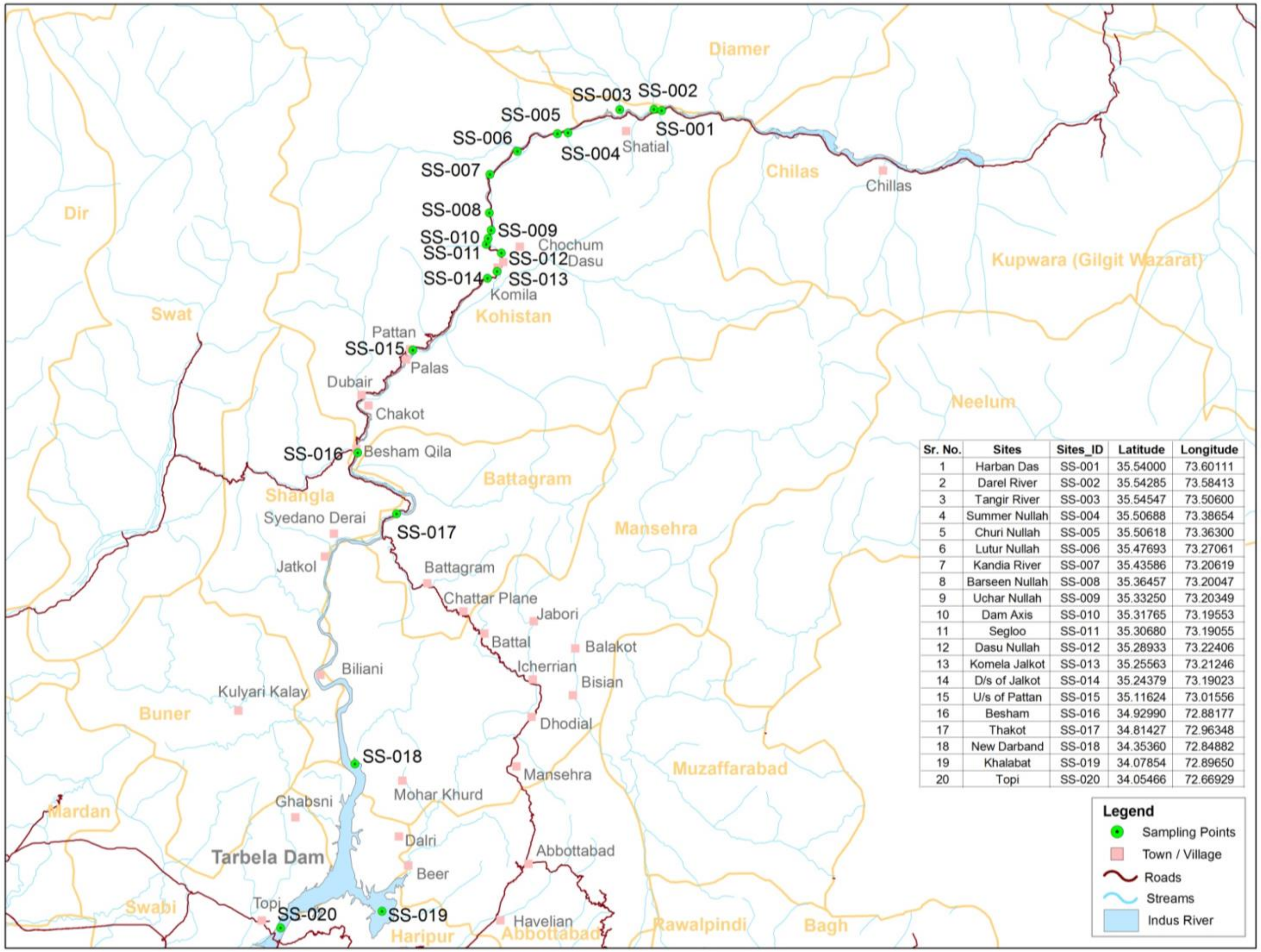
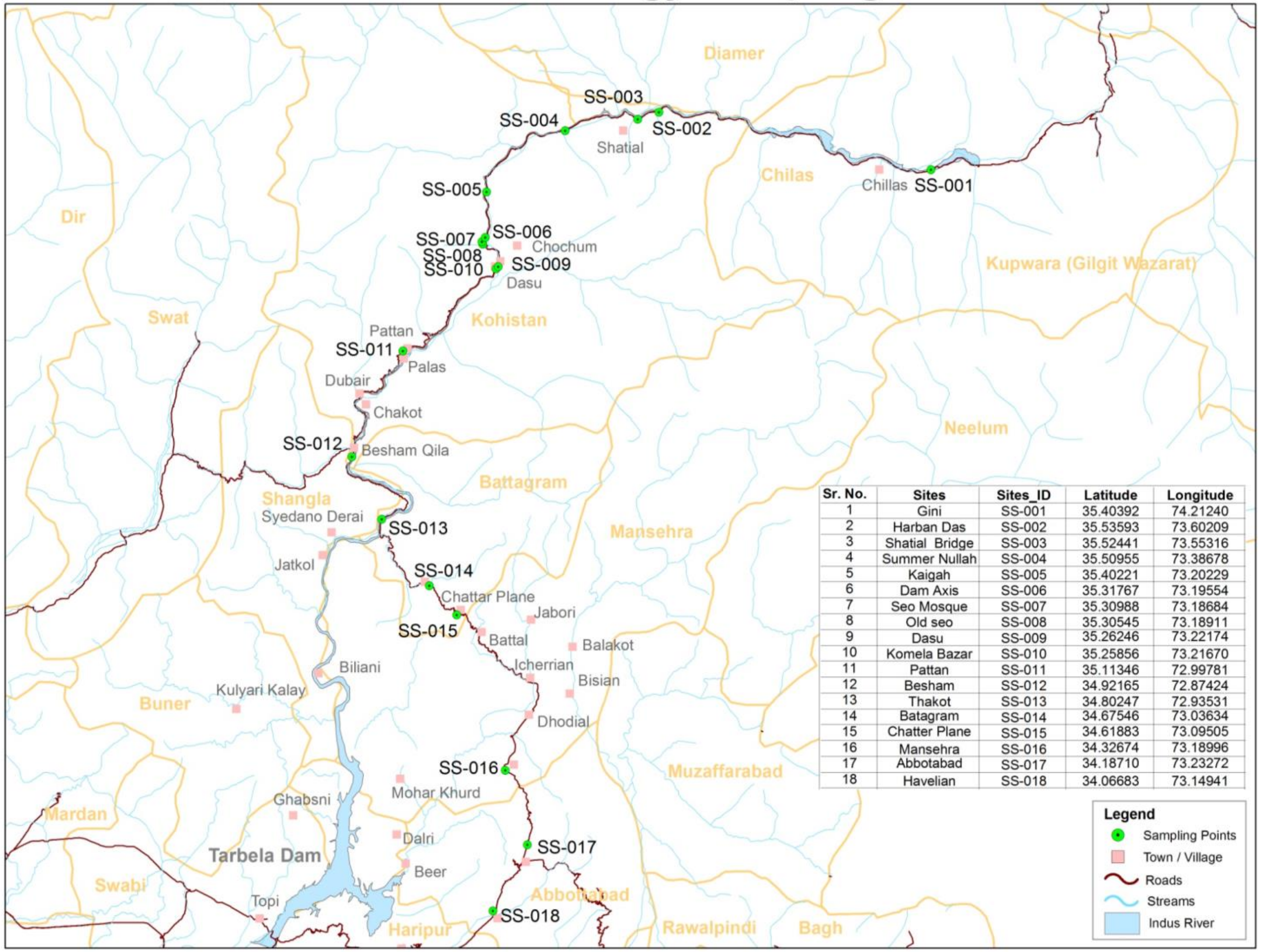


Sr. No.	Sites	Sites_ID	Latitude	Longitude
1	Harban Das	SS-001	35.54000	73.60111
2	Darel River	SS-002	35.54285	73.58413
3	Tangir River	SS-003	35.54547	73.50600
4	Summer Nullah	SS-004	35.50688	73.38654
5	Churi Nullah	SS-005	35.50618	73.36300
6	Lutur Nullah	SS-006	35.47693	73.27061
7	Kandia River	SS-007	35.43586	73.20619
8	Barseen Nullah	SS-008	35.36457	73.20047
9	Uchar Nullah	SS-009	35.33250	73.20349
10	Dam Axis	SS-010	35.31765	73.19553
11	Segloo	SS-011	35.30680	73.19055
12	Dasu Nullah	SS-012	35.28933	73.22406
13	Komela Jalkot	SS-013	35.25563	73.21246
14	D/s of Jalkot	SS-014	35.24379	73.19023
15	U/s of Pattan	SS-015	35.11624	73.01556
16	Besham	SS-016	34.92990	72.88177
17	Thakot	SS-017	34.81427	72.96348
18	New Darband	SS-018	34.35360	72.84882
19	Khalabat	SS-019	34.07854	72.89650
20	Topi	SS-020	34.05466	72.66929

Figure 4.15: Map of Water Quality Sampling Sites



Sr. No.	Sites	Sites_ID	Latitude	Longitude
1	Gini	SS-001	35.40392	74.21240
2	Harban Das	SS-002	35.53593	73.60209
3	Shatial Bridge	SS-003	35.52441	73.55316
4	Summer Nullah	SS-004	35.50955	73.38678
5	Kaigah	SS-005	35.40221	73.20229
6	Dam Axis	SS-006	35.31767	73.19554
7	Seo Mosque	SS-007	35.30988	73.18684
8	Old seo	SS-008	35.30545	73.18911
9	Dasu	SS-009	35.26246	73.22174
10	Komela Bazar	SS-010	35.25856	73.21670
11	Pattan	SS-011	35.11346	72.99781
12	Besham	SS-012	34.92165	72.87424
13	Thakot	SS-013	34.80247	72.93531
14	Batagram	SS-014	34.67546	73.03634
15	Chatter Plane	SS-015	34.61883	73.09505
16	Mansehra	SS-016	34.32674	73.18996
17	Abbotabad	SS-017	34.18710	73.23272
18	Havelian	SS-018	34.06683	73.14941

Figure 4.16: Map of Air and Noise Quality Sampling Sites

Table 4.10: Summary of Water Quality Results

Sr. No	Parameter	Indus				Tributaries				NEQS
		U/S of dam		D/S of dam		U/S of dam		D/S of dam		
		Jul-12	Nov-12	Jul-12	Nov-12	Jul-12	Nov-12	Jul-12	Nov-12	
1	Water Temperature (ºC)	18-21	6.7-8.7	17-18.3	10.1-16.9	15.5-21	8.2-13.9	15.6	15.5	
2	pH	7.03-8.07	7.9-8.05	7.50-8.11	7.3-8.2	7.12-7.82	7.44-8.06	7.65	8.01	6.5-8.5
3	Dissolved Oxygen (mg/l)	8.2-9.3	7.6-7.75	8.02-9.7	6.35-8.09	7.7-8.9	6.5-9	8.1	7.1	
4	Conductivity (µs/cm)	201.3-211.1	265-325	152.6-234.4	230-301	29.1-92.8	56-135	124.9	199	
5	Turbidity (NTU)	3-45	20.6-22.1	57.5-70.5	7.75-29	1-8.45	0.3-32	0.545	0.92	<5
6	Total Hardness as $CaCO_3$ (mg/l)	8-62.6	125-128	30-65	98-135	BDL-23.4	25-65	40.2	90	<500
7	BOD_5 (mg/l)	0.25-1	0.9-1.0	0.42-1.20	1.20-4.7	0.20-0.61	0.71-1.30	0.2	1	
8	COD (mg/l)	0.60-4.27	7.6-8.9	1.4-3.87	5.2-9.6	0.70-2.47	3.50-7.50	1	3.5	
9	Total Dissolved Solids (mg/l)	72.2-105	108-132	75.5-115.8	114-148	14-63	27-68	56	90	<1000
10	Total Suspended Solids (mg/l)	84-127	19-25	16-245	Jan-35	BDL-17	BDL-8	BDL	3	
11	Chloride (mg/l)	9-10	11-18.6	7-12	13.4-37.3	2.5-8	5.5-15.3	1	6.8	<250
12	Chlorine (mg/l)	BDL-0.37	0.04	0.005-0.145	0.02-0.06	0.015-0.195	0.01-0.06	0.025	0.03	0.5-1.5
13	Sodium (mg/l)	3.94-5.95	6.44-6.89	2.29-7.13	4.3-11.3	BDL-3.36	3.12-4.98	3.8	3.99	
14	Fluoride (mg/l)	BDL-1.12	0.22-0.43	BDL-0.9	BDL-0.34	BDL-0.75	0.02-0.11	0.09	0.01	<1.5
15	Iodine (mg/l)	BDL-0.90	0.12-0.19	0.14-0.33	0.09-0.27	0.1-0.75	0.07-0.2	0.16	0.15	≤1.5
16	Sulphate (mg/l)	BDL-37	46-47	3.9-35.5	18-46.5	BDL-4	3-27	0.18	8	
17	Sulphide (mg/l)	0.54-1.18	0.6-1.7	0.05-0.64	0.6-1.8	BDL-0.45	0.2-1	0.23	0.3	
18	Nitrogen Ammonia (mg/l)	0.92-2.53	0.06-0.22	0.73-2.53	0.02-0.23	BDL-1.02	0.01-0.1	0.845	0.09	
19	Nitrate (mg/l)	1.90-3.50	1.6-1.8	0.02-2.3	1.1-2.4	0.09-2.9	1.3-2.8	0.6	3.1	≤50
20	Cyanide (mg/l)	0.008-0.045	BDL-0.002	0.02-0.035	BDL-0.0018	0.003-0.045	BDL-0.0012	0.005	BDL	≤0.05
21	Copper (mg/l)	0.006-0.012	0.005-0.0052	0.008-0.029	BDL-0.0073	0.001-0.006	BDL-0.0065	0.0061	0.007	2
22	Cadmium (mg/l)	BDL	0.0002	BDL	0.00004-0.0012	BDL	0.00002-0.001	BDL	5E-04	0.01
23	Chromium (mg/l)	0.013-0.016	0.017-0.021	0.004-0.033	0.006-0.0243	0.006-0.020	0.005-0.018	0.0093	0.018	≤0.05
24	Lead (mg/l)	BDL	0.009-0.01	BDL	BDL-0.009	BDL	BDL-0.009	0.0101	0.007	≤0.05
25	Silver (mg/l)	BDL-0.00037	BDL	BDL-0.0004	BDL-0.002	BDL-0.0002	BDL-0.002	BDL	0.002	
26	Zinc (mg/l)	0.004-0.014	0.028-0.03	0.013-0.065	BDL-0.042	0.002-0.063	BDL-0.051	0.062	0.037	5
27	Nickel (mg/l)	0.016-0.022	0.016-0.027	0.013-0.021	BDL-0.041	0.005-0.018	BDL-0.034	0.0098	0.031	<0.02
28	Arsenic (mg/l)	0.002-0.007	0.004-0.007	0.005-0.032	BDL-0.027	BDL-0.003	BDL-0.012	0.0014	0.013	<0.05
29	Selenium (mg/l)	BDL-0.008	0.00011-0.00089	BDL-0.00093	BDL-0.00092	BDL-0.0009	BDL-0.00098	BDL	BDL	0.01
30	Manganese (mg/l)	0.044-0.121	0.012-0.097	0.037-0.0846	BDL-0.09	0.0016-0.012	BDL-0.059	0.0054	0.051	<0.5
31	Iron (mg/l)	0.20-0.23	0.035-0.04	0.159-0.562	BDL-0.065	0.066-0.289	BDL-0.047	0.25	0.023	
32	Barium (mg/l)	BDL-0.036	0.12	0.016-0.229	BDL-0.187	BDL-0.034	BDL-0.154	0.1203	0.191	0.7
33	Boron (mg/l)	0.021-0.03	0.026-0.15	0.02-0.21	0.013-0.134	BDL-0.046	0.01-0.131	0.022	0.036	0.3
34	Mercury (mg/l)	BDL-0.0006	BDL-0.00002	BDL-0.0020	BDL-0.00005	BDL-0.002	BDL-0.000014	BDL	BDL	≤0.01
35	Magnesium (mg/l)	3.73-9.29	4.13-8.58	1.20-10.40	1.92-9.85	0.71-2.51	1.53-2.74	3.42	4.86	
36	Phenolic Compounds (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	

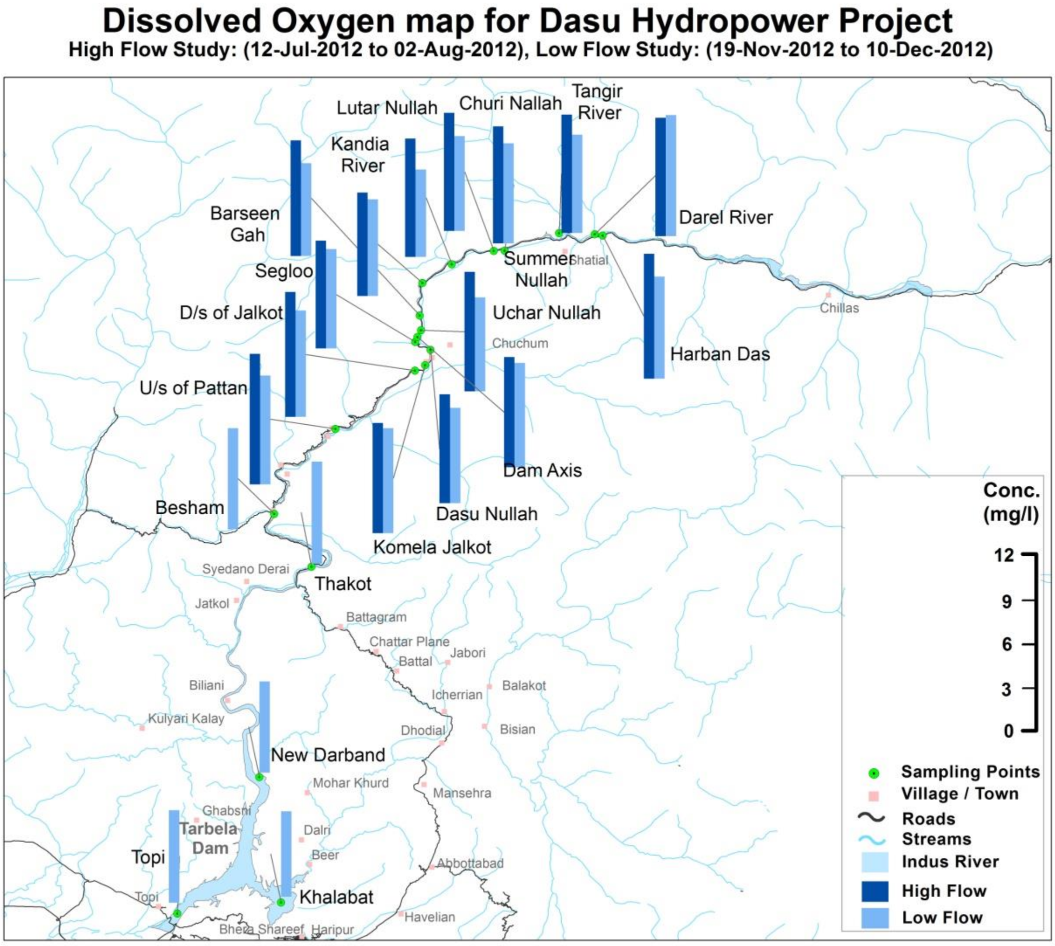


Figure 4.17: Dissolved Oxygen Distribution in Project Area

4.3.2 Ambient Air Quality

24 hour air quality monitoring was conducted during summer and winter seasons of 2012 along the Project area to establish baseline conditions. The locations include all urban areas along KKH from Havelian to Dasu, quarry sites, construction areas and sensitive receptors close to the construction areas.

24-hour average ambient air quality results (July/August 2012 and December/January 2013) are presented in Table 4.11, while hourly concentrations are given in Volume 6. Air quality data of 2007 and 2008 collected during feasibility study are presented in Table 4.12. NEQS for ambient air quality are also presented in these tables.

Generally air quality in the Project area is within NEQS except $PM_{2.5.}$ The high concentrations of fine particulate matter are related to regional sources, not particularly any local source. The concentrations of particular matter are high in winter compared to summer (Figure 4.19), may be due to poor dispersion caused by either atmospheric inversion and calm winds or increased secondary pollutants' load.

Concentrations of CO have exceeded NEQS at Pattan and Beasham, and concentrations of NO_2 have exceeded standards at Mansehra and Abbottabad in winter. The 24 h averaged concentration of CO2 ranged from 339 to 376 ppm and from 346 to 740 ppm in summer and winter seasons respectively.

A graphical representation of air quality from September 2007 to July 2012 at three locations in the project area is shown in Figure 4.18 to understand the general trend of the ambient air quality. In general concentrations of all air quality parameters are higher in 2012 compared to 2007.

Table 4.11: Ambient Air Quality Results (24-hr Average) in July and December 2012

Site	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		SO_2 (µg/m³)		CO (mg/m³)		CO_2 (µg/m³)		NO_2 (µg/m³)	
	Jul-12	Dec - 12	Jul-12	Dec - 12	Jul-12	Dec - 12	Jul-12	Dec - 12	Jul-12	Dec - 12	Jul-12	Dec - 12
NEQS	35	35	250	250	120	120	5	5	-		80	80
Dasu Bridge	19.8	75.4	25.6	79.7	42.5	18	1.6	5.4	342	562	41.1	36.5
Komila Bazar	26.3	109.8	24.5	118.6	44.2	25.9	2.3	3	352	740	41.2	34.8
Old Seo	29.9	55.9	32.2	86.8	37.5	10.7	1.9	1.4	347	499	38.7	30.3
Seo Mosque	35.2	89.2	36.5	64.6	37.8	10.8	1.8	1.3	340	528	34.2	23.3
Dam Axis	31	124.6	42.3	129.8	39.4	18.9	1.9	1.3	341	535	47.5	35.9
Kaigah	34	48.3	38.2	67	38.6	10.1	2.1	1.2	359	584	37.7	31.3
Summer Nallah	47.7	78.7	44.5	84.5	40	12.2	2	1.8	346	608	47.1	26.4
Shatial Bridge	53	51.1	89.3	71.5	38.9	11.7	2.4	1.9	344	728	41.8	32.3
Harban Das	42.6	47.4	44.6	51.1	39.5	11.7	2	2	342	509	37.4	34.1
Gini	51	69.6	87.6	83.8	39.4	11.4	2.2	2.6	339	535	40.8	17.4
Pattan	33.3	26.3	73.2	45.2	38.9	10.1	2.5	10.1	376	366	45.6	21.3
Besham	78.6	50.2	39.8	61.8	45	10.9	2.8	10.9	365	385	47.8	36.7
Thakot	-	3	-	83.2	-	18.8	-	2.2	-	626	-	62.9
Battagram	-	83	-	76.8	-	17.2	-	1.8	-	702	-	54.1
Chatter Plain	-	79.7	-	58	-	17.2	-	1	-	570	-	40.7
Mansehra	-	72.1	-	78.2	-	19.8	-	1	-	437	-	124
Abbottabad	-	182.7	-	110.8	-	33	-	4.8	-	573	-	114.6
Havelian	-	72.1	-	58.5	-	12.5	-	2.3	-	346	-	56.2

Table 4.12: Ambient Air Quality (24 Hour Average) during Feasibility Studies

Site	PM_{10} (µg/m³)		SO_2 (µg/m³)		CO (µg/m³)		CO_2(µg/m³)		NO_2(µg/m³)	
	Sep-07	Jan-08	Sep-07	Jan-08	Sep-07	Jan-08	Sep-07	Jan-08	Sep-07	Jan-08
NEQS	250		120		5				80	
Harban Das	41.55	46.3	7.02	7.6	0.92	1	291	297	10.09	9.7
Summer Nullah	34.37	44.4	6.48	8.9	0.93	1	286	291	11.3	11.2
Dam Axis	53.59	45.5	10.31	10.2	1.35	1	296	302	13.35	13

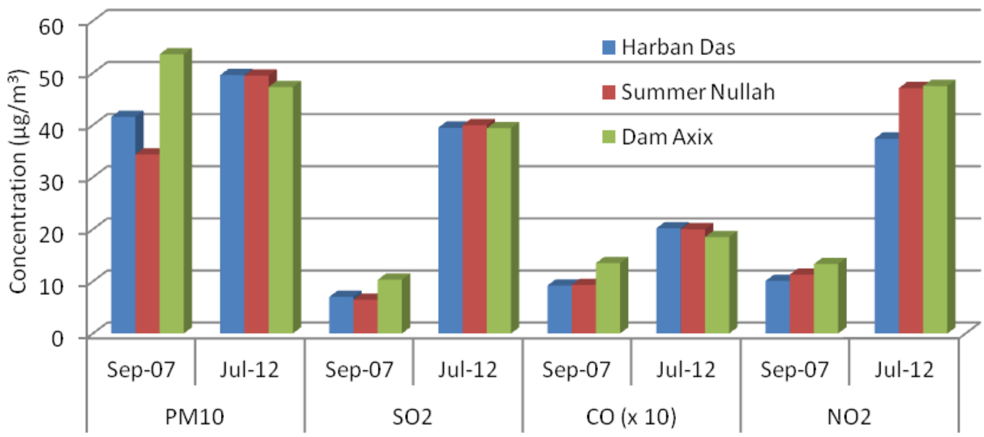


Figure 4.18: Changes in Air Quality from 2007 to 2012

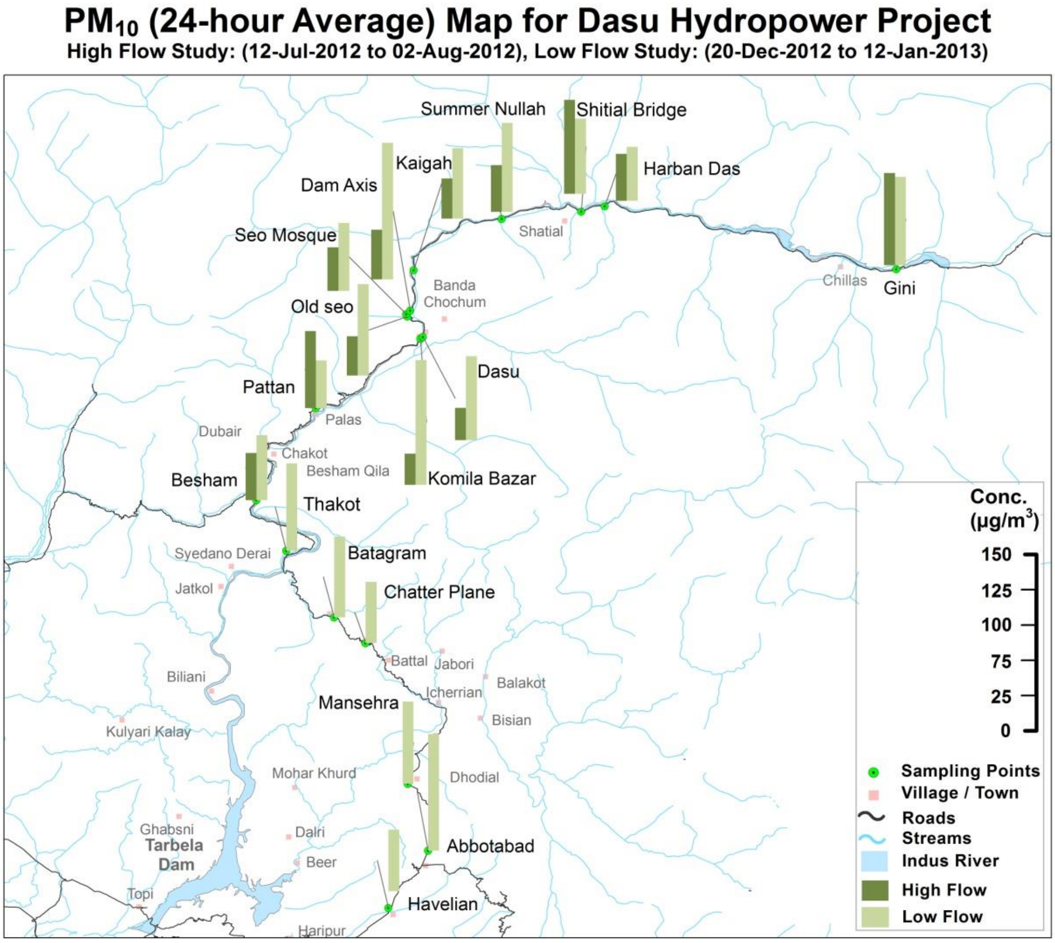


Figure 4.19: Changes in PM_{10} from Jul/Aug 2012 to Dec/Jan 2013

4.3.3 Ambient Noise Quality

Noise quality monitoring results are presented in Table 4.13. Generally noise levels are high along the valley and in most cases exceed the national standards. Average day time noise levels vary from 43 to 67 dBA and night time noise levels vary from 31 to 65 dBA. In Dasu and Komila, the day time noise levels vary from 56 to 58 dBA and night time noise levels vary form 44-52 dBA. With effective form July 2012, the NEQS for day time and night time noise levels in residential area are 55 and 45 dBA respectively.

Table 4.13: Average Noise Level in the Project Area

Sr. No.	Site	Time Weighted Average Noise Level dB(A) Leq						
		High Flow Season (12-Jul-2012 to 02-Aug-2012)			Low Flow Season (20-Dec-2012 to 12-Jan-2013)			NEQS (Effective from July 2012)
		*Day	**Night	24 h	*Day	**Night	24 h	
1	Gini	45.9	44.9	45.6	49.1	48.0	48.7	**Residential Area:** Daytime: 55 Night-time: 45
2	Harban Das	49.8	49.9	49.9	47.5	43.7	46.2	
3	Shatial Bridge	50.5	49.4	50.2	52.9	52.8	52.8	
4	Summer Nallah	53.5	52.3	53.1	58.7	57.9	58.5	
5	Kaigah	47.1	48.5	47.6	48.6	46.7	48	**Commercial Area:** Daytime: 65
6	Dam Axis	51.4	52.0	51.6	56.9	56.3	56.7	
7	Seo Mosque	46.4	49.0	47.3	48.0	42.9	46.4	

Sr. No.	Site	Time Weighted Average Noise Level dB(A) Leq						
		High Flow Season (12-Jul-2012 to 02-Aug-2012)			Low Flow Season (20-Dec-2012 to 12-Jan-2013)			NEQS (Effective from July 2012)
		*Day	**Night	24 h	*Day	**Night	24 h	
8	Old Seo	47.3	50.6	48.4	51.3	47.7	50.1	Night-time: 55
9	Dasu	51.4	47.1	49.9	58.0	44.9	53.6	
10	Komila Bazar	49.1	48.9	49.1	56.1	52.8	55.0	
11	Pattan	55.0	53.8	54.6	53.8	48.8	52.2	
12	Besham	56.8	56.9	56.8	59.4	58.7	59.2	(*Daytime hours: 0600 to 2200 Hrs; **Night-time hours: 2200 to 0600 Hrs)
13	Thakot	-	-	-	53.4	51.7	52.8	
14	Battagram	-	-	-	59.7	54.2	57.9	
15	Chattar Plane	-	-	-	43.6	31.1	39.3	
16	Mansehra	-	-	-	62.3	60.1	61.5	
17	Abbottabad	-	-	-	67.1	61.1	65.1	
18	Havelian	-	-	-	50.7	49.5	50.3	

4.3.4 Soil

Soil samples (virgin soil not used for agricultural) were collected along the valley and were analyzed for mercury at six locations. The concentration of mercury at all six locations was found within the standard limits. Organic soil standard for the total mercury content in soil is 0.07-0.3 mg/kg (UNEP Chemicals, 2002). The results of soil quality are presented in Table 4.14.

Table 4.14: Mercury Content in Soils

Sr. No	Sampling Site	Concentration of Mercury (mg/Kg)	
		July 2012	December 2012
1	Barseen	0.00149	0.00109
2	Sammar Nallah	0.00352	0.00018
3	Shatial Das	0.00219	0.00087
4	Duga Gah	0.00576	0.00022
5	Kandia	0.00284	0.00029
6	Tangir	0.00392	0.00076

4.4 AQUATIC ECOLOGY

Detailed baseline information on aquatic ecology is presented in Volume 4: Aquatic Ecology. A brief summary of this report is provided in this section.

4.4.1 Overview of Fish Indus River

Fish diversity in the Indus River is low as compared to other major rivers of the region. The Indus River has 177 fish species including 12 exotic species, which is substantially lower than other major rivers in Asia like Ganges (350 species), Brahmaputra, Mekong (400) & Hwang Hu (320 species). The main reason for poor diversity is long torrential upper courses in the Himalayas, glacier fed water and high sediment load or low mean discharge rate of water during winter. Most species in the Indus River are members of the carp family (Cyprinidae) and loach family (Noemachcilidae). In order to enhance the fish sources two species of family – Salmonidae (brown trout & rainbow trout) were introduced in Gilgit River and adjoining streams in early nineties.

4.4.2 Fish Species in the Project Area

Field investigations on aquatic ecology were conducted during February 2012, April 2012 and August 2012 from the Indus and its tributaries of project area. The map of aquatic biological sampling sites is given in Figure 4.20.

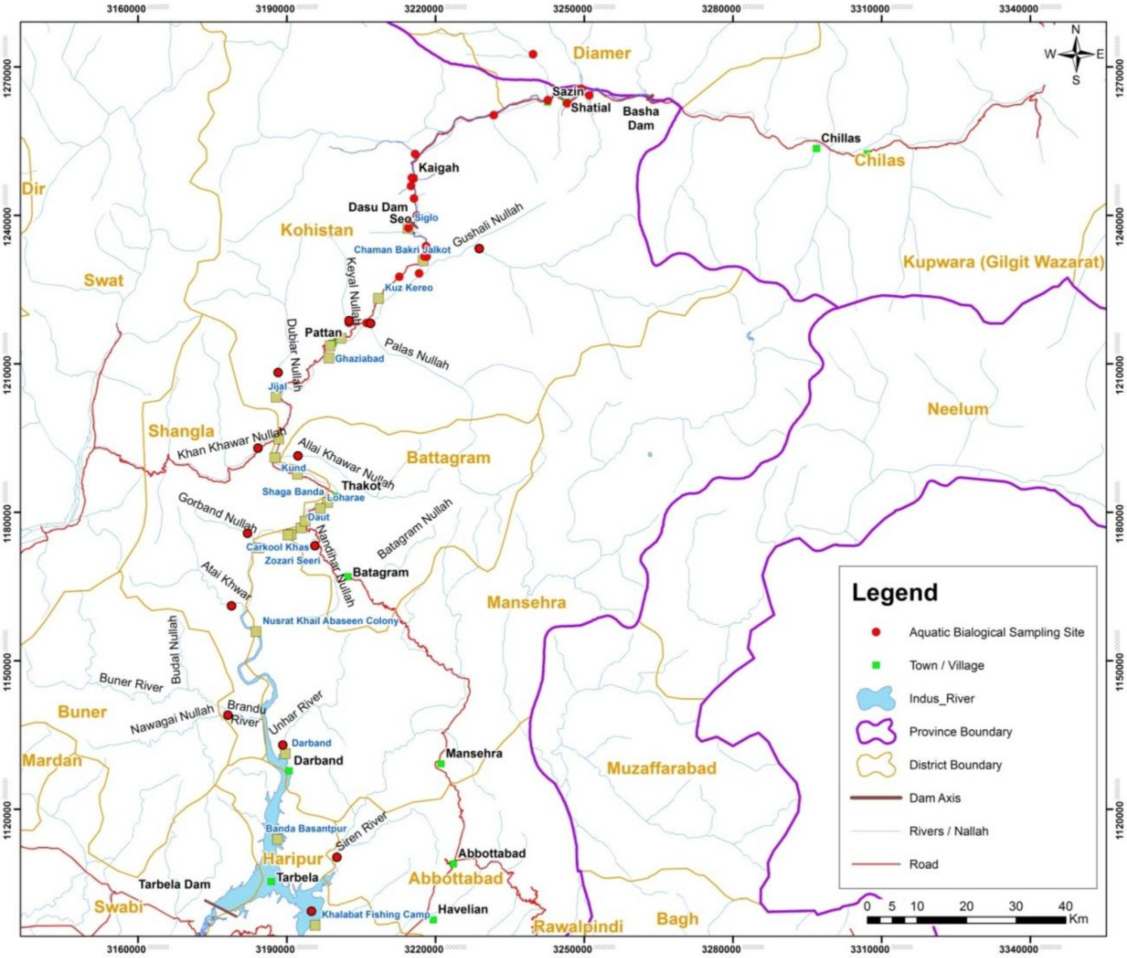


Figure 4.20: Aquatic Biological Sampling Sites

Following sampling stations (Table 4.15) were fixed to collect the samples for investigation and to carry out the fishing operations and collected the related information & data.

Table 4.15: Detail of Sampling Stations

Sr. No.	Location	Code	Distance from Dam Axis (km)	Elevation (m)
Left Bank (upstream) Tributaries				
1.	Ucchar Gah	UG	10.5	833
2.	Barseen Gah	KG	08.0	878
3.	Kaigah	KG	10.0	
4.	Summar Gah	LR	24.00	988
5.	Shatial Stream	SG	54.00	995
6.	Harban Gah	HG	57.23	1000.4
Right Bank (upstream) Tributaries				
7.	Duga Gah	DG	08.00	891.0
8.	Kandia River	Kr	04.8	845.5

Sr. No.	Location	Code	Distance from Dam Axis (km)	Elevation (m)
9.	Uttar Gah	UG		
10.	Tangir River	Tr	47.98	1073.4
11.	Darel River	Dr	56.00	980.0
Downstream of Dam				
	Right Bank Tributaries			
12.	Seglo Nullah	SN	2.5	881.4
13.	Keyal Nullah	KN	28.0	797.2
	Left Bank Tributaries			
14.	Jal Kot Nullah	JN	9.1	797.2
15.	Pallas Nullah	PN	27.0	701.0
	River Main Stem			
16.	Tangir Bridge (upstream)	TR	18.00	1073.4
17.	Near Kaigah (upstream)	KG	10.00	879.5
18.	River before Dasu (downstream)	RD	07.00	840.0
19.	River after Jalkot Nullah (downstream)	RJ	07.50	797.2
20.	River (8 km) from Dasu (downstream)	RD	15.00	797.2

4.4.3 Characteristics of Aquatic Habitat

Indus and its tributaries are characterized by relatively steep gradients and substrate sizes, fast-flowing, turbulent and turbid water. The river is mainly fed by melting of snow and glaciers; flow is high during summer and contribution from rainfall is very small. Physico-chemical conditions of river water changes between the summer and winter seasons. During summer, river water is very turbid and carries a high sediment load. Several river tributaries (nullahs) join the river between Basha and Dasu. All tributaries pass along steep gradients through rocky areas of high mountains, exhibiting variable cascades, riffles and pools and, at confluences with the Indus River, gravel and sand where most spawning sites of snow carp and other species are believed to be located. Streambeds mainly are covered with boulders, cobbles and gravels. Banks of some tributaries have patches of vegetation such as herbs, shrubs and trees.

4.4.3.1 Fish Species Upstream of Project Area (Diamer Basha Area)

During environmental assessment study of Basha Project in 2010, only 13 species of fish were reported. They include 3 species of native snow carps and 2 species introduced trout. Details of these fish species are given in Table 4.16.

Table 4.16: Fish Species of Diamer Basha Dam Site

No.	Fish Species	Common Name	Family	Occurrence
1.	Schizothorax plagiostomus	Gahi, Swati	Cyprinidae	23.0%
2.	Schizothorax esocinus	Chakhat	Cyprinidae	10.5%
3.	Schizothorax intermediatus	Khadule	Cyprinidae	0.70%
4.	Ptychobarbus spp.	Siarriam	-	5.07%
5.	Racoma labiata	Chohan	-	15.7%
6.	Cyprinus carpio	Chinese carp	-	3.30%
7.	Carassius spp.	Gold fish	-	1.76%
8.	Ctenopharyngodon	Grass carp	-	3.50%
9.	Aristis nobilis	Silver carp	-	1.75%
10.	Triplophysa gracilus	Jungli (chemo)	-	3.50%
11.	Glyptosternum reticulatum	Konozobo	-	3.50%
12.	Salmo trutta	Angarazi		2.00%
13.	Salmo gairdneri	Induced species	-	2.00%

Source: EIA of Basha Project, 2012

4.4.3.2 Fish Species near Dasu Damsite and Upstream Area

During investigations, only three species of snowcarp (Schizothorax plagiostomus, Schizothorax esocinus, Racoma labiata), one species of loach (Triplophysa gracilus), and one species of catfish (Glyptosternum reticulatum) have been caught in our limited sampling. The first two sampling trips (April and June 2012) yielded only 25 fish and the third one (August 2012) 47 fish. Biological information of these species is given in Annex 4.2. Details of these species caught during field investigations of August 2012 are shown in the Table 4.17.

Table 4.17: Catch Composition of the Project Area (August 2012)

Fish Species		Upstream	Downstream	Total	% age
Cyprinidae					
Schizothoracinae					
1.	Schizothorax plagiostomous (Gahi)	18	18	36	76.5
2.	Schizopyge esocinus (Chakhat /Swati)	4	1	5	12.0
3.	Triplophysa spp. (Jungli Chemo)	1	2	3	06.4
4.	Glyptosternum reticulum	1	2	3	06.4

4.4.3.3 Fish Species in Downstream of Dam site

- **Dasu to Pattan Area**

Seven species have been reported for the section of the Indus River and tributaries near Pattan (*Schizothorax plagiostomous, Racoma labiata Schyzopyge esocinus, Triplophysa choprai, Glyptothorax stocki, Schistura naseeri, and Glyptosternum reticulatum)*. *Glyptosternum reticulatum* and *Schizothorax plagiostomous* were captured in Keyal Khwar during those studies, the latter restricted to lower reaches.

- **Besham area**

Fish species reported near Besham and nearby Khan Khwar are (Sarhad Hydel Development Organization 1996):

- Indus River – snow carp (*Schizothorax* spp.), *Labeo dyochilus* and forage species; and
- Khan Khwar – (snow carp) *Schizothorax* spp., *Oreinus* spp., forage species and rainbow trout (*Salmo gairdneri*) above proposed dam site.

At least seven species of fish have been reported in Allai Khwar (*Schizothorax plagiostomous Schizopyge esocinus, Labeo dero, Glyptosternum reticulatum, Tor putitora, Hypophtalmichtys molotrix, Cyprinus carpio*) (Dastigir et. Al. 2011). *Schistura naseeri* has also been reported (Mirza 2006). Fish mainly migrate to the Indus River in winter and ascend Allai Khawar in spring/summer.

Golden mahaseer (Tor putitora) is also reported to spawn in Allai Khwar (Dastigir et.al. 2011) ascend the Indus River to Besham Qila and above (Ansari 1974).

- **Tarbela Reservoir**

Prior to construction of Tarbela dam, 35 fish species were recorded in the Indus river and tributaries around Tarbela (Ali et al, 1980). Mahaseer and snow carp were common and utilized as food fish. Other Schizothorax species and Labeo dyochcilus were common but not popular as food fish. Due to permanent deep submergence of many natural breeding grounds of mahaseer in the reservoir, natural propagation of that species drastically declined. Mahaseer migrated upstream and into tributaries where breeders were indiscriminately fished where enforcement of protective regulations were very difficult. A post-impoundment list of fish species is presented in Table 4.18.

Table 4.18: Fish Fauna of Tarbela Reservoir

Sr. No.	Type of Fish	Local Name	% of Total Catches
1.	Ambassis baculis	Kangee	0.75
2.	Ambassis nama	Kangee	4.36
3.	Ambassis sanga	Shisha	1.26
4.	Aspidoparia morar		
5.	Chela gora	Chilwa	0.78
6.	Cirrihinus mrigala	Mori	3.0
7.	Cirrihinus reba	Suni	0.7
8.	Cyprinus carpio	Gulfam	3.3
9.	Ctenopharyngodon idella	Grass carp	2.5
10.	Gagat cenia		0.2
11.	Labco dyocheilus	Tourki	7.9
12.	Labco microphthalamus	Bhagan	2.1
13.	Mastacembelus armatus	Bam	3.0
14.	Ophiocephalus punctatus	Danla	0.4
15.	Puntius Sophore	Chidu	2.9
16.	Puntius ticto	Chidu	1.5
17.	Schizothorax plagiostomus	Mallah	7.4
18.	Salmostoma bacaila	Chilwa	0.8
19.	Salmostoma punjabensis	Chilwa	0.3
20.	Securicula gora	Chilwa	0.1
21.	Tor putitora	Mahseer	8.1
22.	Tor tor	Mahseer	7.0

Source: Survey Investigation Report of FAO/PK/TCP 6657 (1987-88)

Fishery production of the reservoir is dependent upon stocking of fish seed fingerlings, and is mainly comprised of three or four species (major and Chinese carps). Tarbela hatchery at Ghazi produces fish seed which are stocked in reservoir. Mahaseer present in reservoir, attract the anglers (sport fishermen) to the reservoir.

4.4.4 Fish Species of Special Importance

Among indigenous species found in Indus River upstream of Tarbela Reservoir, golden mahseer (*Tor putitora*), is evaluated for IUCN status and considered as endangered. IUCN status of indigenous snow carps (*Schizothorax plagiostomus*, *Racoma labiata* and *Schizopyge esocinus*) has not yet been evaluated. Details of all these four indigenous species is given in Annex 4.2.

Snow Carp (Schizothorax plagiostomus)

Plagiostomus is the dominant fish species in Dasu area representing more than 75% of total fish catch and other two species of snow carp represent about 15% of total fish catch. None of these species are listed in IUCN Red List. Mahaseer is other important cold water fish species of Indus (long distant migrant and endangered), but its habitat starts about 70 to 80 km downstream of the damsite.

Habitat of snow carp: In the project area fish found mainly in the tributaries, while in the mainstem they are found near the confluences during low flow season of winter. Tributaries with snow carp fish habitat on the upstream side of the dam site are Kandia, Tangir, Darel, Kaigah, Summar, and Goshali. While tributaries on the downstream side with snow carp fish habitat are Sieglo, and Jalkot. Snow carps thrive in the snow fed river habitat of clear, shallow water of stony substratum with an average depth from 0.5 to 3 meters, and river flows with low to high velocities (0.5 to

1.5 m/s). Average temperature requirements are 4 to 20 ^{o}C and dissolved oxygen requirements are 8 to 12 mg/l. Snow carps are bottom feeders and mainly feed on peryphyitic algae and diatoms.

Migration of snow carp: Snow carps are short distance migrants. In the project area, they migrate within the tributaries (head waters areas to lower elevations and to Indus confluence areas; and vice versa), not along the mainstem Indus. During April to September (spring and summer, high flows), they prefer upstream head waters habitat at higher elevations. During September to April (low flows and winter), they prefer lower elevations and confluence zone with Indus. The triggers for migrations are high flows, high sediment load and low temperatures. During spring, when flows started increasing in the rivers due to melting of snow, the fish migrate upstream from April and May (within tributaries) due to high flows and turbidity at lower elevations. During autumn, when the temperatures are starts to drop at higher elevations, the fish migrate downstream from September and October.

Spawning of snow carp: Female fishes spawn in two seasons, one in September-October and other in March - April. Sexually matured snow carp (when they reach 18-24 cm length, at the age of 2-3 years) spawn in tributaries in clear water (along stream banks, backwater pools and near confluences of other tributaries and Indus) on gravelly/stony ground or on fine pebbles at 10-30 cm depth. Low water currents of 0.5- 1.5 m/sec, pH 7.5, dissolved oxygen concentration of 8-12 mg/L and gravel sizes of 50-60 mm are the optimum conditions for spawning.

Mahaseer Species (Tor putitora, Tor tor)

Mahaseer is a sport fish, source of attraction for anglers and also primary quality food fish in the region. It has ecological and economic significance. Tor species are habituated in slow moving streams in foothill region and very conveniently breed in gravels & sandy beds.

Golden mahaseer is reported to ascend the Indus River to Besham Qila and above (Ansari 1974) and to spawn in Allai Khwar which has been described as the last upstream safe-haven for this species (Dastgir et. al. 2011). Mahaseer is not reported near Dasu. During fish sampling at Dasu project area, no Mahaseer specimen could be caught. Even EIA study of Diamer Basha Dam did not reveal the occurrence of Mahaseer in its catches.

Status of mahseer and impact of Tarbela on mahseer is poorly understood. Some authors have exaggerated the mahseer status and impact of Tarbela. Of course there was considerable impact on mahseer fishery due to construction of Tarbela dam but still reasonable proportion of mahseer of total catches is being maintained. The occurrence of mahseer in river Haro, Soan and Korang are given in Table 4.19. Further presence of mahseer in Tarbela reservoir and its proportion is given in Table 4.20. Recent study on mahseer (WWF 2010) has revealed out its sustainability in streams and nullahs of foothill areas.

Table 4.19: Percentage of Mahseer fish composition from the flowing waters of Haro and Soan/Korang rivers systems

Visit Place	Total Fish Captured (Number)	Mahseer *(Tor putitora)*	Percentage of *Mahseer*
Nala Gummara (upper reaches)	55	44	80.00
Korang River	32	28	87.5
Simli Dam Nala	22	18	81.81
Nala Gummara (lower reaches)	34	22	64.70

TOTAL	**206**	**172**	**83.49**

Source: Studies on Mahaseer in Himalayan Foothill rivers (Akhtar, 2003)

Table 4.20: Fish Catch Composition of Tarbela Reservoir

Year	Common Carp (Cyprinus carpio)		Major Carps - Rahu - Mori - Silver Carp		Mahaseer (Tor putitora)		Tilapia		Total (in kg)
2000 – 01	60,872	70.0%	11,250	12.9%	5,852	6.7%	8,953	10.3%	86,925
2001 – 02	66,430	68.9%	19,950	20.7%	5,276	5.5%	4,842	5.0%	96,428
2002 – 03	67,200	68.4%	20,135	20.5%	4,920	5.0%	5,930	6.0%	98,285
2003 – 04	69,040	66.8%	21,300	20.6%	5,663	5.5%	7,420	7.2%	103,423
2004 – 05	47,449	48.8%	36,008	37.1%	8,784	9.0%	4,899	5.0%	87,140
2005 – 06	52,040	50.1%	28,380	27.3%	11,601	11.2%	11,914	11.5%	103,935

Source: WAPDA Fisheries Unit, Tarbela Dam Project

In Tarbela reservoir, mahseer has maintained its breeding grounds near Khalabat pocket (particularly northern tributaries "river siran"), which is main source of mahseer and other fish yield. Upstream of reservoir Darband pocket and Unhar streams are also good source of mahseer breeding. Upto Thakot (150 km above Tarbela dam), Mahseer have been caught (Sadaqat, M.Phil. Thesis 2002). This study also stated that upstream of river Indus at Thakot, Schizothorax spp., Crossocheilus spp. & Schitura spp. dominate the streams.

4.4.5 Other Biota

4.4.5.1 Phytoplankton

Fifty-nine species of phytoplankton were identified in plankton samples from stations upstream of the proposed dam site, and they found to belong to the following major groups: blue green algae – Cyanophyto (7 species); Chlorophyta – green algae (10 species); brown algae – Chrysophyta (24 species); Xanthophyta (one species). Thirty-five species of phytoplankton were identified in samples from stations downstream of the proposed dam site. Phytoplankton samples from stations both upstream and downstream of the dam site were dominated by Chlorophyta (green algae) and Chrysophyta (brown algae). Phytoplanton identified from samples collected in August 2012 are shown in Table 4.21.

Table 4.21: Phytoplankton Identification of Project Area

Algae Groups	River Mainstem		Tributaries	
	Upstream	Down-stream	Left hand streams	Right hand streams
Cyanophyceae				
- Anabanea spp	+	+	+	+
- Oscillatoria spp	+	+	+	+
- Phormidium spp	-	+	+	+
- Spirulina spp	-	-	+	+
- Johanneslaptista spp	-	-	+	-
- Cylindrospernum spp	-	-	+	+
Chlorophyceae				
- Closteriopsis sp	+	+	-	+
- Oedogonium spp	+	+	+	+
- Ulothorix spp	-	-	+	+
- Cladophora spp	-	-	+	+

Algae Groups	River Mainstem		Tributaries	
	Upstream	Down-stream	Left hand streams	Right hand streams
- Nitzschia spp	-	-	+	-
- Fragilario spp	-	-	+	+
- Synedra spp	-	-	+	-
- Tabellari spp	-	-	+	+
Chrysophyceae				
- Navicula spp	+	+	-	+
- Pinnularia spp	+	+	+	+
- Cymbella spp	+	+	-	-
- Diatoma spp	-	-	+	+
Xanthophyceae				
- Tribonema spp	-	-	+	+

Source: Sampling during August / September 2012 Trip at Project site.

4.4.5.2 Zooplankton

Zooplankton samples were identified and it was found only on species of protozoan, porifera, two species of rotifers and one species of arthropoda are found in project area. Detail of zooplankton in given in Table 4.22.

Table 4.22: Zooplankton Identification of Project Area

Groups	River Mainstem		Tributaries	
	Upstream	Down-stream	Left hand streams	Right hand streams
Protozoa				
- Paramecium spp	+	+	+	+
Rotifera				
- Karetella sp	-	-	+	+
- Euchlanus spp	+	-	-	-
- Branchionus spp	+	+	+	+
- Tansignus spp	-	-	+	+
Cladocera				
- Bosmina spp	-	+	+	+
- Daphnia spp	-	-	+	+
- Ceriodaphnia spp	-	-	+	+
Decapods				
- Cyclops spp	+	-	+	+
- Diaptomus spp	-	-	+	+
Insecta				
- Damsel Nymph spp	+	+	+	-
- Caddish fly Larva	-	-	+	+
Mollusca				
- Limnaea spp	-	-	+	-
- Valvata spp	-	-	+	+

Source: Sampling during August / September 2012 Trip at Project site.

4.4.6 Resource Use

4.4.6.1 Fishing in the Project Area

Fishing from Indus and its tributaries in the project area is limited to meet protein requirement of local people. Local people fish as a part time activity, not as commercial fishermen. Very few persons sell their catches. No professional fishermen are found in the project area. Only Tarbela reservoir has proper organized commercial fishing.

A survey was conducted from 22 villages on the downstream of the dam from Dasu to upper part of Tarbela reservoir. About 12 percent of households are reported involved in fishing. 110 fishermen were interviewed, 75 percent of them primarily fish for domestic use and remaining 25 percent occasionally sell in the market. . Details of households involved in fishing are given in Table 4.23. Complete results of the survey are given in SRMP Volume 11: Downstream Fishing Communities: Baseline and Impact Assessments.

Table 4.23: District Wise Househollds Involved in Fishing

District	Location (Right/ Left)	No. of Villages Surveyed	Overall HHs of the Sampled Villages	HHs Involved in Fishing	Percentage of HHs involved in Fishing
Kohistan	Right	5	1,040	83	8.0
	Left	5	2,304	390	16.9
Shangla	Right	5	970	62	6.4
	Left	3	180	28	15.6
Battagram	Left	2	140	28	20
Torgher	Left	2	660	35	5.3
Total	**2 Right/ 4 Left**	**22**	**5,294**	**626**	**11.8**

Source: Field Survey October 2012

4.4.6.2 Commercial Fishing

There is very limited commercial fishing in Upper Indus River above Tarbela. Only Tarbela reservoir has proper organized commercial fishing. Fishing rights of reservoirs is being leased out annually or for maximum three year period through open auctions. Fishing contractor engage fishermen on daily wages basis (Rs. 20/kg). Skilled fishermen possess already fishing boats and nets. In Tarbela reservoir, gillnet, set nets and cast nets are applied. Yield and catches are supervised, monitored and transported to the market by contractors' manpower. Catches are being sorted out and auctioned in Rawalpindi, Islamabad and Peshawar fish markets.

Application of fishing gears and technology depends upon the fishermen skill and experience which were imparted by their forefathers. Table 4.24 shows statistics recorded by Tarbela Fisheries Unit. Commercial fishery activities were at a lower scale as compared to Mangla or Chashma reservoirs. Fisheries productivity of the main reservoir was much lower due to its oligotrophic condition; the eastern pocket (Khalabat Area) is more productive as a result of much more shallow conditions and fertile soils along the shore which are seasonally inundated. Ninety percent of the fishery production comes from Khalabat pocket. Fishing activities, engagement of fishermen and mobile landing center were located at Khalabat pocket which was accessed through Haripur – Tarbela road. Mostly gill nets of different mesh sizes were used which showed varied efficiency and mesh selectivity in their catches.

Table 4.24: Commercial Fishing of Tarbela Reservoir

Year	Catches (in tons)	No. of Fishermen	Seed Stocking	Revenue (Rs. in million)
1990-91	50	167	0.150	0.410
1991-92	61	196	0.180	0.490
1992-93	50	250	0.250	0.483
1993-94	120	380	0.300	0.500
1994-95	132	410	0.300	0.600
1995-96	156	450	0.400	0.620
1996-97	173	460	0.600	0.700
1997-98	162	450	0.300	0.650
1998-99	120	350	0.400	0.650
1999-2000	175	400	0.650	0.750

Source: *Wapda Fisheries Annual Report, 2001*

Fishery Department of Government of KP province is managing and developing the Tarbela reservoir fisheries since 2007. Fishing rights have been auctioned in 2008 for three year lease agreement. Fishing contractor is not only fishing out but also stocking the fish fingerlings in the reservoir.

4.4.6.3 Fish processing and marketing

No fish processing or storing centres are located in the project area due to lack of financial resources and awareness. Fish caught are kept in sacks moistened with frequent water sprays. There are no fish shops or fish markets in the project area.

4.5 TERRESTRIAL ECOLOGY BASELINE:

4.5.1 General

Detailed baseline information on flora and terrestrial fauna of the project area is given in Volume 3: Terrestrial Ecology. A summary of this report is given in this section. The studies for terrestrial ecology were carried out over a period of 4 months with field investigations during July to September 2012. These surveys were completed through plant specimen collection/ identification, sampling of floral species, point counts and line transects for representative bird species and photography. Wildlife surveys were conducted at selected vantage points.

4.5.2 Terrestrial Ecosystem

The project area falls in montane dry sub-tropical scrub zone with rocky and barren terrain with scattered vegetation. The river beds are characterized by rocky outcrops with stony cliffs, large boulders and washed gravels. There is no littoral zone outside the tributaries (nullahs). There is soil erosion along steep slopes. Geographically, nearly 60 percent area is composed of barren hills with steep slopes. Vegetation cover is very low with scattered trees and shrubs. Vegetation cover increases with increase in elevations and mountain tops are generally covered with dense vegetation. There are some forest cover is located beyond the direct project impact area on higher elevations, well above 2,000 masl. There are certain permanent wet beds along the perennial nullahs that appear as narrow meadow strips and alluvial fans. These meadows and streams are main outlets for distribution of plant species. This kind of alluvial zone is also a preferable area for breeding/nesting of insects, birds, amphibians and reptiles. Some of the nullahs are perennial in nature and supply water during summer and snow melting period, while other remains dry during winter.

The mountain areas of Pakistan are home to unique wildlife and wilderness areas. Also the mountain reaches above the DHP area have a large biodiversity; but the

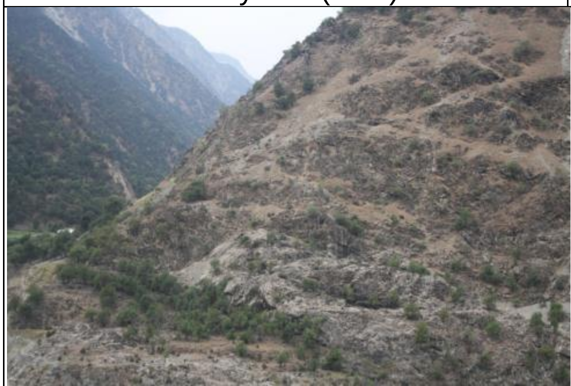
Indus valley bottom (including the project area proper and the future reservoir area) is largely covered with scrub vegetation with its typical low biodiversity. Habitat of wild animals is confined to the mountain tops at higher altitudes (above 3,000 masl) outside the project impact area, and they rarely visit the valleys. From the wider area, 232 species of plants, 199 species of avifauna, 31 mammals and 18 species of reptiles and amphibians are recorded.

4.5.3 Vegetation

There is wide range of floral diversity found in the project area which is a characteristic of a distinctive mountain area setting in northern Pakistan. The vegetation cover between the river and 2,000 masl can be divided into seven major habitats based on geomorphologic features of the terrain associated with typical vegetation types. These habitats and vegetation types are distributed throughout the project area are shown in Figure 4.21 and are described below. A detailed list of all plant species is provided in Appendix 4.3. A total of 232 plant species were identified. These belong to 173 genera and 70 families.

Rocky Cliff (12%)

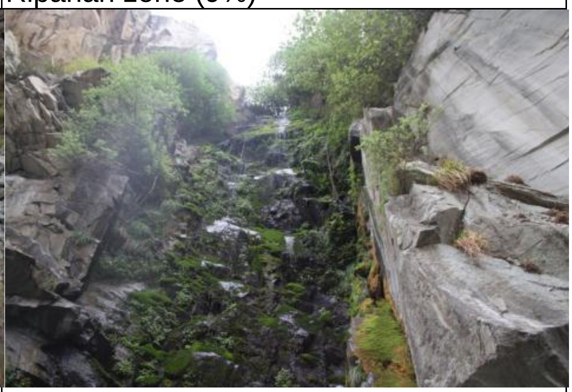
Rocky slopes (31%)



Mountain basement/Stony foothills (15%)

Riparian zone (9%)

Rocky outcrops and boulders (9%)



Spring/waterfall (12%)

Valleys/Cultivated Terraces (12%)	

Figure 4.21: Major Habitat Types in study area

4.5.3.1 Mountain peaks/ cliffs/canyons woodland

This habitat is located on higher altitudes such as the mountain peaks, canyons with very steep and rocky slopes. The upper reaches of this habitat has very little and scanty vegetation. This terrain is largely occupied by sparsely distributed woody species such as *Quercus baloot, Cotinus coggygria, Olea ferruginea, Rhus mysurnesis* and *Cotoneaster* spp.

4.5.3.2 Rocky Slopes Woodlands

This habitat is widely distributed and relatively abundant in the study area with typical steep to moderate slopes on relatively higher elevations characterized by massive rocks. The vegetation consists of woody species with small trees, often with dense shrub layers and many herbs and grasses that are abundantly found in upper slopes. Key vegetation comprised of *Olea europaea, Quercus baloot, Pistacia chinensis, Cotoneaster microphyllus, C. affinis, Maytenus royleanus, Cotinus coggygria* and *Rhus mysurensis.*

4.5.3.3 Mountain basement/ Stony foothills Woodlands

This habitat is found adjacent to Indus River including its tributaries (Nullahs). It possesses a range of geomorphologic and geological features, mostly composed of rocks and gravels along steep to gentle slopes at lower altitudes. Though this is the most abundant community type in the project area, however, it contains relatively less number of species and has low species richness as well as total vegetation coverage. The representative species of this community include *Rumex hastatus, Dodonea viscosa* and *Maytenus royleanus.*

4.5.3.4 Riparian scrublands

The riparian habitat is found in the lowland floodplains of Project area. This habitat is scattered in the project area along River Indus and its major tributaries. The habitat possesses sandy soil intermixed with gravels adjacent to the river and nullahs. The most common species found are *Dodonaea viscosa, Nerium oleander, Debregeasia salicifolia* and *Maytenus royleanus.*

4.5.3.5 Rocky Outcrops and Boulders Shrubland

This habitat type is located in transitional zone between the mountains and riparian habitats on both banks of the river Indus. This habitat possesses sparse vegetation with stunted shrubs and bushes. It is found on intermediate altitudes, where there is mixture of soils and rocky gravel. In this habitat, vegetation cover is very low. The most common species found are *Maytenus royleanus, Olea ferruginea, Rumex hastatus, Artemisia maritima, Heliotropium* sp. and *Periploca aphylla.*

4.5.3.6 Spring /Waterfall

This is a distinct habitat formed by running water from the mountain tops. In this habitat, there is plenty of water and moisture content and plant species are thriving. The most common plant species include: *Debregeasia salicifolia, Adiantum capillus-veneris, Persicaria glabra, Mentha longifolia, Aialnthus altissima, Ficus carica* and *Themeda anathera.*

4.5.3.7 Valleys/ cultivated land terraces

Some high altitude plain grounds/valleys/cultivated terraces are located on the higher slopes and often encircled by rocky mountains. These areas are inhabited by human settlements. This kind of habitat is composed of sandy loamy soils with gravels and is best suited especially for the cultivation of maize and wheat. This habitat showed common weeds as well as grasses with potential for foraging. Common weed species include: *Amaranthus caudatus, A. ovalifolius, Portulaca oleracea, Physalis peruviana, Euphrasia himalyica, Cleome viscosa, Trianthema portulacastrum, Coronopus didymus, Chenopodium ambrisoides, Euphorbia indica, Bidense chinensis, Oxalis corniculata, Achyranthes aspera, Conyza bonariensis, Oxalis corniculata, Verbena officinale* along with grasses such as *Brachiaria distachya and Cynodon dactylon.*

4.5.4 Economic Use of Plants

The existing flora comprised of trees, agricultural crops, vegetables, fruits, medicinal plants and wild species. These species are utilized by local communities in fulfilling their daily life requirement. Ethnobotany plays a prominent role in discovering all sorts of use categories from the remote areas pertaining to plant resources. Overall, ten use categories are reported from the project area. These economic value categories include medicinal, ethno-veterinary, fodder, fuel wood, agricultural implements, fruits, vegetables, weeds and timber. The detailed inventory of all plants with economic value is summarized in Annex 4.3.

Medicinal Plants: Medicinal plants attract local people as well as scientific communities for the treatment of various diseases and ailments. These are not only utilized for acute cases of human being but also for domesticated animals. 61 plant species are mostly used as crude medicine by the local inhabitants for treating various diseases.

Fruiting Plants: There were 24 plant species which are used as fruit including 13 wild species.

Vegetables/Potherbs: Vegetables constitute an important part of the daily diet. There is variety of wild plants in the project area whose edible parts are cooked for preparing local meals. These vegetables include roots, leaves, flowers and even unripe fruits. Altogether, 27 species are used as cooking vegetable, out of which 16 species are cultivated and 11 species are wild collected from the natural vegetation.

Fuel wood: Wood is the major source of energy for cooking and heating purpose. Trees and shrubs are mostly used as fuel wood source by local communities. About 78 species are used as fuel wood.

4.5.4.1 Forests

Forests are located at altitudes more than 2,000 masl, well above the Project impact area (1,000 masl). Forests and non-timber forestry products are important sources of livelihood to the local community. They serve as fuel wood, home construction, furniture and traded to Gilgit Baltistan (GB) and the down country to meet commercial and business objectives. In Dasu, local people are heavily dependent on the forests and forestry products (Table 4.25).

Table 4.25: Timber Yielding Trees Recorded from DHP

Sr. No.	Plant Species	Family	Local name
1	*Abies pindrow* Royle.	Pinaceae	Chur
2	*Cedrus deodara* (Roxb. Ex Lamb.) G. Don	Pinaceae	Beesh
3	*Dalbergia sissoo* Roxb.	Fabaceae	Shesham
4	*Diospyros lotus L.*	Ebenaceae	Amlok
5	*Juglans regia L.*	Juglandaceae	Achhoe
6	*Leucaena leucocephala* (Lam.) de-Wit	Mimosaceae	-
7	*Morus alba L.*	Moraceae	Marath
8	*Morus nigra L.*	Moraceae	Marath
9	*Pinus gerardiana* Wall. non Lamb.	Pinaceae	Thulesh
10	*Pinus wallichiana* A.B. Jackson	Pinaceae	Chhar
11	*Populus deltoides* Bartram ex Marsh.	Salicaceae	Sufaida
12	*Quercus baloot* Griffith	Fagaceae	Bani/Jaand
13	*Quercus dilatata* Lindl. ex Royle	Fagaceae	Kagani/Zharyun

Forests in the Project area can be classified as ‘Private Forests’ owned by the local community, but managed by KP Forest Department, which is responsible for overseeing commercial timber extraction and timber sales. Previously local communities would sell the timber on standing basis to logging contractors. KP Forest Department attempted to regulate volume extracted through the use of harvesting plans. Forests are quite a significant source of income for local communities as private owners, woodchoppers and timber cutting thereby selling through government leasing. The forest royalty ratio is 80:20 i.e. 80% share goes to community and 20% share goes to the government treasury of KP. Selling of fuel wood is an important business in the Project area and common practices on KKH. People harvest Oak tree, Wild Olive and other fuel wood trees from hill sides and store in the form of wood toll on main KKH. Collection of pine nut, walnut and mushroom are also important seasonal business of the area. Various needs of local communities also place considerable pressure on natural forests. These include: timber for housing, agricultural implements, furniture and other issues; and firewood for cooking and heating.

4.5.5 Animal Biodiversity

4.5.5.1 Birds/ Ornithology:

58 bird species belonging to 28 families/subfamilies are recorded during present studies (Annex 4.4). The largest family recorded is *Turdidae* with 11 species followed by *Columbidae* and *Corvidae* (five species each). Among the recorded birds about 62% species were found to be resident in the area, 24% summer breeder and wintering and 14% Passage migrant. Status of 72% species is Abundant and Common.

Important bird species (Table 4.26) in the Project area are Western-horned Tragopan and Monal Pheasant (listed respectively as vulnerable and rare by Birdlife International). Tragopan is reported to habitat on elevations above 3,000 masl on the left bank; however no individuals were recorded during the present study. All other birds are common and abundant in population. Most frequently encountered species were White-cheeked Bulbul, Shrikes, Tits, Wagtails, Jungle Crow, Common Myna, House Sparrow, Thrushes, and Blue Rock Pigeon. The least encountered species were Marsh Harrier, Indian Roller, Common Kingfisher, White-bellied Redstart and Eagle Owl.

Table 4.26: Important Bird Species in the Project Area

Sr. No.	Common Name	Scientific Name	Family	Status	Remarks
1.	Western Tragopan	*Tragopan melanocephalus*	Phasianidae	Vulnerable	Reported from higher valleys of Kandia, Laachi, Sazin Kot, Kaigah
2.	Himalayan Monal	*Lophophorus impejanus*	Phasianidae	Rare	Stuffed bird at Dasu town hunted from Kandia Valley few month ago; reported from Kaigah, Laachi, Sazin
3.	Rufous-tailed Rock Thrush	*Monticola saxatilis*	Turdidae	Rare	Razika

4.5.5.2 Migratory Birds, Waterfowl and Wetland Birds

Indus valley is a part of Central Asian Flyway for hundreds of thousands migratory birds. The flyway covers the areas used by a diversity of species of birds with the main migratory routes through Central Asia. The flyway area extends through 21 countries from the Arctic Ocean in the north to the Indian Ocean in the south. It overlaps with both the African-Eurasian flyways in the west and the East Asian Australasian flyways in the East. This famous route from Siberia to various destinations in Pakistan over Karakorum, Hindu Kush and Suleiman Ranges along Indus River down to the Indus delta and is commonly called as international migratory bird route number 4 (Figure 4.22). It is also called as the “Green Route” or more commonly “Indus Flyway”. The birds from north spend entire winters in different wetland of Pakistan, which are distributed almost throughout the country from the high Himalayas to coastal mangroves and mud flats in the Indus delta. After successful wintering they go back to their native habitats for breeding purposes. List aquatic, wetland birds reported from secondary sources are given in Annex 4.4. 15 wetland birds are recorded during field surveys from July to September. However, it is anticipated that more wetland birds will be recorded during winter, early migration and breeding season.

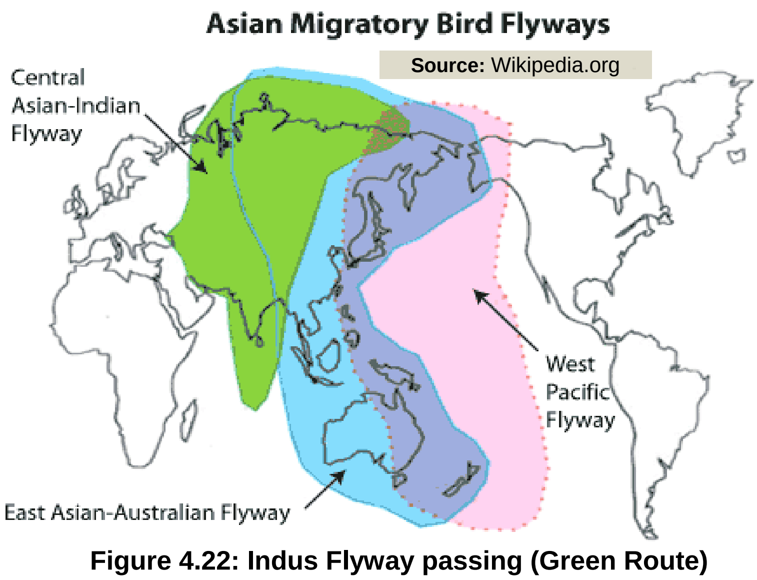


Figure 4.22: Indus Flyway passing (Green Route)

4.5.5.3 Mammals

Wildlife is generally located about 3,000 masl on the mountain tops or at higher altitudes. A total of 10 species of mammals were recorded from the study area (Table

4.27) during the present surveys. According to IUCN's Status and Red List of Pakistan Mammals, two mammalian species are reported Critically Endangered (Common Leopard and Caracal cat); three species are Endangered (Indian Wolf, Himalayan Musk deer and Markhor); one Vulnerable (Asiatic Black Bear); three Near Threatened (Hill fox, Asiatic jackal, Rhesus macaque) and one Data deficient (Leopard cat).

Table 4.27: The List of Important Mammals from Project area

S/No	Common Name	Scientific name	Family	Status	Remarks
1.	Asiatic jackal	*Canis aureus*	Canidae	NT	Pellet Laachi Nallah, Melar
2.	Indian wolf	*Canis lupus*	Canidae	EN	Reported by locals from Laachi nullah and Kandian Valley
3.	Hill or Kashmir fox	*Vulpes velpes griffithi*	Canidae	NT	Pellet near Melar Village, reported by locals from Kandian valley, Laachi Sazin kot area
4.	Common Leopard	*Panthera pardus*	Felidae	CR	Reported rarely by locals of Kandian, Laachi
5.	Leopard cat	*Prionilurus bengalensis*	Felidae	DD	Preserved skin at house-Laachi Nallah
6.	Caracal	*Felis caracal*	Felidae	CR	Crossed KKh near Kandian suspended bridge in evening time; also reported by locals of Kandian valley
7.	Asiatic Black bear	*Ursus thibetanus*	Ursidae	V	Reported from higher elevation of Laachi, Kandian, Sazin and Chochung area
8.	Himalayan musk deer	*Moschus chrysogaster*	Moschidae	EN	Youngone captured from Pallas by local of Dasu and sold for Pak Rs. 15000. Also reported from higher valleys of Kandian, Laachi and Palas valley
9.	Markhor	*Capra falconeri cashmiriensis*	Bovidae	EN	Stuffed specimens at Laachi nullah, Sazin kot, Kandian valley-Aliel village. Summara Nallah police check post- hunted one female; reported from Kaigah, Laachi, Sazin and Kandian Valley
10.	Rhesus macaque	*Macaca mulatta*	Cercopithe idae	NT	Reported by locals from Laachi nullah, Kandian, Sazin kot, Chochung, Jalkot areas at higher elevation

NT=Near threatened; EN=Endangered; CR=Critically Endangered; V=Vulnerable; DD=Data deficient (status described by IUCN-Pakistan, 2005)

4.5.5.4 Amphibians and Reptiles

Six species are observed during the study period (Table 4.28). Two types of lizards are common in the area from Dasu to Basha while one toad is recorded near Dasu village.

Two killed snakes were found; one at Gobar Nullah and other near the dam axis site. It is a common practice that locals kill the snakes whenever encountered.

Table 4.28: Amphibian and Reptiles Recorded in DHP

S. No.	Scientific Name	Common Name	Family	Status	Remarks
1	*Bufo viridis*	Green Toad	BUFONIDAE	C	Near Dasu
2	*Laudakia pakistanica*		AGAMIDAE	NE	Near Razika
3	*Agama agrorensis*	Agrore Valley Agama	-do-	NE	Near Dasu; Shori Nullah
4	*Macrovipera lebetina*	Blunt-nosed viper	Viperidae	NE	Killed by someone near Gobar Nullah; identification is tentative as specimen was not in good condition
5	*Ptyas mucosus*	Dhaman	Colubridae	NE	Killed near dam site area; identification is tentative as specimen was not in good condition
6	Varanis monitor	*Goh Lizard*		NE	Chochung village

4.5.6 Insect Biodiversity

Both the beneficial and harmful role that insects play in the human environment is well recognized. However, the current state of knowledge about Northern Pakistan insect biodiversity is very inadequate and a lot of research is needed. Review of literature shows that *Papilio polyctor polyctor* is common in the Himalaya and Hindu Kush foothills between April and September and between March and October at lower altitudes (500-600 m.- i.e. Islamabad). The monsoon brood is particularly colorful and large. The host plant is *Zanthoxylum armatum*. *Papilio machaon* is common or locally common in mountain areas of northern and western Pakistan. *Hyponephele pulchra* and *Hyponephele. pulchra astorica* are two subspecies of *Hyponephele pulchra* and are morphologically quite distinct. While *species pulchra* has a uniform chocolate brown ground color on the upper side of both wings, while species *astorica* has its forewing ground color replaced by a warm shade of orange brown with a thin brown outer margin. Species *pulchra* has been observed on lush meadows near the villages in KP. *Hipparchia parasatis* is common in a range of habitats throughout northern Pakistan. Some bugs, dung, beetle and weevils have been reported in the study area. Multipedes, centipedes and other soil insects are common. According to health authorities in KP, the Sand fly commonly exists along Dasu and Chilas range of KKH.

4.5.7 Ecologically Protected and Significant Areas

There are no designatged protected areas close to the project area. A Community Conservation Area (CCA) is located more than 12 km away from the dam site near Kaigha . It is a private game reservoe and a community managed conservation area (not a protected area) for Markhor covering about 5000 ha. It also provides protection to Musk deer, Tragopan, Monal pheasant and other species at higher elevation. Within this game reserve, markhor inhabit lower elevations (located about 3 to 5 km from the proposed reservoir submergence area) in winter and higher elevations during summer (located about 12 km from reservoir area).

Other significant/sensitive areas for Markhor, Musk deer, Black bear, Tragopan, Monal pheasant as well as other species in the project boundaries are Laachi Nullah and

Sazin kot on left bank of Indus while on right bank Kandia Valley (between the villages Thooti and Aliel) and the area opposite to Shori Nullah.

4.5.7.1 Community Conservation and Trophy Hunting

KP has introduced trophy hunting programs to gain community support for wildlife conservation and control poaching. Markhor and ibex are highly priced species for trophy hunting. The province offer trophy hunting of both these species on a limited scale. According to 'Conservation on International Trade in Endangered Species of Flora and Fauna' (CITES), the quota for Markhor hunting for Pakistan is 12 (CITES, 2002). Out of hunting quota of 12 animals, four were allotted to KP, five to Baluchistan, and three to GB. Annually one hunting permit is issued for Kaigah conservancy. Each permit costs about USD 80,000 to 100,000 and 80% of this fee goes to the community. The money is kept in a conservation funds and is spent by the village conservation committee on conservation and community welfare programs. This has brought a sense of ownership among the local communities and now they are extending their full support and cooperation in the protection of wildlife.

4.5.7.2 Palas Valley

The Palas valley is located about 50 km downstream of the project site. The palas valley supports about 1,000 of Western Tragopan (Tragopanmelanocepahalus - IUCN vulnerable), an important pheasant in the Himalayan region. The Palas Valley also supports populations of at least seven other rare bird species, including Phylloscopustytleri is classed as near vulnerable and the remaining are restricted range. The Palas Valley is listed by Birdlife International as the most important site for bird conservation in this bio-geographical zone.

Populations of most if not all of the mammals found in the Western Himalayas are found in Palas. These include Brown and Black Bears, Himalayan Ibex, Markhor, Snow Leopards, and Wolves. Inventories now being undertaken of smaller mammals and especially bats. Total area of the Palas valley is about 1400 km2 with elevations ranging 700 m to 5200 m amsl. Both the winter and summer ranges of much of the wildlife are included within the valley. The biodiversity of these mountainous ecosystems is under heavy stress from deforestation, firewood collection, overgrazing, over-hunting, over-harvesting of medicinal plants, soil erosion, use of pesticides, and weak law enforcement

4.6 SOCIO-ECONOMIC ENVIRONMENT

Detailed socioeconomic information in the Project area is presented in SRMP Volumes 2 (Socioeconomic Baseline and Impact Assessments) and Volume 3 (Analysis of Poverty, Conflict and Development Nexus: The Case for DHP). This section presents a summary of these documents.

4.6.1 Kohistan District

The word Kohistan literally means "land of mountains." It is one of the most isolated and the most deprived district not only in Hazara Division but considered one of the least developed districts in the country. Swat is situated to its west, Chilas, Darial and Tangir on the northern side and Naran, Kaghan and Alai valley surround Kohistan from the southern and eastern sides. Dasu is the District headquarters, whereas Pattan, Palas, Kandia and Dasu are the four Tehsils (revenue unit) of Kohistan District. The River Indus flows through Kohistan and divides it socially and culturally. Its national significance is the Karakoram Highway that runs through the District to the Northern Region and to the Chinese border to the northeast. This road is the main source of trade, transportation and link between Pakistan and China.

4.6.2 Demographic Information

The Population of the Kohistan district in 2008 was 477,000, 99.6 % of population is Muslim of which 55.43% are males and 44.57% are females. Kohistan District consists only of rural population and the population density is low with 63 per km2, while the male per 100 female ratios is 124. Average household size in 1998 was 6.4 while the Average Annual Growth Rate (1981-1998) was 0.09% much below the national rate of 2.69. The demographic information of Kohistan is presented in Table 4.29.

Table 4.29: Demographic Profile of Kohistan

Indicator	Kohistan District	Pakistan
Average Annual Growth (1981-1998)	0.09%	2.69
Sex Ratio (males per 100 females)	124	108.5
Population density/ per Sq. Km	63	166.3
Average family size	6.4	
Unemployment ratio	7.2%	19.68
Age Dependency Ratio	112	88.34

Source: District Census Report, 1998.

4.6.3 Villages to be affected

Considering direct and indirect impacts of the project interventions and associated project facilities the total project affected area has been defined to include 17 hamlets/villages on the Left bank and 17 on the Right Bank of the Indus River, coming under in 02 Tehsils of Kohistan District. Thus, 34 hamlets/villages, 17 on both Left and Right Bank of Indus River are affected by the inundation of the hamlets by the reservoir filling and realignment of 68 km of KKH. The list of hamlets and villages within the project area is given in Table 4.30.

Table 4.30: List of Hamlets and Villages within the Project Affected Area

No.	Hamlet	No of Population	Village	Union Council
	Right Bank			
1	Komila*	69	Komila	Komila
2	Kass*	09		
3	Rango*	24		
4	Seo*	101	Seo	Seo
5	Siglo	1218	Siglo	Siglo
6	Melar	336	Maliyar	Kuz Purwa
7	Koz Kai	143		
8	Kai Dogah	60	Dooga	
9	Seer Gayal	504	Gayal	
10	Kot Gal	219	Kot Gal	Thuti
11	Warisabad	95	Thuti	
12	Nut Bail	40		
13	Thuti	229		
14	Sluch	137		
15	Doonder	45		
16	Gummo	106		
17	Cheer Shial	85		
Total	**17**		**8**	**6**
	Left Bank			
1	Chuchang*	880	Dasu	Dasu

No.	Hamlet	No of Population	Village	Union Council
2	Khoshe*	63		
3	Logro	**	Logro	
4	Uchar Nallah	367	Uchar Nullah	
5	Barseen	242	Barseen	
6	Largani	73		
7	Kaigah	588	Kaigah	
8	Gul e Bagh / Maidan	227		
9	Pani Bah	141		
10	Gadeer	53		
11	Chalash	78		
12	Looter	86	Looter	
13	Shori Nullah	116	Shori Nullah	Sazin
14	Summer Nullah	69	Summer Nullah	
15	Lachi Nullah	118	Sazin	
16	Sazin Camp	86		
17	Shatial	346	Shatial	
Total	**17**		**10**	**2**
G. Total	**34**	**6953**	**19**	**8**
*** Villages downstream of Dam Site but not affected by the reservoir. ** Due to local tribal conflict population data of this village could not be collected.				

4.6.4 Housing and Settlement Patterns

Since the terrain along the Indus River is mountainous with steep slopes, the villages are on the terrace lands and slopes. Typically, people have built permanent houses on the lower altitudes of the mountains but migrate to temporary abodes at higher elevations of the same mountains during summer to avoid the heat and feed the livestock. This cyclical seasonal transhumance is common all over in the Valley in Kohistan.

The hamlets/villages on both river banks are old settlements with their own social and cultural heritages dating back to hundreds of years. The hamlets are scattered and the population density is low. The houses are largely *katcha* (temporary, made of wood with mud walls). There are also semi-*pucca* houses and *pucca* (brick built) houses (Figure 4.23). Two or more extended families related by blood or marriage live in one house. Thus, the basic residential/economic unit is the patrilocal joint family. Typically, this unit includes an elder's household and his married sons' families. Married sons generally live in their father's household with the latter or the eldest brother exercising authority over the extended family.

Figure 4.23: Types of Houses (Katcha, Semi-Pacca, Pacca)

The authoritative head of the household (father or elder brother) has the responsibility and authority to make decisions on behalf of the entire household members. It is within the joint family that the primary solidarities for daily economic activities and for the solution of practical matters are found. In joint families all family members pool together their incomes and share collectively their expenses on food, clothing, education, health, births, marriages and funerals. However, during the last few years it has been observed that this trend of living in joint households is gradually changing and people have also started living in single family households. However, the primary unit of social structure in Kohistan is still the joint family living under one roof and the next unit is the small village or hamlet. Kinships and tribal organizations permeate the social and cultural life of the Kohistani people.

4.6.5 Civic Amenities available in Villages

In Project area, an average village consists of 20 to 25 household units. Most villages already have a range of civic amenities. For example, access roads to the villages are fairly common with some having internal roads too. Micro-Hydel power and irrigation systems are also found in the hills using the natural stream sources. Nearly every village has a mosque. One in every three villages has a school for boys; however, rarely for girls. Some villages have latrines and better sanitary conditions than others. Every second village has a community graveyard. A Basic Health Unit (BHU) is available for a cluster of villages. Finally, the villages have good access to markets and transportation networks.

4.6.6 Seasonal Migration

The communities in the Project area are mainly transhumant agro-pastoralists. Seasonal migration is very common in project area and the people practice it due to a variety of reasons: climate, local psyche, culture, preferences and livelihood main among them. This seasonal migration is practiced to cater to the need of the time and local living style, and not only providing fodder for livestock but also for harvesting forest products from higher altitude. Usually people commence migrating to higher elevations in May and start moving back in mid-October. Most of the people have two houses at different elevations one is called the middle house and other is called higher elevation house. Some people who are shepherds also have a fourth house at the top and move to there to graze their livestock.

Seasonal migration pattern of the people in the project area is graphically shown in During the winter season people reside along the banks of Indus River from October to April. In the Winter Residence Zones villages are scattered along the Indus River up to a maximum level of almost 1,500 masl. Due to open grazing in winter people grow limited crops at lower elevations.

During summer when the ambient temperatures are high villagers prefer to move to higher elevations (1500masl to 2000masl) to beat the heat. In addition, most villagers have livestock and subsistence agriculture because the size of agricultural fields is of one to two acres in the middle and upper area of the valley and during summer their livelihood mainly depends upon these. Further, while at the lower elevation, villagers have to buy fuel wood but when they move to upper levels during summer they can gather fuel wood from own and communal forest areas where fodder is also available. Therefore, the seasonal trans-humane to upper elevations not only provide them with favourable living conditions and fodder for livestock, but also economic benefits. People, who remain living in the winter houses throughout the year are those engaged in government employment, other private sector jobs and also the tenants who have to care for others’ agriculture fields. A satellite map showing settlements at different elevations are shown in Figure 4.25 to understand the migration pattern of the local community.

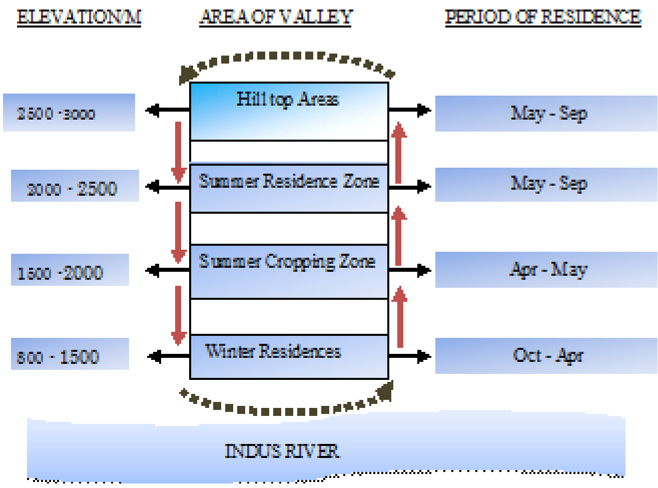


Figure 4.24: Seasonal Migration Pattern of People in the Project Area

Figure 4.25: Settlements at Various Elevations along the Hill Slope

Out-migration from the project area is quite limited and largely tied to paid labour opportunities in places like Abbottabad, Mansehra, Rawalpindi and Swat. Entrepreneurs, too, migrate to downstream areas where there are more opportunities. Out migration is also noticed in case of those who seek higher education.

4.6.7 Tribalism

Kohistan is divided in to two parts i.e. right bank and left bank or Swat Kohistan and Hazara Kohistan. Both parts of the Kohistan have their own history, culture and language. Further the district is divided into different tribes and valleys.

The Main tribes of Kohistan district are Manzar, Money, Koka Kheil, Manik Kheil and Darram Kheil. The two main tribes Manzar and Money occupy the Right bank of the Indus River known as Swat Kohistan while the main tribes on the Left bank of the Indus River, the Hazara Kohistan, are Koka Kheil, Manke Khail and Darram Khel.

Generally two to three villages comprise a sub tribe and, traditionally, these sub tribes are headed by a tribal head named Malik. Malik is a title name which means the head man of the village. In every village or sub tribe there is at least one Malik, but informally people use the term Malik to more than one person in the village. Malik is a person with money, power and respect from the villagers. The Malik takes an interest in people's issues and tries to resolve them. The Malik takes decisions on behalf of his village community with involvement and consultation of the notables of the village and tribe. Issues beyond the level of the Malik are resolved through the Jirga process.

The Right Bank area of the Indus River where 17 affected hamlets are located is divided into two main tribes, Manzar and Money. The affected hamlets of Left Bank belong to the main tribes of Koka Kheil, Manke Khail and Darram Khel.

4.6.8 Religion and Cultural Norms

The Kohistan is a deeply conservative society, and religious values prevail. Religious practice is generally confined to prayer and fasting. It is reported that, 'More priority is also given to tradition.

There are no religious tensions within the local population because there is no Shi'a or other minority sects: all are followers of the Sunni sect. Moreover, conflicts found elsewhere between different schools of thought within Sunni'sm – notably between Deobandis and Barehlvis[1] – are also absent, because the population is virtually 100 % Deobandi (Ahl-e-Hadith). Kohistan District has also remained immune to the religious militancy that has affected other parts of KP and FATA.

The tribal people of Kohistan consider themselves as substantially different from the majority of Pakistan population, especially, with regard to ancestry. Religious leaders have a strong influence on the local populace and the social set-up of the area. There prevails a sense of suspicion that outsiders, particularly NGOs, have a hidden agenda of social change detrimental to their religious and cultural practices and traditions prevailing in the area. Information disseminated through Imams of the mosques is considered more reliable and acceptable.

4.6.9 Education

Literacy rate is very poor in the project area with nearly 77 % people are illiterate. Among literates only 2% have higher education, about 4% studying up to Matric and 17% up to primary level as presented in Table 4.31.

Table 4.31: Education Level of Affected Population (Project Area)

Education Level	Total Number of Persons			
	Lt. Bank	Rt. Bank	Total	Percentage
Illiterate	824	1007	1831	77.00%
Up to Primary	342	53	395	16.61%
up to Matric (10th- High School)	79	6	85	3.57%
Higher Education	50	2	52	2.19%
Professional and Post Graduate	15	0	15	0.63%
Total:	**1310**	**1068**	**2378**	

Source: Field Surveys, Env.& Soc. Safeguards Study, Detailed Design 2012, DHC

[1] Both Deobandis and Barehlvis trace their origins to India. While both are part of the Sunni sect, their approach to Islam and religious practice is very different. Deobandis are close to the 'puritan' Wahabi movement, and lay stress on following the Quran and Sunnah, and establishing a direct link with God. The Barehlvi movement/sect, by contrast, is close to Sufism and its practices include: commemorating the Prophet's birthday; use of devotional music; visiting shrines of the Prophet, his companions and 'saints'; asking 'saints' to intercede on behalf of the living with God.

4.6.10 Health

Primary health care is provided through Basic Health Units (BHU) and Rural Health Centre (RHC) in the Kohistan District, Dasu town and in the project area. BHUs are situated on union council level and meant to provide basic curative and preventative services with no inpatient facilities and no laboratory. In Kohistan the main activities in the BHUs are offering limited basic curative services due to lack of staff and due to cultural restrictions only minimal preventive health care is feasible. The Expanded Program of Immunization (EPI) is foreseen to be carried out in each BHU, playing also an active role in the polio eradication program.

Each BHU is supposed to be staffed with at least one Lady Health Visitor (LHV). Their presence is even more essential since the District Kohistan there is no lady doctor available. LHVs are expected to provide both antenatal and postnatal care patients and also assist in deliveries in the health facility. Social mobiliser would have the responsibility for social/outreach health promotion activities such as health education in the community, school health education, and awareness rising about malnutrition.

Some facilities are equipped with social mobilisers/health promoters. They interact with the community (only men) for issues on health awareness such as safe drinking water, hygiene promotion and proper waste disposal of the houses. Even though a BHU should have one Medical Officer (MO) posted, in Kohistan most of BHUs are run by medical technicians or dispensers due to unavailability of doctors. There are thirty three BHUs in the Kohistan district, in which. eight BHUs in Dasu tehsil (3 in the affected area) and four BHUs are in Kandia tehsil (1 in affected areas).

Available health data on Kohistan are rudimentary and/or missing; for example no figures can be traced on reproductive health, other data are only partially segregated by gender and age. Therefore data have to be read and utilized in this context. The absence of essential data is itself informing on the status of the health information system in the District Kohistan. There are two types of common diseases in the project area are (i) infectious diseases (ii) nutritional diseases. Infectious diseases in the project area are typhoid and TB. Few cases of Kalazar fever are also reported in the project area. Nutritional diseases are osteomalacia and anemia. The health facilities detail in the project area is given in Table 4.32 below.

Table 4.32: Health Facilities in Project Impact Area

Sr. No.	Health Institutions	No. of Health Facilities		
		Left Bank	Right Bank	Overall
1	Hospital	0	0	0
2	Rural Health Center	1	0	1
3	Basic Health Unit	0	4	4
4	Dispensary	0	1	1
5	TB Centre	0	0	0
6	Maternity Home	0	1	1
7	Private Clinic	0	3	3
8	Quack	0	1	1
9	Hakeem	0	1	1
10	Homeopathic Clinic	0	3	3
11	Midwife	0	6	6
12	Medical Store	3	7	10
	Total	**4**	**27**	**31**

Source: *Socioeconomic Surveys*

4.6.11 Water supply and sanitation

Indus water is not used for drinking because of its non-accessibility, high water currents and turbidity. Tributaries and springs are the sources of drinking water to the local community. The water from springs and tributaries are diverted through the pipelines by gravity. The sources of water in the project area are given in Table 4.33.

Table 4.33: Sources of Water in Study Area

Sr. No.	Categories	Left Bank		Total	%	Right Bank		Total	%
		Drink-ing	Irriga-tion			Drink-ing	Irriga-tion		
1	Dug Well	0	0	0	0.00	0	0	0	0.00
2	Hand Pump	0	0	0	0.00	0	0	0	0.00
3	Tube Well	0	0	0	0.00	0	0	0	0.00
4	Pipe water	2	2	4	5.19	0	0	0	0.00
5	Water Tank	1	2	3	3.90	4	0	4	5.71
6	Natural Spring	14	16	30	38.96	10	10	20	28.57
7	Water Channel	0	14	14	18.18	6	20	26	37.14
8	Nullah	8	18	26	33.77	7	12	19	27.14
9	Others	0	0	0	0.00	1	0	1	1.43
Total		**25**	**52**	**77**	**100.00**	**28**	**42**	**70**	**100.00**

Source: *Field Surveys, Env. & Soc. Safeguards Study, Detailed Design 2012, DHC*

About 51 percent of the population of KP had access to proper sanitation facilities (underground, covered or open drains) in 2006/07 and only 44 percent of rural residents had access to sanitation facilities. Pit latrines are the common type of latrines in the project area.

4.6.12 Income and Livelihood

The Kohistan district has the lowest per capita income in whole KP province. But it is interesting to note that almost every individual in the project area has three homes and land for agriculture at three different places. One near the Indus River, one in the middle elevations and one in the very high elevations near the glaciers for extreme summers. Overall the people of Dasu area are lower middle class agrarian society. Poverty can be checked through two methods, one refers to state of basic human needs and secondly measured as an index of income inequality. Economically they look strong but as far as basic facilities are concerned, they are deprived of these basic facilities and are poor. People do not have schools, education, health facilities, safe drinking water, no roads to many locations of people‘s residence and so on. Moreover the people have to pay higher prices for edible and every day needs than the urban centers of KP. These deprivations class them as poor.

Livelihood sources of the community vary with the valley slopes. The valley slopes can be divided into lower elevation (less than 1,500 masl), middle elevation (1500 to 2000 masl), higher elevation (2000 to 2500 masl), and top hills or alpine pasture (2500 to 3000 masl). Various sources of income at differerent elevations and their contributions to total income are given in Table 4.34.

Table 4.34: Major Income Sources at Various Elevations

Sr. No.	Source of income	Total Income from Livelihood source (%)	Contribution to Income from various elevations (%)			
			Lower Elevation	Middle Elevation	Higher Elevation	Alpine Pasture
1	Agriculture	15.41	20	45	35	0
2	Livestock	5.45	39	6	10	45
3	Forest-timber	25.0	0.5	4.5	30	65
4	Forest-fodder	2.5	45	10	15	30
5	Fruit trees	1.0	10	45	45	0
6	Medicinal plants	0.3	3	17	20	60
7	Mushroom	0.4	10	20	30	40
8	Fisheries	0.4	55	45	0	0
9	Business	10.26	40	30	25	5
10	Skilled labor	1.65	35	40	25	0
11	Unskilled labor	15.28	25	45	30	0
12	Government employment	11.26	50	45	5	0
13	Private Job	2.98	55	45	0	0
14	Commercial activities	5	65	30	5	0
15	Soniwal (gold extractor)	2.69	100	0	0	0
16	Fuel wood Tolls	1.14	65	35	0	0

Source: Socioeconomic Baseline Surveys

Major sources of income are the non timber forest products such as timber, vegetables and fruits. Other major sources are livelihoodare agriculture, business, employment and livestock. Average annual income f5om each of the livelihood sources are given in in Table 4.35.

Table 4.35: Average Income by Livelihood Sector

Livelihood Sectors	Persons Involved	Average Annual Income (Rs.)
Agriculture	511	3,269
Forestry and Business	176	24,970
Skilled Work/ Handicrafts	10	17,850
Government Jobs	60	20,344
Private Jobs	27	11,944
Agri. Labour Permanent	1	30,000
Livestock Rearing	81	7,293
Labour	156	10,615
Soniwals	28	10,417
Others	36	13,447
Overall	1086	9,981

4.6.12.1 Forestry

There are forests on both right and left bank of Indus River. They are placed under two forest divisions i.e. Lower Kohistan Forest Division and Upper Kohistan Forest Division. Forests, though essentially located on high elevation, are the most important natural resource of the area and are both private and communal assets. Firstly, they meet the fuel wood requirements of the local inhabitants. Secondly, forests are quite significant source of income for communities; privately owned timber cutting and thereby, selling through government leasing is an income source. The forest royalty ratio is 80:20 i.e. eighty percent share goes to community while 20% share goes to the provincial treasury for re-plantation purposes. Although there are no regular orchards in the project area, there are scattered fruit trees in the valleys.

Fruit trees consist of walnut, almond, fig, apricot, pomegranate, mulberry, grapes, peaches, apple and others and usually, most of these are found on high elevations above the inundation level of the reservoir/dam. Walnut and grapes (white and black) are marketable. The cost of one kilogram soft walnut (*Kaghzi Akhroot*) is PKR 150-200 per kg in the local market. In local market the rate of Pine nut is PKR 450-500 per kilogram which varies from time to time. Shade trees are grown on the private land inside and around the villages which are significantly considered as the shade during summer, fuel wood and as fodder for the goats and sheep as well as cows and buffaloes.

Collection of Medicinal Plants, Mushroom and Pine nut (*Chalghoza*) is common practice in the area. Some medicinal plants are also collected from the mountains for trade but the proportion in financial returns to the affected community is negligible. One of the plants collected is Black Cumin (*zeera*) which is found in higher elevation and usually collected during the months of May and June and then sold in the local market. The average market rate is PKR 1250-1350 per kilogram.

Mushroom locally called "*Ghuchi*", is considered to have medicinal value. They are mostly collected by the people in their respective valleys. People earn money by collection of Mushroom from top hills, high, middle and lower elevations of the area. In local market, the rate of Mushroom is Rs.3000/ per kilogram.

4.6.12.2 Agriculture

People typically move into the middle elevations in the month of April and start preparing and leveling land for sowing summer crops in their lands on terraces. There, the major crop is maize along with red and white beans, potatoes, and all kinds of summer vegetables such as pumpkins, okra, wild spinach, carrot and radish. These vegetables are used for consumption and the excess vegetables are usually dried in the sun for winter consumption. The traditional subsistence farming system has been widely practiced for generations in the area. It is the predominant economic system, which in general supplies the people with most of their daily needs. Area under different crops is given in Table 4.36.

Table 4.36: Area under different Crops in project area

Crops	Area Under Different Crops (ha)	
	Area (ha)	%
Wheat area	190	44.37%
Maize are	226	52.73%
Sorgam Area	0.10	0.02%
Vegetable area	10	2.35%
Fodder area	2	0.53%
Total	**428.1**	**100.00%**

Source: Field Surveys, Env.& Soc. Safeguards Study, Detailed Design 2012, DHC

4.6.12.3 Livestock and Grazing

A majority of the people are also engaged in livestock production. Livestock breeding and rearing makes a significant contribution to the family income. Generally, bullocks are used for ploughing. People also use donkeys and horses for transportation in the valleys. Most of the daily consumer commodities such as milk, *ghee*, butter and meat are being produced for self-consumption. The main reason of migration from lower to high elevation is livestock and agriculture because each family and household keep some animals for their domestic and commercial purposes as at higher elevations livestock fed on grass and other plantations and people cultivate lands. Livestock is mostly reared by grazing in the pastures due to limited fodder availability. These cattle barely supply the household needs of dairy products and meat. There is a traditional '*Gujar System*', under which livestock herds graze throughout the seasons in the valleys within the vicinity of their habitations. However, due to scarcity of vegetation, trans-humance system of bringing herds of goats, cows & sheep to high altitude meadows in different regions of different valleys is quite common (see Table 4.34).

The livestock in the project area includes buffalos, goats, cows, oxen, sheep, chicken and Horses and others represent mules, ducks, parrots and pigeon etc. The average livestock in the affected villages is given in Table 4.37, the percentages represent the percent of that animal from the total livestock in the area.

Table 4.37: Livestock Population in Affected Area

Sr. No.	Livestock	No. of Livestock	Percentage
1	Buffalo	60	0.36
2	Cow	839	5.06
3	Goat	9476	57.16
4	Sheep	1350	8.14
5	Oxen	271	1.63
6	Calve	564	3.40
7	Donkey	260	1.57
8	Horse	122	0.74
9	Chicken	3577	21.58
10	Others (Mule, Ducks, Parrot, Pigeon etc.)	59	0.36
	Total	**1,6578**	**100.00**

Source: Field Surveys 2012, DHC

At present, traditional and very unscientific methods are used to get fodder production. For example, more seed is put to get the thick stand of crops (wheat, maize). Later on, some of the plants are uprooted / cut and fed to the livestock, which is a good practice for getting fodder but at the expense of reduced yields. Probably, the farmers cannot afford to put sufficient areas under fodder due to requirements of the staple crops of wheat and maize.

In winter season the people use the leaves of Bani & Wild Olive as a fodder for their Cows, Goats & sheep. In Project area, there is a big problem of fodder because agriculture fields are less and the population is increasing day by day which cannot meet with this fodder deficiency. This is the main reason; the people keep only Goats, Cows & Sheep which can easily graze openly in the hilly areas. To overcome the fodder deficiency, Barani Area Development Project-II and Kohistan Development Project Introduced mot grass practices in the area which is still applicable in some areas.

4.6.12.4 Business

The common business in the project area is selling of fuel wood which is common practice on main KKH in winter season as well as in summer season. The people harvest Oak Tree, Wild Olive and other fuel wood trees from hill side and store in the form of wood toll on main KKH. The daily sale of fuel wood is very high and the people earning huge amount. The local selling rate of the fuel wood is Rs.260-300/- per 40 Kg in summer and Rs. 350-400 per 40 kg in winter at different spots.

Collection of Pine nut (Chalghooza) is also a seasonal business of the area. The pine nuts are commonly found in Gayal, Kandia Valley, Doonder, Gummo on right bank; and Khoshi, Gadeer, Shori Nala and Summar Nullah on the left bank.

4.6.12.5 Skilled & unskilled Labor

The literacy rate in the project area is very low. Majority of the inhabitants are engaged with skill & unskilled labour. They are searching labor inside the district as well as outside of the district. Majority of the people depend on labors and meet with their daily expenditure through this practice.

On the other hand, the females are mostly working in domestic agriculture, often doing the hard work on land and livestock breeding, all over the year.

The reasons for this compulsion to labor are: - Higher rate of unemployment and population, which forces the parents to send their children to work. There is lack of any special / vocational education in the area due to this reason, majority of adult boys are forced to assist in shops, workshops and other places. Children are also working as per their traditional family system in the agriculture, mostly involved in grazing and feeding of animals. The average of affected persons is engaged with skilled & unskilled labor is 13%.

In other rural areas, many males mostly young and un-married, are working in other parts of the country that include some locations of Abbottabad, Mansehra & Swat followed by Karachi. Most of these jobs include drivers, construction workers, cleaners, cooks and others. Very often, the family decides that a certain enterprising young man should go for working in other area of Pakistan.

4.6.12.6 Government Employment / Jobs

Governmental jobs are generally of three types: regular jobs on a monthly basis for civil servants, contractual staff and daily-wages support staff. Employees are performing their duties in District Head Quarter Dasu.

Education Department is the main job contributor in the entire district while police department is second in providing the job opportunities to all kind of people. Some people are performing their duties in Forest Department, Agriculture, District Administration, Health, Social Welfare & Women Development Department, Population Welfare, Fisheries, National Bank of Pakistan, Archaeology at Shatial and Meteorological point at Kandia.

The other types of jobs existing in the area are through the contractors like National Program for Water Management, National Data Base Registration Authority (NADRA), however, most of the jobs under these contracts are of technical nature with limited scope for locals due to low illiteracy rate. The government jobs contribute the income of the inhabitants to 9% of the total affected area.

4.6.12.7 Private Jobs

People of the project area are also doing private jobs. Most of the young educated people of the area are working with some national and international NGOs. These NGOs are working for the development of the local population. Some people are working in schools provided by different NGOs.

4.6.12.8 Soniwal

Soniwal are basically tribes of the northern area of Pakistan. They can be found from Skardu to Thakot. Soniwal are earning their livelihood through gold extraction from sand which is deposited on the banks of Indus River. There are13 households in Darail valley just near the Shatial bridge. Although their houses are not going to be affected their livelihood will be affected. Soniwal extract 6-7 tollas (1 tolla = 11.78 gram) of gold in one season. The season normally starts from late October and goes up to first week of April normally. This one season extraction of gold is their earning for a year. All members of the family take part in extraction of gold from river sand.

4.6.13 Tourism

The Project area has a potential for lot of tourism, but no tourist facilities are available. Important tourist attractions in the Project area are archaeological remains (Rock Carvings) in Shatial and historical and beautiful mosque at Seo. Some locations along KKH such as Summer nullah and Zaid Khwar nullah provide picturesque view of Indus valley. There are restaurants at these locations.

4.6.14 Transport and Communications

KKH is the main source of communication in terms of road and it runs across the Kohistan District. The link roads are constructed by the C&W Department and Kohistan Development Authority. The access to side valleys is very difficult and almost 70% of the valleys do not have any access road. Road infrastructure (if present) in these valleys is very poor, drivable tracks are there inside main Kandia valley. There was a 46 km metaled road inside Kandia valley before the 2010 floods made by FWO and it was washed away in floods and after that this road could not be constructed due to lack of funds. While metaled roads are there inside Tangir and Darail valleys. People have to travel a long way from side valleys to reach KKH and then to Dasu or Chilas. The security along KKH is provided by police department in some sections of the KKH in the project area. Many police check posts are present along KKH.

At present there are 4 sub post offices and 6 branch post offices in the district as far as the telephone is concerned, the district is connected with the rest of the country by means of two NWD telephone exchanges, one exchange at Pattan and Komila (Dasu). The people in the project area live on the left and right bank of the Indus River. People on the right bank cross the river through the dolleys and reach to the main KKH and from there they travel to the other towns by taxi or bus. There are two types of dolleys in the project area. One is hand pulled while the other is mechanical (Figure 4.26). Due to influence of the Religious Leaders and the distance from other parts of the country, dissemination of daily general information is very limited. Electronic media such as television is still not generally accepted and newspapers are not readily available in the villages. Further, due to the high illiteracy rate printed material is not used much.

Figure 4.26: Traditional Cable Cars for Crossing Indus

4.6.15 Gender Aspects

Project area has a highly patriarchal society in which women are completely absent from public life. Females have very limited or no opportunities to access education. Publicly they are almost “invisible.” They do not have any say in decision-making, even within the household. Kohistan was among the only districts in Pakistan not to field any female councilors for the local government system introduced through the LGO 2001, in which 33% of all local government seats were reserved for women.

Purdah is very strictly observed. Even the entry of male first cousins into female areas of the home will often be forbidden. The role of women is as wives and mothers; they also carry out the majority of household and agricultural chores – cooking, washing, cleaning, collecting firewood, looking after livestock and working in the fields. The latter tasks are undertaken within the confines of *purdah*: areas of the forest, for example, are designated for women and no men will go there.

Polygamy is the norm in Project area: each married men will have two or more wives and numerous children. The first wife is typically from within the family/sub-tribe, usually a first cousin. But increasingly, those with the means will have second or third wives from Swat or Gilgit. They consider the women there to be 'cleaner' and more refined and educated than their local women. These outside women will often be kept in better rooms and living conditions than local wives. The permission of previous wives is never sought before taking on new wives.

4.7 PHYSICAL CULTURAL RESOURCES

4.7.1 Cultural Heritage of the region

The study area is a part of historical Silk Road and witnessed raise and fall of Buddhist Culture over a long span of millennia. Physical Cultural Resources (PCRs) identified in the study area are (i) Shatial rock carvings, (ii) historical mosques at Seo and Seer Gayal, (iii) graveyards and (iv) moveable artefacts. Locations of these PCRs are shown in Figure 4.27. Detailed description of PCRs in the project area and the impacts of the projects on these PCRs are presented in Volume 5 of EMAP: Physical and Cultural Resources.

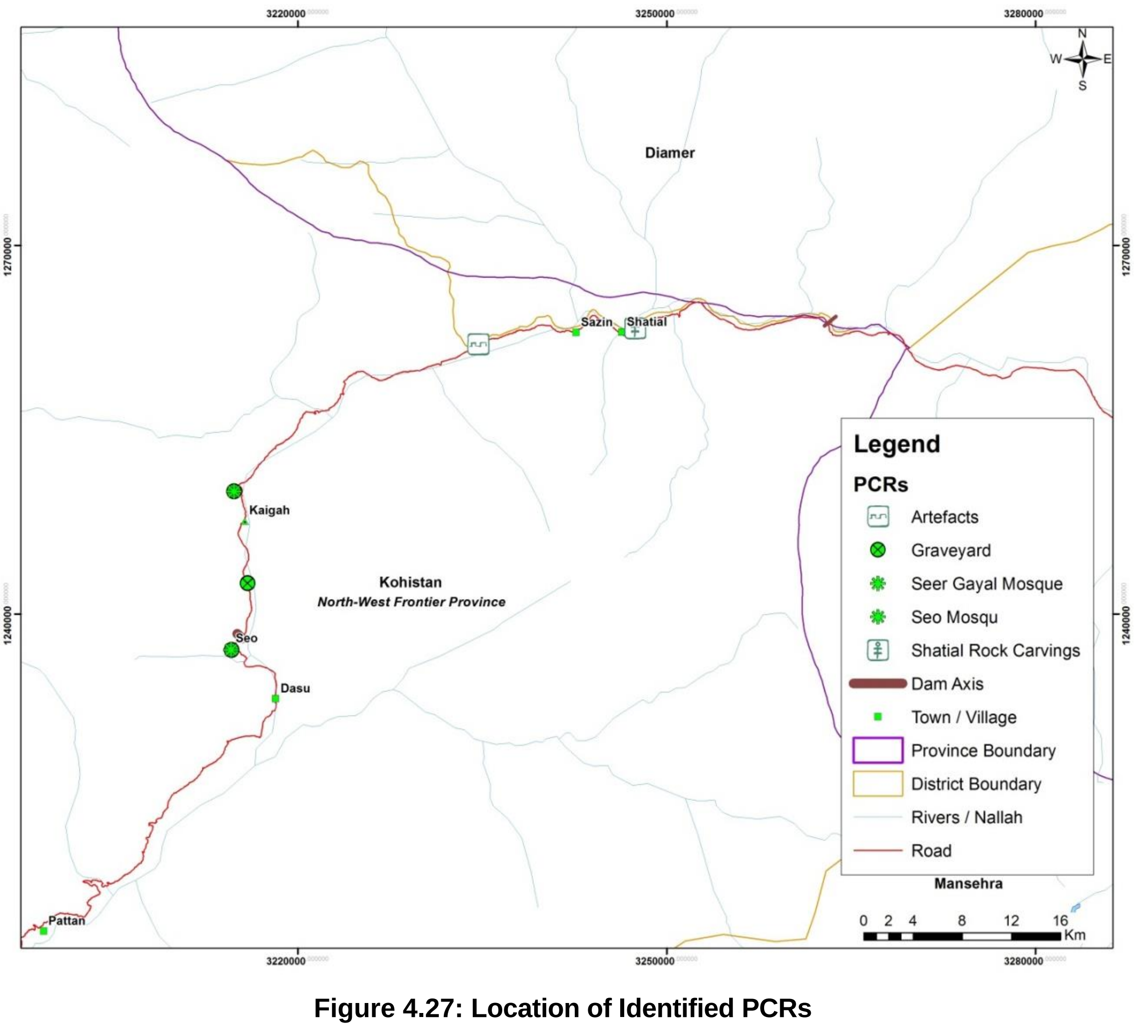


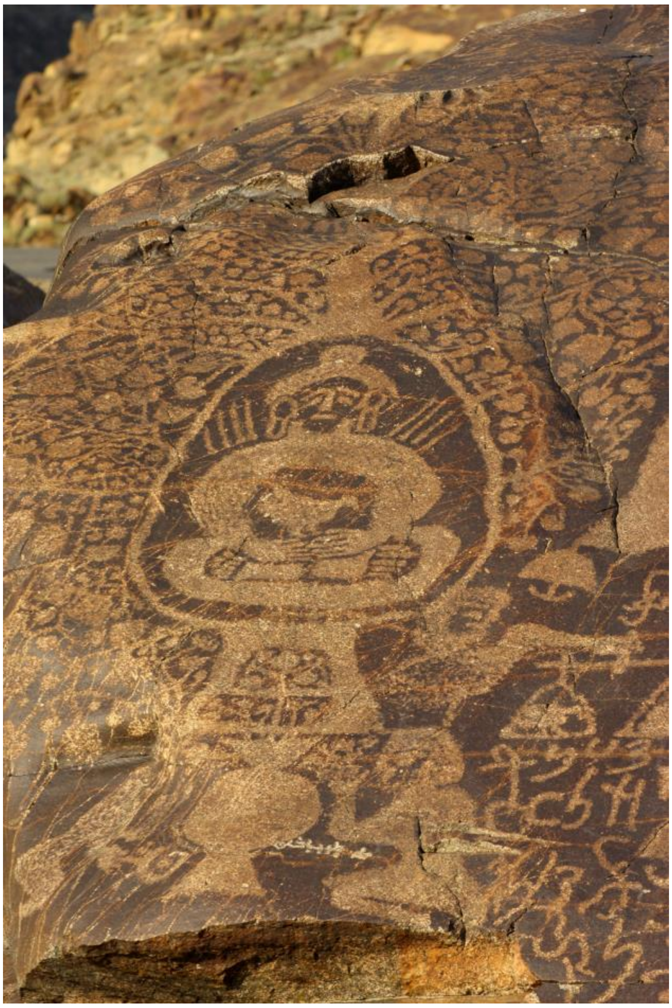
Figure 4.27: Location of Identified PCRs

4.7.2 Rock Carvings at Shatial

Shatial is located about 52 km upstream of DHP damsite. Rock carvings located near Shatial between the Indus and Karakoram Highway (KKH) is a designated archaeological site. It consists of 46 major rock boulders with carvings representing a wide variety of anthropomorphic (having human characteristics), zoomorphic (representing animal forms), and inanimate images. Anthropomorphic depictions range from simple line drawings of humans to an elaborate rendering of the sibi-jataka[2] (Figure 4.28) with in a large triptych. Most zoomorphic images are drawings of mountain goats, including ibexes and markhors characterized by long exaggerated horns. These rock carvings belong to 1st to 7th century AD. These are of interest, in addition to the scholars, to local and foreign tourists particularly the Buddhists for their religious significance.

Rock carvings at Shatial are a part of a large complex of over 30,000 petroglyphs and 5,000 inscriptions, spread over 30 sites stretching over 100 km from Shatial to the Raikot Bridge (located outside the study area).

The boulders on which these carvings have been made are presently not in good state of preservation. Many of them have developed cracks while almost all of them bear the adverse weathering effects. The surface of rock at most of the places is eroded and the inscriptions are not readable. The rock carvings are located in a private properly and are not protected with fencing or security, and hence are subjected to vandalism. Some of the carvings had already been deformed by vandals.



[2] Sibi Jataka is one of the tales of Buddha's incarnations in which he offers his flesh in sacrifice

Figure 4.28: Rock Carving depicting Sibi Jataka

4.7.3 Seo Mosque

The Seo mosque, the widely revered mosque in the region, is located in the Seo village, on the downstream of the proposed Dasu dam. According to the local tradition the mosque is approximately 400 years old. The mosque is constructed in dressed timber trunks placed one over the other. This religious building is currently in use for prayers and imparting Islamic religious education. Muslim visitors to Dasu visit this mosque in reverence. It also attracts common tourists for its ancient style of building and remarkable wood carvings (Figure 4.29).

Figure 4.29: Seo Mosque showing wooden pillar and brackets

4.7.4 Seer Gayal Mosque

The mosque at the village Seer Gayal (Figure 4.30), like the Seo mosque, is said to be over 400 years old. The wooden mosque has the same articulately carved motifs, which suggest their origin in the same period as that of the Seo mosque. This mosque is also decorated with carving work on its wooden columns, door or other decorative elements like brackets.

Figure 4.30: Seer Gayal Mosque: Decorated Wooden Pillar and Brackets

The structure of the Seer Gaya mosque is in good state of preservation. Religiously the mosque has less significance compared to the Seo mosque and frequented by only local community.

4.7.5 Moveable Artefacts

The area has not yet been intensely explored by any archaeological team, or any archaeological digging carried out to precisely find out the ancient wealth. Based on the consultation with local community, the artefacts found in the area is limited to just one iron sword with handle, which fortunately was in good state of preservation. This is thought to belong to the period when there was Sikh rule in Kashmir. Another find was a piece of pottery, which was a chance discovery during diggings for laying building foundation. This pottery item is a rimmed jar with two handles and a spout. It is in fairly good state of preservation except for a small portion of the rim, which is missing. From its design appearance, it appears to belong to the Mughal period.

4.8 KARAKORAM HIGHWAY

Karakoram Highway (KKH) is the lifeline of Northern Pakistan and it is only highway connecting Northern Pakistan with rest of the country. All the materials (cement, steel, etc.) required for construction of the Project has to come through the KKH. KKH, with many rock overhangs and sharp bends, runs along Indus right from its crossing on Indus at Thakot. During rains and snow fall, the traffic is susceptible to occasional disruptions due to landslides. Hence KKH is also strategically very important for timely delivery of the materials and construction of Project.

KKH starts from Hassan Abdal and goes up to Gilgit and further up to China. KKH was constructed over an 11 year period (1968-1978) by the Pakistan Army's Frontier Works Organization (FWO), with Chinese assistance. This asphalt road stretches some 840 km, and provides the northern areas of Pakistan with a vital link to the rest of the country. Beginning in Hassan Abdal, the road winds through Haripur, Abbottabad, Mansehra, Batagram, Thakot, Besham, Pattan, Dasu, Sazin, Shatial, Chilas, Gilgit and Hunza; it the crosses the Khunjerab pass at an altitude of 4,733 m, to reach the Chinese frontier. Apart from its strategic importance, the KKH is also historically significant, since it follows closely that segment of the ancient Silk Route. The completion of the KKH opened up the northern areas of the country to an unprecedented influx of developers, immigrants and tourists.

The traffic is counted at ten different locations including Dasu, Komila Bazar, Pattan, Besham and Thakot. The average daily traffic along KKH is shown in Table 4.38. Detailed traffic counts conducted by the environmental team are presented in Annex 4.5.

Table 4.38: Average Daily Traffic along KKH

Location	Motor Cycle	Car	Jeep	Pickup	Min bus	Bus	Trucks (3-axle)	Heavy Loader (3-axle)	Tractor	Military Vehicles	ADT Total
Thakot	214	413	191	282	180	103	363	126	113	103	2088
Besham	225	1383	255	827	308	68	231	55	20	40	3422
Pattan	216	488	184	256	260	20	256	120	4	0	1804
Komila	312	967	295	464	417	147	324	53	41	31	3051
Average	242	813	231	457	291	85	2934	89	45	44	2591

Source: Consultants Surveys, June 2012

Average traffic on KKH is 2961 vehicles per day. Nearly 18 percent of the vehicles are heavy vehicles (trucks and busses, see Figure 4.31). The average growth rate of the existing traffic is observed to be 0.65 percent per annum (based on the traffic count conducted at Barseen in 2007).

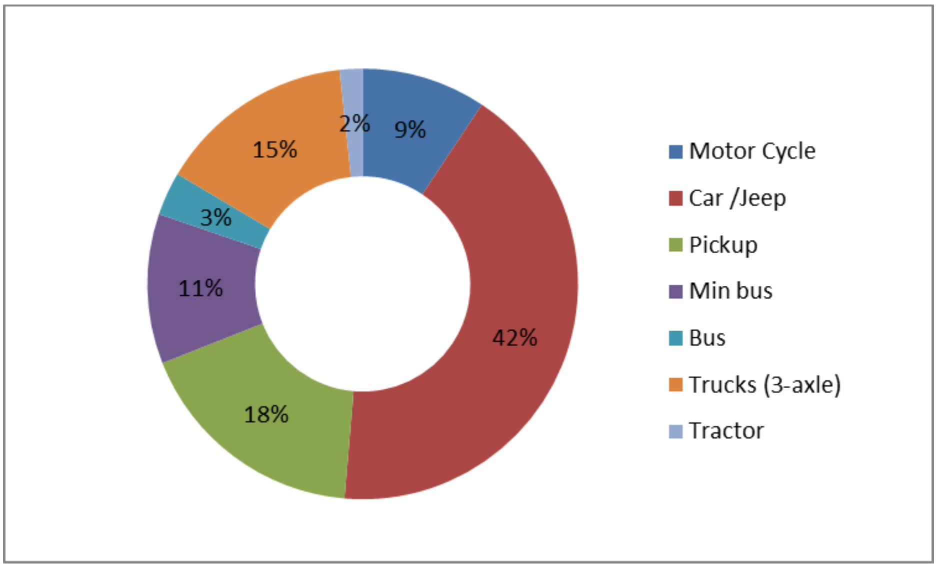


Figure 4.31: KKH Traffic Mix

Chapter 5
ANALYSIS of ALTERNATIVES

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5. ANALYSIS OF ALTERNATIVES

5.1 FRAMEWORK FOR ANALYSIS OF ALTERNATIVES

Social and environmental aspects, along with various other criteria, are considered in siting and design of various components of the Project. The framework considered for analysis of alternatives of DHP is shown in Figure 5.1. The framework consists of criteria and sub-criteria used for analysis of various project alternatives.

Technical Robustness	Hydrology — Geology — Structural Soundness — Energy Production
Constructability	Construction Program — Ease of Construction
Maintenance	Durability — Operational Issues
Cost	Construction Cost — Operation Cost
Social and Resettlement	Land Acquisition — Affected Households — Employment Potential
Environment	Footprints — Material Quantity — Excavation/ Blasting — Ecology; U/S&D/S impacts — Physical Cultural Resources — Safety — Transport Requirements
Previous Proven Technique	Proven Previous Successful Technique

Figure 5.1: Framework of Analysis of Alternatives in DHP

The respective criteria and sub-criteria are used wherever feasible to compare the following key components of the Project:

- Location of the dam
- Type of dam
- Generating units

- Construction program
- Resettlement of affected people
- Source of construction material
- Project office and colony
- Alignment of power and tailrace tunnels
- Sediment flushing

In addition, the following alternatives are studied to establish rationale for justification of DHP:

- 'No Project' or 'Without Project' Alternative
- Hydropower Projects other than Dasu
- Non-hydropower generation option (coal, oil, gas, nuclear and other types of renewables)

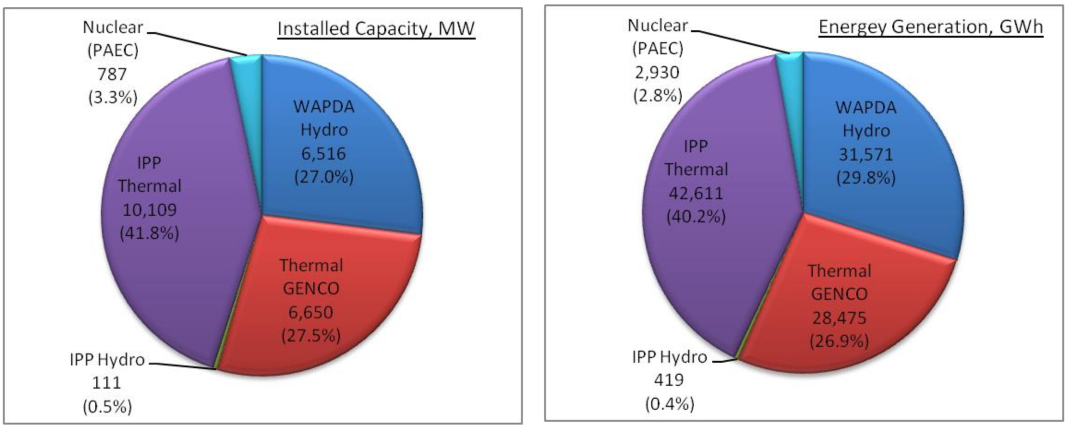
5.2 'NO PROJECT' OR 'WITHOUT PROJECT' ALTERNATIVE

Pakistan is suffering from an acute power and energy crisis which is primarily caused by insufficient energy supply and increasing demand. The total installed capacity was 24,173 MW, yet only a peak demand of 19,924 MW could be served in 2011. Power shortages resulted in long hours of load shedding, impacting households, industrial and commercial activities. Power shortages coupled with fuel shortages impacted export performance and economic growth. These issues are elaborated in the following sub sections.

5.2.1 Demand versus Generation

Pakistan per capita energy consumption is one of the lowest in the world with 450 kWh compared to the world average of 2,730 kWh. Since 1971 the per capita energy consumption has increased by nearly five times from 91 kWh to 450 kWh in 2009, and 62.4 percent of the population has access to electricity (World Bank Development Indicators, 2011).

The overall installed capacity of the country as of June 2011 was 24,173 MW and the annual energy generation was 106,006 GWh (Figure 5.2).



Source: NTDC Electricity Marketing Data. 2012

Figure 5.2: Installed Capacity and Power Generation in Pakistan as on June 2011

From 2000 to 2011, the installed capacity increased from 14,444 MW to 24,173 MW (3.2 percent average annual growth rate from 2000 to 2011). By 2035, the planned power capacity will be 39,817 MW (2.9 percent average annual growth rate from 2000 to 2035).

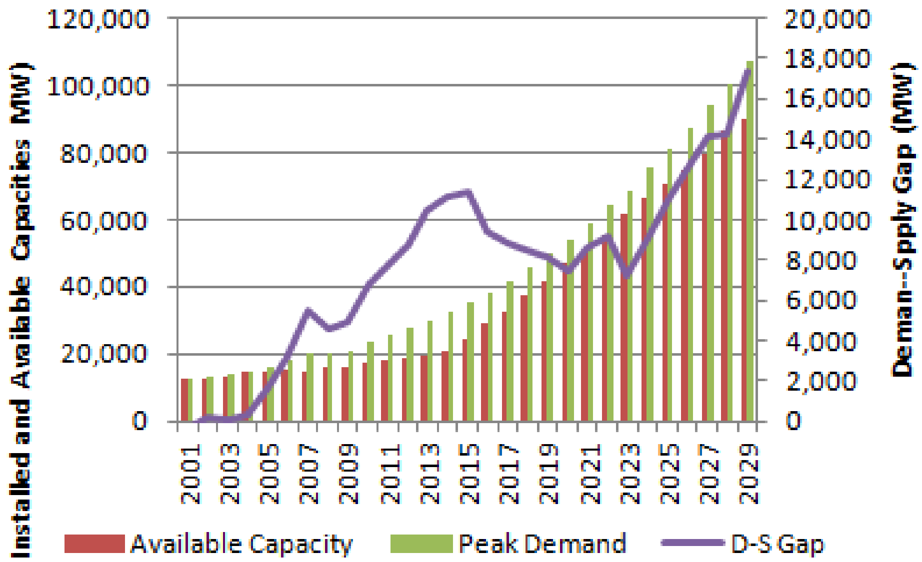
On other hand, peak demand of 12,344 MW in 2001 grew 7.6 percent annually to 25,648 MW by 2011 and further expected to grow 7.7 percent to 107,477 MW by 2029. With sharp differences in the planned installation and expected demand, the gap in demand and supply is expected to increase at 16.4 percent for the period of 2001-29, supply shortfall (power load shedding) is projected to be 17,367 MW in 2029. Meanwhile, recent energy demand of 115,857 GWh (2009) is forecasted to increase to 279,648 GWh (2019) and 798,514 GWh (2034) with annual growth rates of 19.3 percent and 7.7 percent, respectively[1].

Demand and supply gap in the past decade and forthcoming two decades are summarized in the Table 5.1 and depicted in Figure 5.3.

Table 5.1: Power Demand and Supply Gap (2000-2011) and Predictions (up to 2029)

	2001 (MW)	2011 (MW)	Growth Rate p.a.	2029 (MW)	Growth Rate p.a.
Available Power	12,708	17,924	3.5	90,110	7.0
Demand	12,344	25,648	7.6	107,477	7.7
Gap	+364	-7,724	13.1	-17,367	16.4

Source: Economic and financial analysis of DHP, Basic Design Report, 2012



Source: Economic Analysis of DHP, Basic Design Report, 2012

Figure 5.3: Future Demand and Supply of Power

5.2.2 Load Shedding

Due to large gap in power demand and supply, and non-functioning of existing thermal power plants to their full capacity due to their dependence on imported fuel supplies (and shortage of these supplies due to lack of foreign exchange to pay for imported fuel oil), there has been load shedding of about eight hours daily throughout the year. The load shed at generation, primary transmission and secondary transmission level is estimated to be about 5000 MW in 2011. Estimates of load shedding are given in Table 5.2.

[1] Demand: up to 2010 by NTDC op.cit., June 2011, p.-16, p. 63, and afterwards by The Planning Division, NTDC Electricity Demand Forecast Planning Division, p. 37

Table 5.2: Load Shedding Estimates

Financial Year	Annual Sales GWh/annum	Load Shedding GWh/annum	Total Demand GWh/annum	Load Shedding %
2003	52661		52661	
2004	57467	560	58027	0.97
2005	61247	265	61512	0.43
2006	67608	1208	68816	1.76
2007	71947	2040	73987	2.76
2008	72518	12578	85096	14.78
2009	69668	18222	87890	20.73
2010	73595	21821	95416	22.87
Growth (average. p.a.)	4.90	4.13	8.86	69.48

Source: ADB Power Sector Rehabilitation Project, 2012

Load management by shedding and supplying power to various areas and sectors on a rotation basis affected the industries, services and businesses with some being shut down or running at far less than optimum periods of time. The impact of load shedding has been estimated at 3 percent to 4 percent of GDP, costing about US$ 10b a year. This has rendered about 7.5 percent of the work force jobless. This situation is causing serious economic losses to the country as well as being socially and politically divisive and could lead to an increasing risk of social unrest. It is also increasingly being manifested in public protests.

Lack of power severely affects people's quality of life: summers are uncomfortable, children have no light to study, people cannot watch TV, they cannot cool food, and so on. But the impact of the energy crisis extends far beyond daily life. It affects schools, colleges, clinics and hospitals; it affects shops and businesses, reducing sales and revenue; and it affects industry, reducing productivity. It also deters investment. This means, on a macro level, reduced economic growth which translates into loss of livelihoods, jobs and income.

Demonstrations on the streets, blocking traffic on motorways and highways, burning of tyres and even attacks on WAPDA and other government offices are becoming commonplace, as people vent their frustration at prolonged and repeated power cuts. Public protests were held in many parts of the country to illustrate the growing public anger at the situation.

5.2.3 Heavy Reliance on Imported Fossil Fuels

Power system in the country has steadily relied more and more upon thermal energy. This greater reliance upon thermal sources also resulted in increasing dependence upon imported fuels, as Pakistan imports most of its liquid fuels.

Availability of scarce fossil fuel resources of oil and natural gas for power generation and large imports of the former are adversely affecting the national balance of payments. As much as 85 % of oil and allied products are imported and during the year 2007-2008 this bill stood at US$ 1.25 billion. Progressively increasing shortage of natural gas has necessitated increased use of furnace oil, prices of which are also tied with the oil prices in the international market. Coal usage is not significant but its use is also decreasing due to deterioration of the only coal fired power plant on the PEPCO System and non-exploitation of coal reserves in Thar.

Fuel prices have increased about 3 times (in nominal terms) in the period 2000-2010, at an average annual rate of 11.25% p.a. In the recent past (last 5 years) prices have risen at a sharper rate of 13.45%. Gas prices have increased at about 8% average p.a. in the 10 year period, unregulated HSD and Furnace Oil prices, however, have risen at a higher rate of 16% and 12% respectively in the same 10 year period. PEPCOs increased usage of HSD and furnace oil has driven up generation costs by almost 13 % average p.a., in the last 5 years.

5.2.4 Hydropower Potential and WAPDA Vision 2025

Pakistan is endowed with a very large renewable energy resource in the form of hydropower with a conservatively estimated potential of around 46,000 MW. Out of this, only about 6,516 MW has been exploited to date. Hydro energy has grown at an average annual rate of 3.96% over the period 1980-2010, this growth dampened to 1.85% in the last 10 years and to 1.05% during the last 5 years. Hydro energy as percent of total energy declined from about 72% in 1980 to about 31% in 2010 (Figure 5.4).

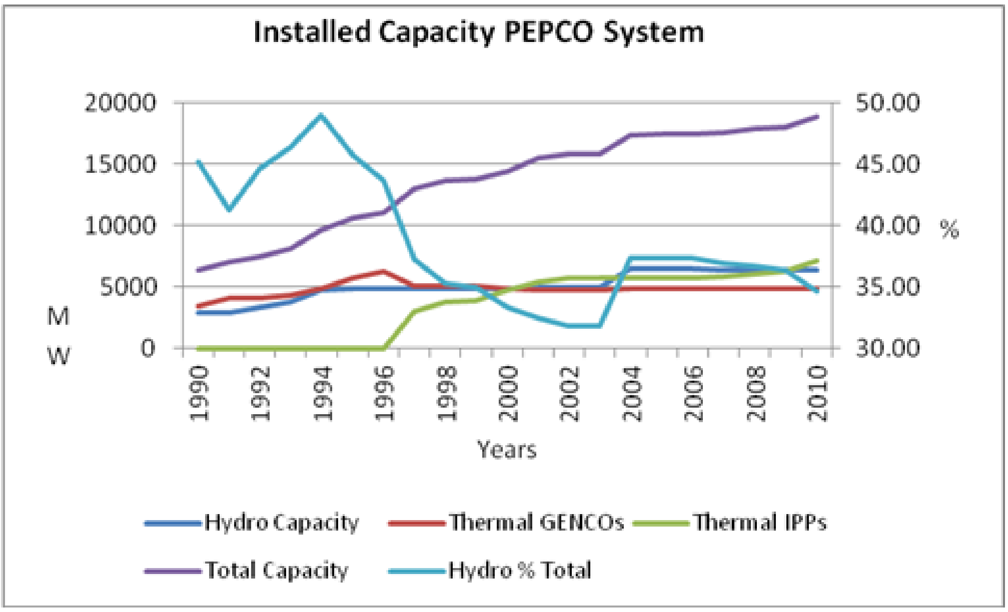


Figure 5.4: Installed Capacity PEPCO System

To cope with the increasing water and power demands of the country, WAPDA prepared “Water Resources and Hydropower Development - Vision 2025 Program”, which was approved by the Government in 2001. This program is a US$25 to 33 billion development program with projects that could generate up to 16,000 MW of additional hydropower plants. It was focused on the development of water storage projects to strengthen the economy by reinforcing agriculture, by optimizing water resources and by enhancing hydropower generation with an aim of establishing the Indus Basin Irrigation System in future.

5.2.5 Conclusion on the Without Project Scenario

Unless the energy crisis is addressed - through exploitation of indigenous resources rather than import of costly fuels – the country will face increasing hardship, growth and development will be further hampered, in turn increasing the chances of social unrest.

The without-project scenario is not acceptable since this will seriously deteriorate the situation of power production in the country. However, Pakistan is presently exactly in the situation of ‘no project’ with widespread power shortages at all time of the year, and with little progress of eliminating these shortages in the near future. Indeed, given the prohibitive costs of fuel oil based electricity generation, development of Pakistan’s hydropower resources represents the only reasonable prospect of eliminating these shortages. On the total generating capacity of electricity there is currently a considerable shortfall as explained above. In the coming years this shortfall will further increase since demand for electricity is growing with an estimated 7.5 percent per year. As a result, more load shedding and power cuts will be experienced with considerable social and economic impacts such as impeded economic growth, increased unemployment, and poverty.

The Government of Pakistan is committed to resolving the energy crisis and achieving energy security of the country. The government's policy objectives of power generation are to promote (i) least cost and sufficient capacity to fulfill country's power demand, (ii) indigenous resource-based power generation including natural gas and renewable energy, and (iii) harmony with natural environment. With this, the short-term strategy is to reduce load shedding through rehabilitating existing plants, and implementing fast-track projects, whereas the long-term strategy including developing indigenous resources (coal, hydro, and renewable energy), setting tariff at affordable level, and limiting gas-based generation to curb LNG import (NTDC 2011).

DHP along with other hydropower developments in the country will help to address the energy crisis in the country.

5.3 ALTERNATIVE HYDROPOWER PROJECTS

Potential list of hydropower project candidates in Pakistan have been studied by the NTDC least cost capacity expansion plan study (NTDC 2011). The study assessed the unit cost of energy of the each project and ranked them as shown in Figure 5.5. According to this study, Dasu is among the least cost hydropower projects (4th rank) in Pakistan, which makes it an immediate candidate for development compared to other hydropower projects. Tarbela IV ranked 20th in this study and Diamer Basha ranked 26th in this study.

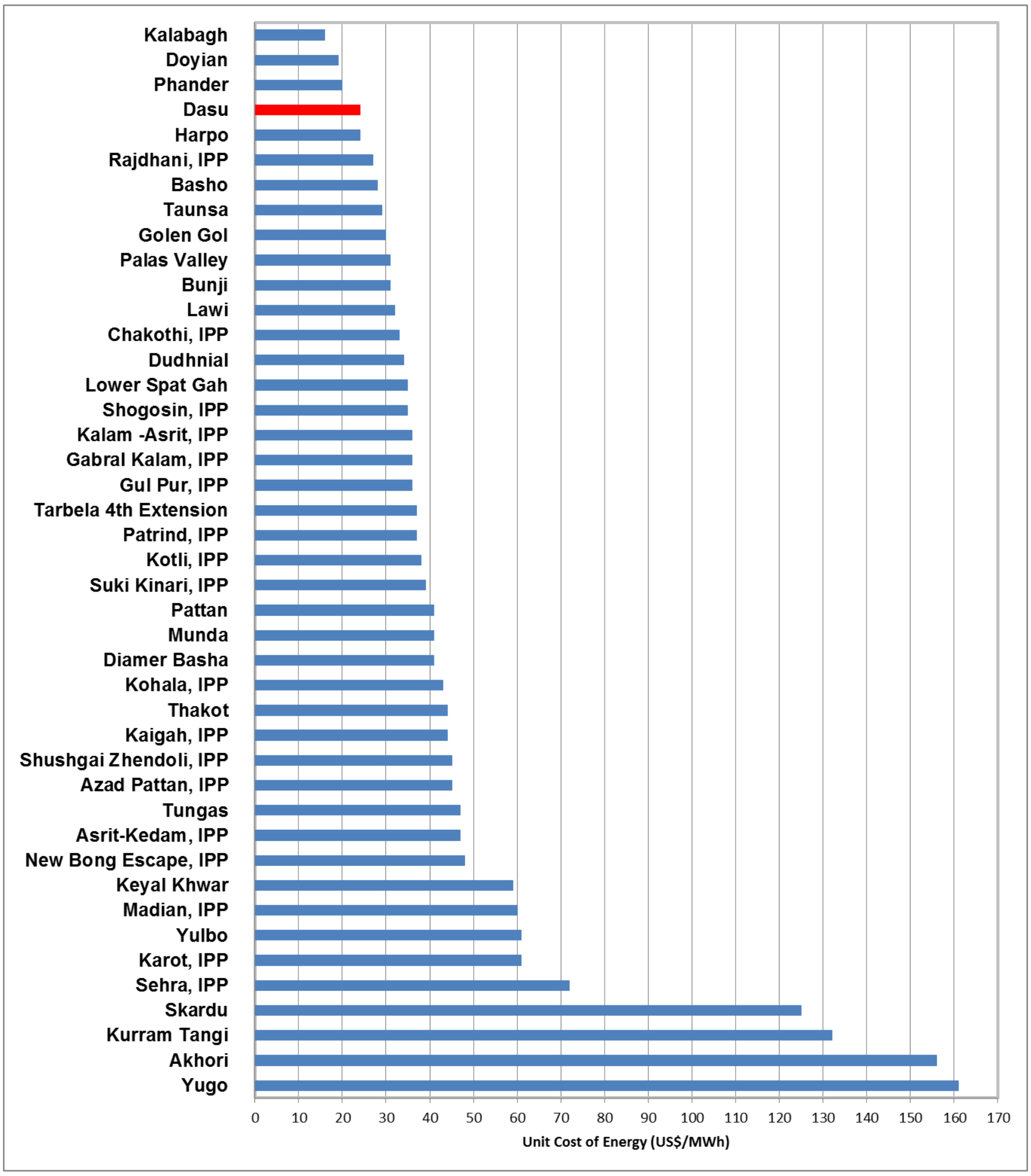


Figure 5.5: Ranking of Hydropower Projects

5.4 ALTERNATIVE SOURCES OF ENERGY

5.4.1 Thermal Generation

In Pakistan, the domestic gas resources are limited, oil is mostly imported and exploitation of Thar coal is still under investigation. As explained in Section 5.3.2, the present generation is highly dependent on imported thermal resources, which are adversely affecting the national balance of payments (US$ 1.25 billion of imported on oil products in 2007-2008). Further fuel prices have increased about 3 times (in nominal terms) in the period 2000-2010, at an average annual rate of 11.25%.

DHP is compared with various thermal alternatives such as combined cycle gas turbine (CCGT), Natural Gas, fuel oil (high sulfur, HSFO) and coal in terms of their energy cost and CO_2 emissions (Table 5.3). CO_2 emissions from thermal alternatives vary from 6.7 to 17.2 million tons per annum, while CO_2 emissions from Dasu reservoir are negligible (details of greenhouse gas emissions are discussed in Chapter 6). Further thermal generation will emit large amounts of particulate matter (PM), sulfur dioxide (SO2), carbon monoxide (CO), nitrogen oxides (NOx) adversely damaging ambient environment and public health.

Table 5.3: CO_2 and Other Emissions from Thermal Alternatives

	Unit	DHP	HSFO	Thar Coal	Natural Gas	CCGT
Required Capacity[1]	MW	4,320	2476.5	2476.5	2476.5	2476.5
Load Factor	%		85%	85%	85%	85%
Annual Electricity Generated	GWh	18,440	18,440	18,440	18,440	18,440
Efficiency (%)[2]			39%	39%	39%	55%
Calorific Value[3]	Btu/Kg		40,216	21,844	936.79[5]	936.79[5]
Calorific Value[3]	TJ/Ton		0.04243	0.02000		
Annual Fuel Consumption	million		4.01 tons	8.51 tons	161.33 mmbtu	114.40 mmbtu
CO_2 Emissions [6]	million tons	0.0045[7]	13.169	17.226	9.549	6.771
CH4 Emissions	tons	38[7]	136		170	121
PM Emissions[8]	ton	0	19,078	2,202	701	497
CO Emissions	ton	0	2,553		3,064	2,173
NO_X Emissions	ton	0	34,043	13,277	42,554	30,175
SO2 Emissions[8]	ton	0	240,968	26,154	5,261	3,730
Total CO2 eq. Emissions	million tons	0.0055	13.187	17.226	9.558	6.778
Unit Energy Cost[9]	USD/kWh	0.02	0.203	0.220		0.116

Note: [1]: Required capacity for thermal alternatives to generate 18,440 Gwh
[2]. Efficiency rates of fuel consumption for new plants with recent technology (Source: Dasu FS Report)
[3]. Sources for Calorific Values: (i) HSFO is based on PSQCA Specifications, (ii) Thar Coal (average of 6,200-11,000; www.sindhmines.pk.gov), (iii) Natural Gas (ADB's EIA reports of Guddu and Jamshoro Thermal Power Plants)
[5] For Natural Gas units are (BTU/SCF)
[6] Emission factors from 2006 IPCC (CO_2 in ton C/TJ: HSFO = 21.1, Natural Gas = 15.3, Lignite (Thar coal) = 27.6; PM in HSFO = 4.56 kg/m3, NG = 7.6 lb/10^6 scf; Lignite = 0.47 lb/ton (ESP controlled) or 58 lb/ton (uncontrolled); NOx in kg/TJ : HSFO = 200, NG = 250, Lignite = 78)
[7] Table 6.4
[8] PM and SO_2 emissions for Coal are ESP and FGD Controlled, HSFO with 3% sulphur content is considered without FGD
[9] Economic and Financial Analysis Report of DHP Detailed Engineering Design

Health impacts of air pollution from thermal power generation are severe. High concentrations of NOx can cause airway inflammation and reduced lung function. High concentrations of SO_2 can affect airway function and inflame the respiratory tract. SO_2 also contributes to the formation of particulate matter in the atmosphere. PM can penetrates into sensitive regions of the respiratory system, and can cause or aggravate cardiovascular and lung diseases (EEA 2011).

The impacts of thermal alternatives are much more difficult (and costly) to mitigate than those that arise at hydropower projects. The health damage impacts of air pollution in terms of monetary costs is estimated and presented in Table 5.4. Health damage costs for thermal alternatives varies from 20 to 73 million USD per annum. CDM costs of all these alternatives are also shown in Table 5.4.

Table 5.4: Health Damage and CDM Costs of Thermal Alternatives

Health Damage cost	Unit	DHP	HSFO	Thar Coal	Natural Gas	CCGT
NOx damage cost (1,308 USD/ton)	Million USD	0	44.53	17.37	55.66	39.47
PM damage cost (1,504 USD/ton)	Million USD	0	28.69	3.31	1.05	0.75
CDM Cost						
CDM Price of CO_2 (9.5 USD/ton)	Million USD		125.11	163.65	90.72	64.33

Note: Health damage costs are extrapolated from European damage cost estimate (EEA 2011) by the ratio of purchase power parity per capita GDP (Source: DHP Economic and Financial Analysis and Project Justification)

5.4.2 Other Renewable Sources[2]

The main sources of alternative renewable energy available to Pakistan are small hydro and wind. Both are being actively developed. Per kWh delivered to the system, these sources both have the same beneficial impact in avoiding the environmental externalities of fossil generation. However, the scale and nature of these resources are such that neither can be viewed as a mutually exclusive substitute for Dasu. Both of these options need to be developed to the extent technically and financially feasible: they are complements, not substitutes to DHP. Moreover, from the perspective of mobilising the necessary finance for the power sector, they do not compete for the same sources of finance: wind and small hydro can be 100% financed from local commercial banks, whose resources are simply not available to large hydro projects. Phrased differently, DHP will not crowd out the ability to finance small renewables.

5.4.2.1 Wind power

Several wind projects are under development, particularly in the identified wind corridors in the coastal areas of Gharo and Jhimpir. Generation licences have been awarded to about a dozen wind power producers. Three of these are at an advanced stage: a 49.5 MW project by FFC Energy Limited at the Thatta district of Sindh; a 50MW project under development by the Three Gorges Company of China, and a 50 MW expansion of an existing 6MW project owned by the Zorlu Group of Turkey.

However, wind power is expensive. For example, NEPRA has approved a levelised tariff of 0.16 USD/kWh (Rs 13.7/kWh) for the 49.5MW wind project in Jhimpir; its completed costs are $133.5million, or $2,687/kW (NEPRA, 2011 State of Industry Report). By comparison, the levelised tariff of DHP Phase 1 is estimated at Rs5/kWh (with subsequent phases having much lower costs, since Phase 1 includes the high upfront cost of the dam).Wind power also suffers from the disadvantage that it is non-dispatchable, and makes little contribution to meeting peak loads.

No matter what is the theoretical potential of wind, to replace the 18,440 GWh annual energy of DHP, at a typical 28% annual load factor the installed capacity of wind would require 7,500 MW, requiring a capital investment (at the same cost noted above for Jhimpir of $2,687/kW) of $20 billion - over three times the total financial cost of DHP. Indeed, large hydropower generally has the lowest generation cost among alternative renewable energy options.

5.4.2.2 Small Hydro

Pakistan has an active small hydro program, mainly in the northern parts of the country. Just in 2012, 100 MW in 10 projects became operational with ADB funding. A further 187 MW in 12 projects are under review. Another 43 projects are being developed with GIZ and ADB funding, and 102 micro hydel projects are under

[2] This section is mostly drawn from DHP Economic and Financial Analysis Report and Project Justification

development in GB with UNDP/GEF assistance. However, as in the case of wind power, small hydro is not a substitute for large hydro.

5.4.2.3 Solar Power

Solar energy too offers opportunities: For 10 hour a day, the average solar radiation intensity throughout the year ranges from 1,500 W/m^2/day to 2,750 W/m^2/day in the country, especially in southern Punjab, Sindh, and Balochistan regions (Shazada et. al. 2012). The total existing solar generation in Pakistan is less than 2 MW. The requirement of land for solar power will be very high compared to Dasu. Solar energy integration with the thermal plant has been examined under ADB Power Sector Rehabilitation Project at the Jamshoro thermal power plant, in order to partly replace fossil-fuel generated power. A 5MW plant proposed in the Jamshoro thermal power plant requires 30 acres of land and the installed cost is USD 13.13 million (ADB 2012). Based on this information, the land requirement for a solar power plant of DHP capacity is nearly 4.3 times higher than DHP (power densities of solar and DHP are 41.18 and 181.13 W/m2, respectively) and 1.6 times more expensive than DHP.

5.4.3 Nuclear Power

Two nuclear power plants currently operate in Pakistan, and there exist plans for additional nuclear projects, the main justification for which is to diversity the supply mix. However, nuclear projects are designed for year-round base load operation, and cannot substitute for peaking/intermediate duty at annual load factors around 50%, or for projects that support the summer load peaks. Moreover, while the social and environmental impacts of large hydro projects can be mitigated with appropriate social and environmental management plans, the main environmental impact of nuclear power - the disposal of its radioactive waste - has yet to be satisfactorily solved. In short, under no circumstances can nuclear power be considered a mutually exclusive alternative to hydropower in general, or to the DHP in particular.

5.5 ALTERNATIVES FOR DAM SITE

WAPDA conducted a study in 1981 (MONENCO, 1981) to identify potential hydropower and storage development projects in Upper Indus Basin. The study recommended a cascade of hydropower projects from Bunji to Tarbela with approximate locations of various dam sites. The area of interest locating a high dam which could develop the hydropower potential of river stretch between Basha and Dasu is 10 km segment of Indus River upstream of Dasu town. Dasu town represents the downstream limit of possible damsite in the stretch as the river valley of Indus on downstream of Dasu is significantly wider making is the dam more expensive. On the other hand, the submergence and resettlement of entire Dasu town would never be accepted by the local community given the difficulty of finding adequate resettlement in the area.

5.5.1 Alternatives for Dam Site Location in Feasibility Study

The feasibility study has identified six possible alternative locations (Figure 5.6) for the siting of dam for preliminary analysis and finally considered three alternatives for detailed analysis. These 3 alternatives (Axis 2, Axis 5 and Axis 6) are located about 3.9 to 9.3 km from Dasu town on upstream. Alternative assessment of these 3 sites is given in Table 5.5. . Alterative 2 (Axis 5) was finally selected based on its lesser impacts on the population displacement and submergence of physical cultural resources.

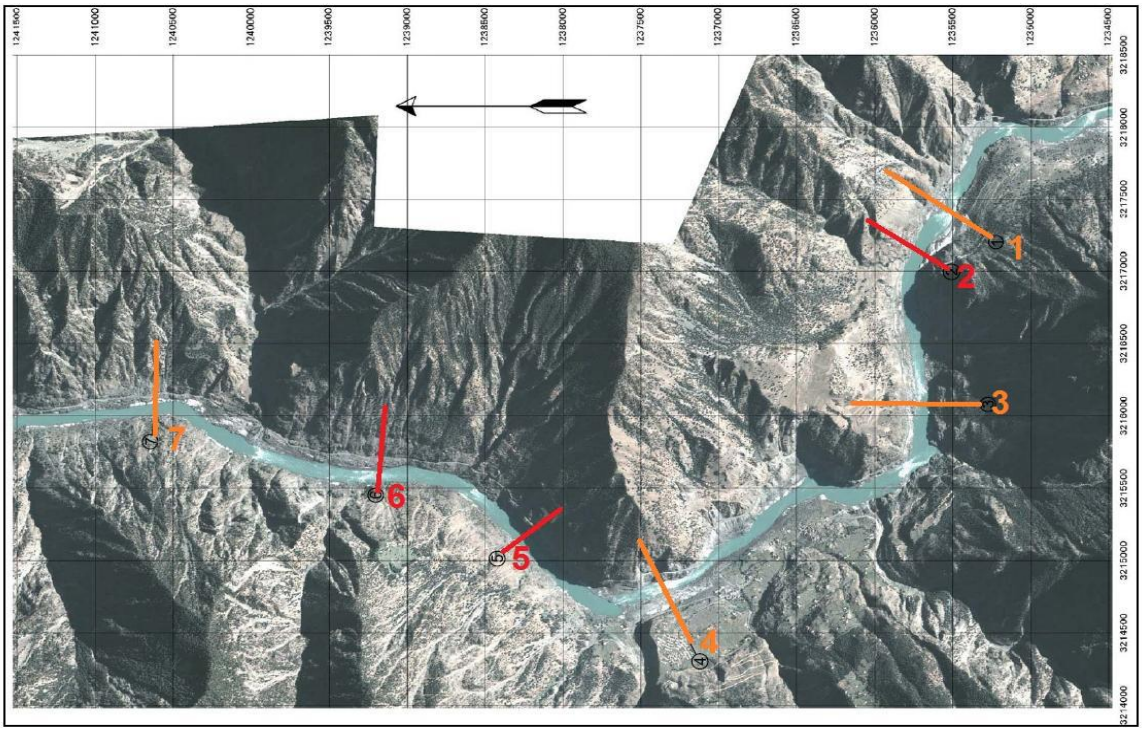


Figure 5.6: Locations of Alternative Sites for Dam

Table 5.5: Alternatives of Dam Location (Feasibility Study)

	Alternative 1 (Axis 2)	**Alternative 2 (Axis 5)**	**Alternative 3 (Axis 6)**
Description	Located 3.9 km upstream of Dasu bridge along KKH	Located 8.2 km upstream of Dasu bridge along KKH	Located 9.3 km upstream of Dasu bridge.
Technical Robustness			
Hydrological conditions	Similar to other alternatives There is no major tributary located within the reach of 3 alternatives that changes the hydrological conditions. Hence, the hydro-logical conditions such as river flow, floods and sediment flow are similar for all the alternatives.	Similar to other alternatives.	Similar to other alternatives
Geological and Geotechnical Conditions	Relatively poor compared to other alternatives, but still considered acceptable for the dam. At this site the right bank consists of a series of scarps and narrow benches and has an overall high inclination angle of nearly 50 degrees. The left side slope has more gentle profile with a steep scarp over the river edge and then the gentle topography. It has an overall slope of about 35 degrees. Above river level the area mostly consists of bedrock terrain, predominantly of amphi-bolite gneiss with some schistose phases.	More preferable The upstream reach flow through a V shaped symmetrical valley with slopes inclined at 35 to 40 degrees on each side of the river. This upstream area consists mostly of bedrock terrain, whereas the river channel beneath the flow is covered alluvial deposits. The bedrock consists predominantly of meta-diorite/granulite which is coarsely crystalline, very strong and generally non-foliated in surface outcrop.	More preferable Conditions are similar to Axis 5
Seismic Hazard	Similar to other alternatives The region is characterized by significant seismic activity. An inactive fault (Khoshe contact) is located on the left bank. The Khoshe contact will be submerged under reservoir for this alternative.	Similar to other alternatives The Khoshe contact will be located on the downstream of the dam and will be crossed by tail race tunnels for this alternative	Similar to Alternative 2 The Khoshe contact will be located on the downstream of the dam and will be crossed by tail race tunnels for this alternative

	Alternative 1 (Axis 2)	Alternative 2 (Axis 5)	Alternative 3 (Axis 6)
Energy Production	Higher potential 4,320 MW 20,613 GWh (annually) This alternative produces 6 to 8% more energy than other options.	Less potential 4,280 MW 19,381 GWh (annually) However, a subsequent re-optimization of the design allowed for this alternative to have the same power output of Alternative 1 (Axis 2)	Less potential 4,000 MW 19,050 GWh (annually)
Cost			
Construction Cost for RCC dam	High 2,588 million US$ (only for dam)	Low 2,468 million US$ (only for dam)	Very high 2,651 million US$ (only for dam)
Resettlement (for Dam and Reservoir)			
Land acquisition Land required	High 7,363 acres	Less 6,439 acres	Similar to Alternative 2, but no detailed assessment was made.
Households affected	High 778 households Entire Seo village will be flooded	Less (65% less compared Alternative 1) 278 households (Seo village will not be affected) (Surveys during detailed design indicate 767 households will be affected. This also imply that affected households for Alternative 1 will be much higher than 778 as the entire Seo village consisting of about 500 households will be affected)	Similar to Alternative 2
Population affected	7,670	3,670 (52% less compared to Axis 2) (Surveys during detailed design indicates 6,953 people will be affected)	
Environment			
Loss of Trees	22,149	21,000	
Physical and cultural resources	High A 400 year old mosque, located at Seo, that is highly revered both locally and	Medium Though, there is no impact on the Seo Mosque, However another historical	Medium Similar to Alternative 2

	Alternative 1 (Axis 2)	Alternative 2 (Axis 5)	Alternative 3 (Axis 6)
	regionally will be affected. One graveyard in Seo with 5,000 graves will be affected. Another historical mosque located at Seer Gayal (said to be similar age of Seo mosque but religiously not important as Seo mosque) will be submerged.	mosque in Seer Gayal will be submerged (this will be common for all alternatives). Unlike Seo mosque, this is a regular mosque without any specific religious importance. Being a wooden structure, the mosque can be easily relocated to a new location, which was agreed by the local religious leaders and community.	
Kaigha private game reserve	Similar to other alternatives About 51 ha of private game reserve (1% of total game reserve area) will be submerged. The submerged part is mostly consists of residential and agricultural area of Kaigha village	Similar to other alternatives	Similar to other alternatives
Public acceptance	Negative The Jirga of Seo village decided against this alternative due to submergence of Seo mosque.	No opposition	No opposition
KKH realignment	51 km	48 km (The total realignment based on detailed engineering design is 61.7 km)	
Conclusions		Alternative 2 (Axis 5) is selected based on lesser social and environmental impacts and cost.	

Source: DHP Feasibility Study Report, 2009 (updated by present study)

5.5.2 Alternatives for Dam Site Location in Detailed Design

The alternative selected in the feasibility study (Axis 5) was subjected to further alternative assessment to a limited extent during detailed design stage primarily to define the exact position of the dam. Two additional alternatives are considered, one 55m on upstream and other one 135 on downstream. Locations of these alternatives are shown in Figure 5.5 and analysis is presented in Table 5.6 The upstream alternative, Alternative 2, is chosen because of its environmental benefits.

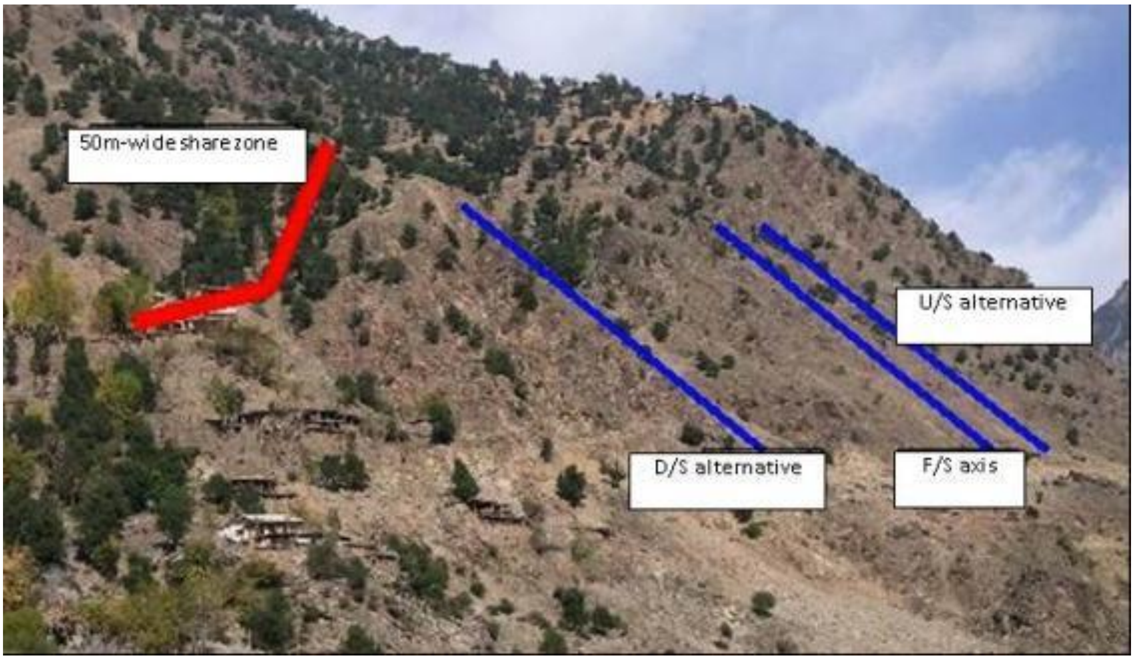


Figure 5.7: Alternatives for Dam Site Location in Detailed Design

Table 5.6: Alternatives of Dam Location (Detailed Design)

	Alternative 1 (Feasibility Study Axis 5)	**Alternative 2 (Up Stream Alternative)**	**Alternative 3 (Down Stream Alternative)**
Location	Recommended Alternative in Feasibility Study	55m upstream from Alternative 1	135 m downstream from Alternative 1
Technical Robustness			
Topography (constraints on availability of space for dam and its associated facilities)	Not enough space for plunge pool	Enough space for plunge pool, it will restrict the optimized location of power intake structure	Has some little advantage for dam foundation, but reduce the plunge pool space.
Geology	Similar to all	Similar to all	Similar to all
Shear Zone (A 50m wide shear zone is located across the right abutment of D/S alternative axis and this shear zone striking N10 to 15 W and dips 70 northeast. The rock mass within this zone is highly fractured.)	No evidence show that this shear zone extends to the abutment slope of this alternative	No evidence show that this shear zone extends to the abutment slope of this alternative	Such wide shear zone would affect the dam foundation stability if this D/S axis is chosen. Furthermore several springs were observed within the shear zone, which indicates shear zone would form a potential water path after reservoir impoundment and consequently may induce instability of dam body due to increase of pore pressure. Thus the D/S axis is not recommended
Environment			
Concrete volume	Higher 5,067,000 m^3 (4.25 million m^3 was estimated in Feasibility Study)	Lower 4,975,000 m^3	Medium 5,035,000 m^3
Excavation volume	Higher 2,337,000 m^3 (0.84 million m^3 was estimated in Feasibility Study)	Medium 2,175,000 m^3	Lower 1,606,000 m^3
Conclusion		Alternative 2 is considered due to the requirements of less volume of concrete as well as excavation	

5.5.3 Dam Height

To maximize the benefits of the Dasu Project, it is logical to adopt a maximum normal reservoir level equal to the tailrace level of Diamer Basha dam, which ranges from minimum elevation of 947 masl to 970 masl under PMF conditions. At Dasu, the maximum normal reservoir level has been adopted as 950m being the normal tailrace water level of Diamer Basha. Any operational level, higher than the normal tailrace level would have increased the cost of dam without achieving any significant gain in the energy production. Thus, the dam height of the Project (950 m operation level) is determined to maximize the power out from the cascade of project and to match tailrace water level of Basha dam. During excessive flood events (which will be a condition for a few days the water levels in the reservoir levels will be allowed to 959.5m. This will allow routing of floods. Final height of dam was chosen by reservoir operating level and flood volumes, and also geotechnical conditions for dam foundation.

5.6 ALTERNATIVES FOR DAM TYPE

Three types of dams were considered during the feasibility study, (i) Roller Compacted Concrete Dam, RCC; (ii) Concrete Faced Rockfil Dam, CRFD; and (iii) Earth fill Dam. The feasibility study recommended RCC dam based on the analysis given in Table 5.7.

Table 5.7: Alternatives of Dam Types (Feasibility Study)

	Roller Compacted Concrete Dam (RCC)	Concrete Faced Rockfill Dam (CRFD)	Earth fill Dam
Description	RCC dams are a more recent development in the field of dam engineering that involves the on-site production of low-slump concrete that is placed using conventional earthwork equipment such as dozers and rollers.	Dam body filled with rock or gravels compacted in layers, and also with its face slab as an anti-seepage system.	Embankment alternative involves a low permeability core material, which is adjacent to graded downstream filter layers that control the seepage through the general earth fill shell
Topographic and Geological Suitability	Suitable to DHP	Suitable to DHP. With a CFRD, extremely high permanent excavation slopes are required to locate the spillway in the abutment, posing very serious slope stability concerns, particularly in view of the high seismicity of the area	Not Suitable to DHP and hence not further evaluated.
Associated facilities.	A concrete dam allows the incorporation in its body of spillways, low level outlets, or alternative the power intakes, if the river downstream can accommodate an outdoor powerhouse at the dam toe.	None of these are feasible with a CFRD dam, which requires a separate spillway in one of the abutments and low level outlets and power waterways arranged in separate tunnels	Earth fill dam doesn't allow any spillway
Construction limitation	A RCC dam can tolerate overtopping during construction and thus accept a lower design flood for the river diversion facilities than required for a CFRD.	CFRD dam cannot tolerate overtopping and hence required higher flood design for river diversion facilities required for RCC	Similar to CFRD
Diversion facilities	Diversion facilities can be designed for a short flood interval, say for a 5 year design flood (4,500 to 7000 m^3/s).	Diversion facilities has to be designed for a 100 year design flood (about 13,370 14,050 m^3/s.	Similar to CFRD
Environmental issues such material use, and quarry/borrow areas requirement	Requires very large quantities of cementitious material (cement, aggregates, and pozzolan). The power demand during construction is higher, because of the needs of the aggregate crushing, concrete batching and transportation systems.	Requires very large quantities of rock and earth material. The sources of material can be found close to the dam site.	Requires very large quantities of impervious earth material (clay) including sand, gravel). Impervious material is not available locally and to be transported from faraway distances.

	Roller Compacted Concrete Dam (RCC)	Concrete Faced Rockfill Dam (CRFD)	Earth fill Dam
	The source of aggregates can be found close to the damsite		
Cost (including diversion works, dam, spillway, and outlet works)	0.68 billion US$	1.29 billion US$	Not estimated
Construction Period	Shorter construction period due to high speed of construction allowed by RCC technology.	Longer construction periods. Minimum one year higher than the RCC dam.	
Proven Previous Technique	Various RCC dams exceeding 200 m height are presently at the final design stage. The highest RCC dam presently constructed is Longtan, China, with a maximum height of 192 m, however, this is now in the process of being raised to 216m	The highest dams built to date include Kárahnjúkar, Iceland,198 m; Campos Novos, 202 m and Barra Grande, 185 m, both in Brazil. High CFRD dams under construction include Nam Ngum 2, Lao PDR, 182 m, and Bakun, Malaysia, 205 m	Tarbela, with a height of 108m, is the highest Earthfill dam constructed in the world
Conclusions	This option is chosen taking into account the difference in costs; environmental issues such as quarry material availability, and the technical aspects.		

Source: DHP Feasibility Study Report, 2009

5.7 ALTERNATIVES FOR GENERATING EQUIPMENT

Feasibility study proposed 8 units of 540 MW turbines to generate the estimated installed capacity of 4,320 MW based on the reservoir operation study. Generally, the unit capacity of generating equipment is decided considering (i) unit size of generating equipment in the power grid to be connected, (ii) economically least cost among alternatives, (iii) topographical and/or geological constraints, etc. This recommendation is further evaluated based on the transportation capacity of the equipment along KKH. Two more alternatives, 432MW and 360MW, were studied based on the equipment size recommended in Basha Project and trial runs conducted by Basha Project. Details of assessment are given in Table 5.8.

Table 5.8: Alternatives for Generating Equipment

	Alternative 1 (540 MW)	**Alternative 2 (432 MW)**	**Alternative 3 (360 MW)**
Installed Capacity	4,320 MW	4,320 MW	4,320 MW
Number of Units Required	8 units of 540 MW	10 units of 432 MW	12 units of 360 MW
Rated discharge, Total	2,600 m^3/s	2,600 m^3/s	2,600 m^3/s
Rated discharge per unit	325 m^3/s	260 m^3/s	217 m^3/s
Size and weight of the Equipment	Turbine runner : 5.5 ~ 6.0 m diameter Unit transformer (1-phase, 765/20 kV, 190 MVA) : 7.7 m (L) x 4.0 m(W) x 4.8 m (H), 160 tons	Turbine runner 5.5 m dia, 3.0m height, 80 tons Unit transformer 5.5 m (L) x 4.0 m(W) x 5.0 m (H) 130 tons	Turbine runner: 5.0 m dia, Unit transformer (1-phase, 550/16.5 kV, 128 MVA): 5.5 m (L) x 4.0 m(W) x 5.0 m (H), 120 tons
Environmental Considerations			
Possibility of carrying them to the site along KKH	Not feasible KKH contains a lot of overhand, narrow turns, culverts and bridges.	Not Feasible A trial run was made by the Basha Project in 2003 for 450 MW equipment transportation. The trial run and .further evaluation considered the unit rating of 350 MW satisfies the transportation condition of KKH	Feasible
Possibility of equipment to accommodate low flows (historical 10-day lowest flow is 291 m^3/s; and possible 20% decrease of low flows due to climate change)	Not feasible Less energy production at low flow	Not feasible Less energy production at low flow	Feasible More energy production at low flow
Possibility to accommodate required Environmental flows in future peaking operations	Not feasible Less energy production at low flow	Not feasible Less energy production at low flow	Feasible More energy production at low flow
Conclusion	Alternative 3 is chosen because transportation requirement of KKH as confirmed by trial runs along KKH. Further smaller unit capacity could contribute to the energy production at low flow season; and could accommodate changes in future river flows due to climate change.		

5.8 ALTERNATES FOR CONSTRUCTION PHASING

The DHP requires huge and committed investment. A staged development is the practical way to achieve earlier power generation with the minimum investment cost (committed finance from the World Bank) and to deal with uncertainties in future investment. It was agreed between WAPDA and World Bank that a two staged approach will be followed for DHP with each stage divided into two phases as shown in Table 5.9. The stage 2 development is assumed to be implemented after Basha project construction, which has some implications on the sediment load to DHP and thereby operations of DHP.

Table 5.9: Staged Development of DHP

Works	Stage I		Stage II	
	Phase-I	Phase-II	Phase-III	Phase-IV
	Full dam & Three Turbines	Three Turbines	Three Turbines	Three Turbines
Cumulative Installed Capacity MW	1,080	2,160	3,240	4,320
Cumulative Generation GWh	8,058	12,256	15,544 (18,730 in post Basha)	18,440 (21,485 in Post Basha)
Total Project Cost (US$ million)	4,400	425	1,563	970

Three alternatives of construction phasing are considered focusing on the Stage 1 implementation. Construction schedule of these alternatives are given in Figure 5.8 and their analysis are given in Table 5.10..

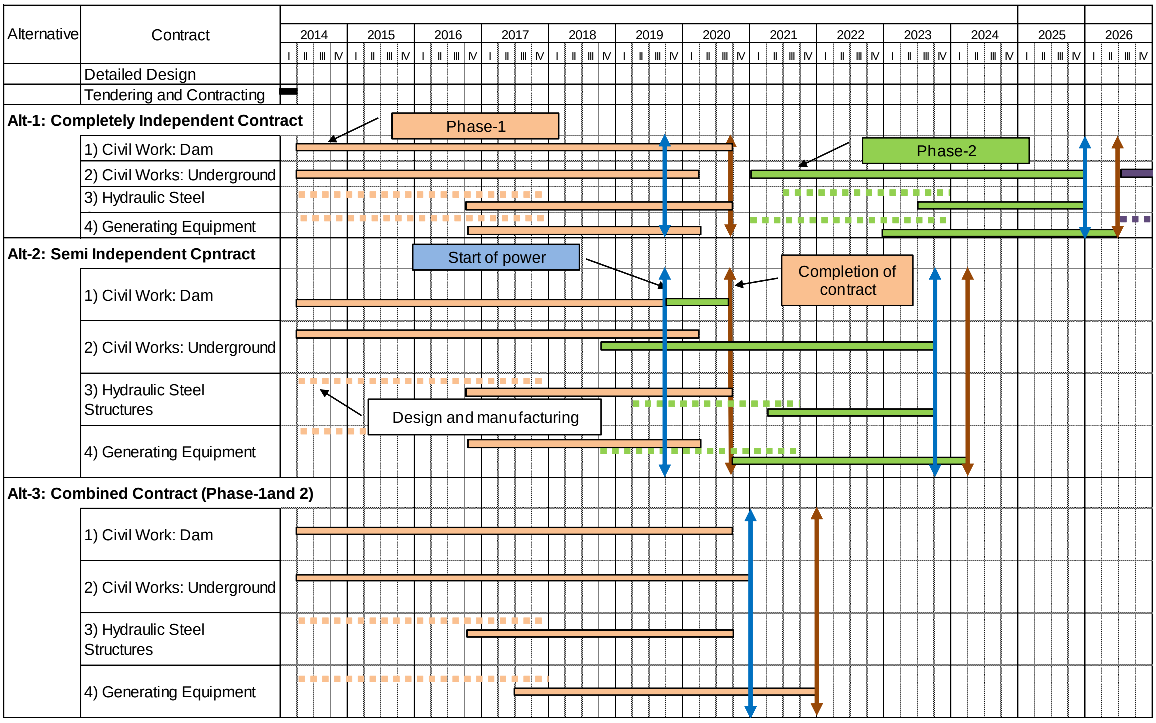


Figure 5.8: Alternative Construction Scheduling for Stage 1

Table 5.10: Alternatives of Construction Program For Stage 1

Item	Alternative 1	Alternative 2	Alternative 3
Construction mode	Sequential Development Phase 2 starts after completion of Phase 1	Semi-simultaneous Development Phase 2 work start after relevant Phase 1 work finish	Simultaneous Development
Procurement of contractors	Different contractors for Phase 1 and Phase 2	Different contractors for Phase 1 and Phase 2	Same contractors for Phase 1 and Phase 2
Start of Phase 1 commissioning	5 years (60 months)	5 years (60 months)	5 years (60 months)
Start of Phase 2 commissioning	10 years (120 months)	8.6 years (104 months)	7.3 years (88 months)
Contract conditions	Use of Standard Contracts	Need of special conditions	Use of Standard Contracts
Cost	less annual disbursement	less annual disbursement	high annual disbursement
Temporary facilities	Duplication	Duplication	No duplication
Design of E/M equipment	Double work due to different contractors	Double work due to different contractors	Single work
Contract management	Simple	Complicated	Simple
Environmental and social considerations	Delayed power generation by 2.5 years will increase the environmental and health impacts from thermal power generation.	Delayed power generation by 1.3 years will increase the environmental and health impacts from thermal power generation.	Earlier power generation avoid environmental and health impacts from thermal alternative, and brings earlier economic growth, and increased employment

Economically, contractually and environmentally Alternative 3 has several advantages due to earlier generation of power in Phase 2. Early generation and distribution of hydro-generated power means that environmental impacts of thermal power generation can be reduced and brings earlier economic growth and increased employment socio-economic development of the area.

5.9 ALTERNATIVES FOR SOURCE OF CONSTRUCTION MATERIAL

The project will require 4.1 million cubic meters (MCM) of Roller-compacted Concrete (RCC) and 2.0 MCM of Conventional Concrete (CVC). The production of standard quality and durable concrete at economical cost is therefore of paramount importance for the project. Industrial material required for the concrete such as steel (0.15 million tons) and cement (0.8 million tons) will be procured from the market, while natural material required for the concrete such as coarse aggregates (9.2 million tons), sand (5 million tons) and pozzolan (0.5 million tons) will be sourced from the nearby quarries. Studies have been conducted both during feasibility and detailed design to identify potential sources of natural material with required quantity and quality.

5.9.1 Alternatives for Coarse Aggregates

About 9.2 million ton of coarse aggregate will be required for both RCC and CVC works. The major concrete works include the main dam, powerhouse structure, power tunnels and different components of the project. The feasibility study has assessed 5 sites and identified 4 sites (Uchar Nullah, Barseen, Kaigah and Panibah). Locations of these sites are given in the Table 5.11.

Table 5.11: Alternative Sites for Coarse Aggregates

No.	Name of Site	Location	Suitability
1.	Uchar Nullah Rock Quarries	1 km upstream from Dam Axis	Unsuitable due to insufficient quantity available
2.	Barseen Rock Quarry	6 km upstream from Dam Axis	Unsuitable – material suitable, but no flat area available
3.	Kaigah Rock Quarry	8 km upstream from Dam Axis	Very suitable, sufficient quantities and flat area available. Already in use as quarry site by the FWO (Frontier Work Organisation)
4.	Panibah Rock Quarries	10 km upstream from Dam Axis	Unsuitable due to difficult terrain
5.	Rock excavations and river bed	1-2 km upstream from Dam Axis	Not suitable. Amphibolite is not suitable due to anisotropy but possible to use. For river bed material intensive screening/crushing is required

All prospective quarry sites preferably should be located in the future reservoir area, since this area already acquired for the project. Moreover downstream of the dam there is no suitable site available so close to the city of Dasu-Komilla. For geomorphological reasons all potential sites are concentrated on the left bank side, since the right bank side of the Indus is very steep and susceptible for landslides, Moreover an important consideration is that all quarry sites should be accessible at an early stage of the project. This is not the case on the right bank (the right bank access road will only be constructed at a later stage of the first phase). From an environmental point of view it is also an advantage that the sites are situated in the future reservoir area and will be inundated after the borrowing activities are completed and will be covered by sediment. The future landscape and vegetation therefore will not be affected by the excavations. The rock quality in three sites (site 2, 3 and 4) was considered to be suitable. The Uchar Nullah site was abandoned since insufficient quantity of good quality rock is available.

Two sites, Kaigah and Panibah are adjacent to the area defined as the Kaigah Nullah Community Conservation Area (5000 ha). This conservation area was established in 1993 as Private Game Reserve and is managed by the local community of Kaigah. Construction activities in the quarry area (estimated to be about 2.75 years) will negatively affect the wildlife area in the game reserve (which can be mitigated through appropriate measures as discussed in Chapter 7). The site in Barseen is nearest to the project, but has hardly any flat terrain needed for establishing sites for crushers, equipment and for a stockpile. Also the area at Panibah was considered as unsuitable, since the quarry is situated in very rugged terrain with few level areas. No other feasible options except Kaigah materialized during field studies.

5.9.2 Alternatives for Fine Aggregates

It is estimated that 5.0 million ton of good quality sand will be required for both RCC and CVC. Natural sand is the ideal material to be used as fine aggregates (size from 75µ to 4.75). During the feasibility study, no significant source of sand could be identified/ located close to the damsite. The river bed alluvium was eliminated as a potential source due to its fine nature and limited quantity. Finally the feasibility study recommended two sources: Maira and Chilas Sand deposits, located about 80km downstream and 120km upstream from Dasu respectively. During detailed design, manufacturing sand from Kaigah aggregates have been studied and found to be suitable. Locations of all the sites studied are given in Table 5.12.

Table 5.12: Alternative Sites for Fine Aggregates

No.	Location	Remarks	Result
1.	Maira Sand	80 km downstream of Dam Axis (near Thakot) on both sides of Indus	Suitable
2.	Chilas Sand	120 km upstream of Dam Axis	Suitable
3.	River Sand near Dam Site	Too fine and not enough quantity	Not Suitable
4.	Manufactured Sand from rock at Kaigah	8 km upstream of Dam Axis	Suitable

Manufacturing of sand from Kaigah quarry is found to be environmentally more advantageous compared to other two options of natural sand extraction proposed in the feasibility study due to the following reasons and hence recommended for the Project.

- Borrowing sand from Maira and Chilas will affect the aquatic ecology of Indus,
- Traffic and transportation costs can be reduced
- Kaigah is already selected for course aggregates, and same facilities can be used for fine aggregates. However, a new crusher to be installed
- In addition to Kaigah quarry, the raw materials for manufacturing sand will also be available from excavations for power tunnels, power house etc.

5.9.3 Alternates for Pozzolanic Material

Pozzolan material, when combined chemically with hydrated lime will form hardened compounds at normal temperatures and can be used in mortar and concrete. It is estimated that 500,000 ton of pozzolanic material will be required as partial replacement (about 40%) of cement in concrete to improve water tightness of concrete, improve workability and other properties of concrete, and reduce the use of chemical admixtures.

Three types of pozzolanic material can be used for concrete production. They are (i) slag and fly ash; (ii) natural pozzolan; and (iii) manufactured or processed pozzolan. Potential sources studied by the feasibility study for pozollanic material are shown in the Table 5.13.

Table 5.13: Alternative Material and Sites for Pozzolan

No.	Material	Location	Suitability
I. Slag and Flyash			
1	Blast Furnace Slag	Pakistan Steel Mills near Karachi (1900 km from dam Site)	Quality is satisfactory but available quantity is insufficient
2	Flyash (Pakistan)	Lakhra Coal Power Plant (1700km north of damsite)	Due to high gypsum content not suitable
3	Flyash (South Africa)	Import is only possible through Indian Exporters	Quantity is enough but the cost is not economical (twice of cement)

No.	Material	Location	Suitability
4	Flyash (Bathinda, India)	200 km Lahore, seems to be feasible	Required permission of Pakistan government (2000 t/day production)
5	Flyash (China)	Location and production quantity of nearest plant is not known	Promising
II. Natural Pozzolan			
1		Khoshe terrace (near damsite)	Unlikely
2		Seo Terrace, right bank (near damsite)	Promising
3		Tial and Maidan terrace (near damsite)	Not promising
4		Thorli-95 km upstream of dam site (Lacustrine Deposit)	Low pozzolanic activity
5		Gini-128 km upstream of damsite (Moraine Deposits)	Potentially suitable
6		Located 170 km from Islamabad at Sawabi (tuff rock)	Not sufficient
7		Kirana Hills (Sargodha) (Rhyolytic Lava and interbedded Volcanic Ash)	Unattractive due to specified fineness
III. Manufactured Pozzolan (Calcined Pozzolan)			
1		Manufactured at Maple Leaf Cement Factory (Daudkhel, – 580 km from damsite)	Confirmation is required
2		Bestway Cement Factory, (Chakwal, 430 km from damsite	OPC 1200 t/day by wet and 1000 t/day by dry process, possible by wet process
3		Manufactured at Gharibwal Cement Factory (Jhelum 500 km from project site).	OPC 1800 t/day by wet process, possible by wet process

Source: DHP Feasibility Study, 2009

The feasibility study recommended natural pozzolan at Gini, located 128 km upstream from dam axis. However, during detailed design, two more sites namely Kandia Valley (18km upstream) and Thorli Nullah (95km upstream) are further studied with a purpose to reduce the hauling distance.

Detailed physical and chemical analysis of materials conducted during detailed design at these 3 sites (Gini, Kandia and Thorli Nullah) concludes that moraine deposits of Gini area are physical and chemically more suitable for pozzolan. Further alternatives are being considered by the design engineering team to manufacture the pozzolanic type material from the excavated material or the aggregates of Kaigha quarry. The contractor can also import material with the permission of WAPDA, if suitable material of sufficient quantity is not locally available.

5.10 ALTERNATIVES FOR RESETTLEMENT

It is common in major hydropower projects that resettlement townships will be developed to facilitate the relocation of affected communities. Given the nature of transhumance of the affected communities within the valley between higher and lower elevations (Section 4.6.5); experiences learned from the past hydropower projects in Pakistan; and consultations with affected community, two options were discussed the affected community. Detailed treatment of this topic is presented in 'SRMP Volume 5: Resettlement Action Plan'. A summary of these options are given below:

Option 1: Community-based relocation close to the current settlements, but at a higher location, with site and services to be developed by the project. This option includes the possibility of a self-managed relocation in Dasu Tehsil or in Kohistan District, with additional compensation and benefits prior to relocation. About 90 percent of the community preferred this option.

Option 2: Relocation to "down country" (outside Kohistan), with extra compensation and benefits prior to relocation. A minority of about 10 percent of the affected community preferred this option.

5.11 ALTERNATIVES FOR WAPDA OFFICE AND COLONY

A Project colony will be established with offices, residential quarters, and various appurtenant facilities such as hostels, resthouse, schools, mosques, hospital, market etc. The Project colony should be located as near to the project site as possible. However, Dasu is being a gorge; flat areas for large colony development near the damsite are not available. Tial Medhan was selected for the colony by the feasibility study. One more alternative was studied during detailed design at Choochang. Locations of both the sites are shown in Figure 5.9.

Tial Medhan area (1100 to 1200 masl) is located on a higher mound with relatively less flat area, about 7 km downstream of damsite. Development of the land requires large scale excavation with steep gradient roads and hairpin (sharp) turnings. Thus road safety will be a critical issue. A view of Tial Medhan from Komila is also embedded in Figure 5.9 to show the outline of existing track (which is difficult to access now). The site is located away from KKH and nearly 3.4 km of new access road is to be constructed from KKH. The access road has to pass through steep slopes and landslide prone areas and also through Dasu town.

Choochang will be located to adjacent to new relocated KKH, 3 km downstream of damsite with already two large existing terraces. However, 104 houses are located in this area, but they are interested to give land to the Project and move on their own to other part of the village, where they already own the land.

This site in Choochang is found to be more suitable than Tial Medhan since it is very close to the damsite, adjacent to KKH and no large scale excavation is required.

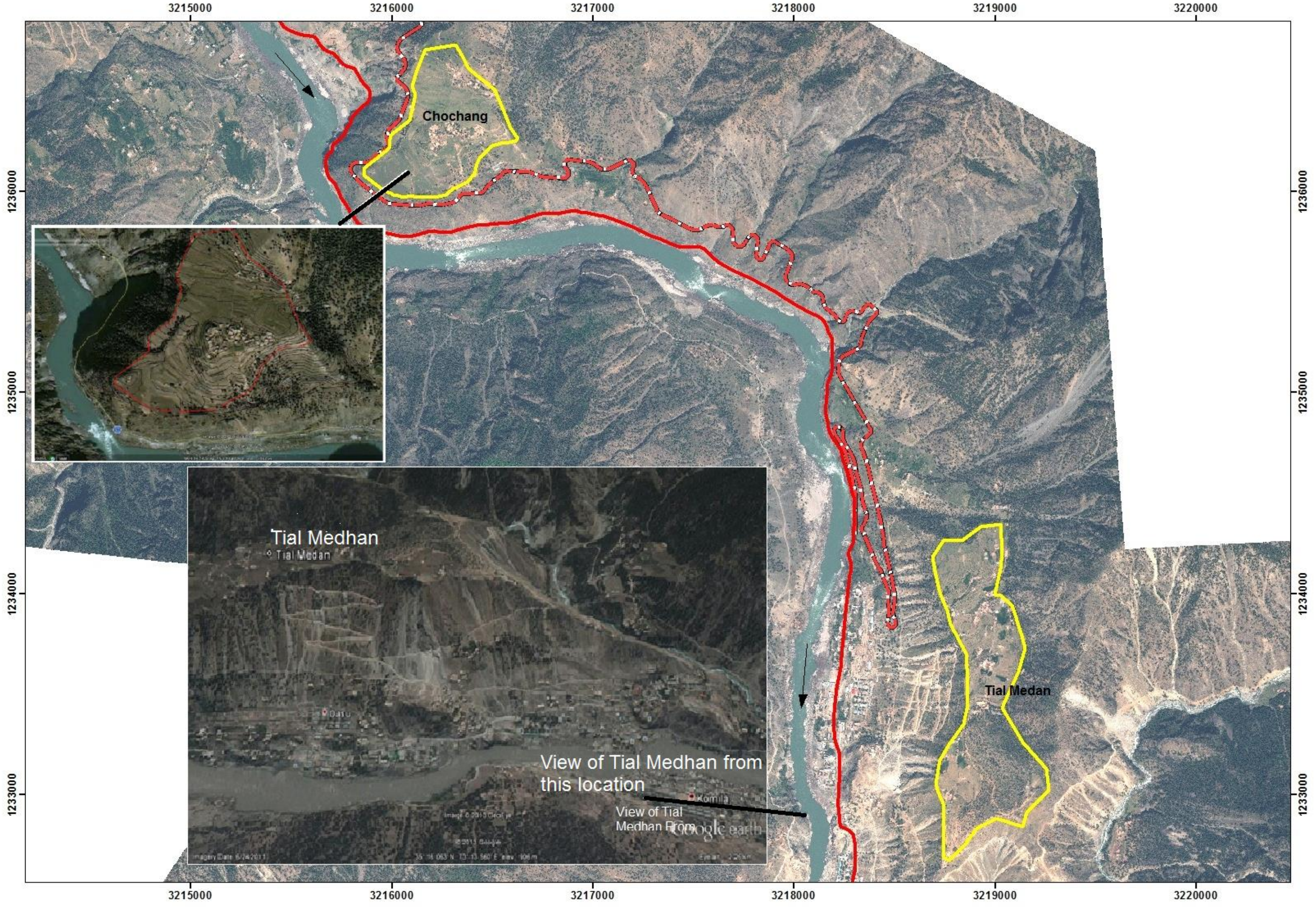


Figure 5.9: Alternative Sites for Project Office and Colony

5.12 ALTERNATIVES FOR RIGHT BANK ACCESS ROAD

An access road of about 13 km is required along the right bank of Indus to the damsite from the existing KKH. Two options were considered for this alignment for first one km section of this road. (i) through Komilla village and (ii) bypassing Komilla village. Both these alternatives follow the same alignment after the first kilometer. Access road bypassing through Komila village will be advantageous due to reduced resettlement and risk of traffic safety. But this option is technically not feasible due to very poor geotechnical conditions and landslide zone (See pictures in Figure 5.10). A comparison of both the alternatives is given in Table 5.14.

Table 5.14: Alternatives to Right Bank Access Road

item	Option 1	Option 2
Existing conditions in the first 840 m	Existing road with a width of 4.8 to 6.6 m. Many houses are located on both sides in the first one kilometer of the road	Covered with sliding material from rock falls. Few houses are located at the starting.
Design issues	Standards carriageway 7.3m) and shoulders (1.5m both sides) cannot be secured based on existing road widths explained above	Concrete wall of 3 to 4m high is required for a 1 km section against sliding Also concrete slab of 1 km long may be required to secure flat surface
Construction of road	Safety measures are inevitable	Protection wall is temporarily required and strict monitoring against sliding is inevitable. Any vibration shall be avoided.
During operation	Traffic control, noise protection and safety measures are inevitable	Standard traffic rules are adopted, but monitoring on potential sliding and further remedial works are inevitable.

Based on the above comparative study between two options, Option 1 is still recommended in technical and practical feasibility. However, in designing Option 1 resettlement will be reduced without widening the existing road. The section between 0+285 and 0.415 is too narrow to allow both-way-traffic and therefore watchmen for traffic control during construction shall be provided by the contractors. Pedestrian passes will be built to avoid the construction traffic.

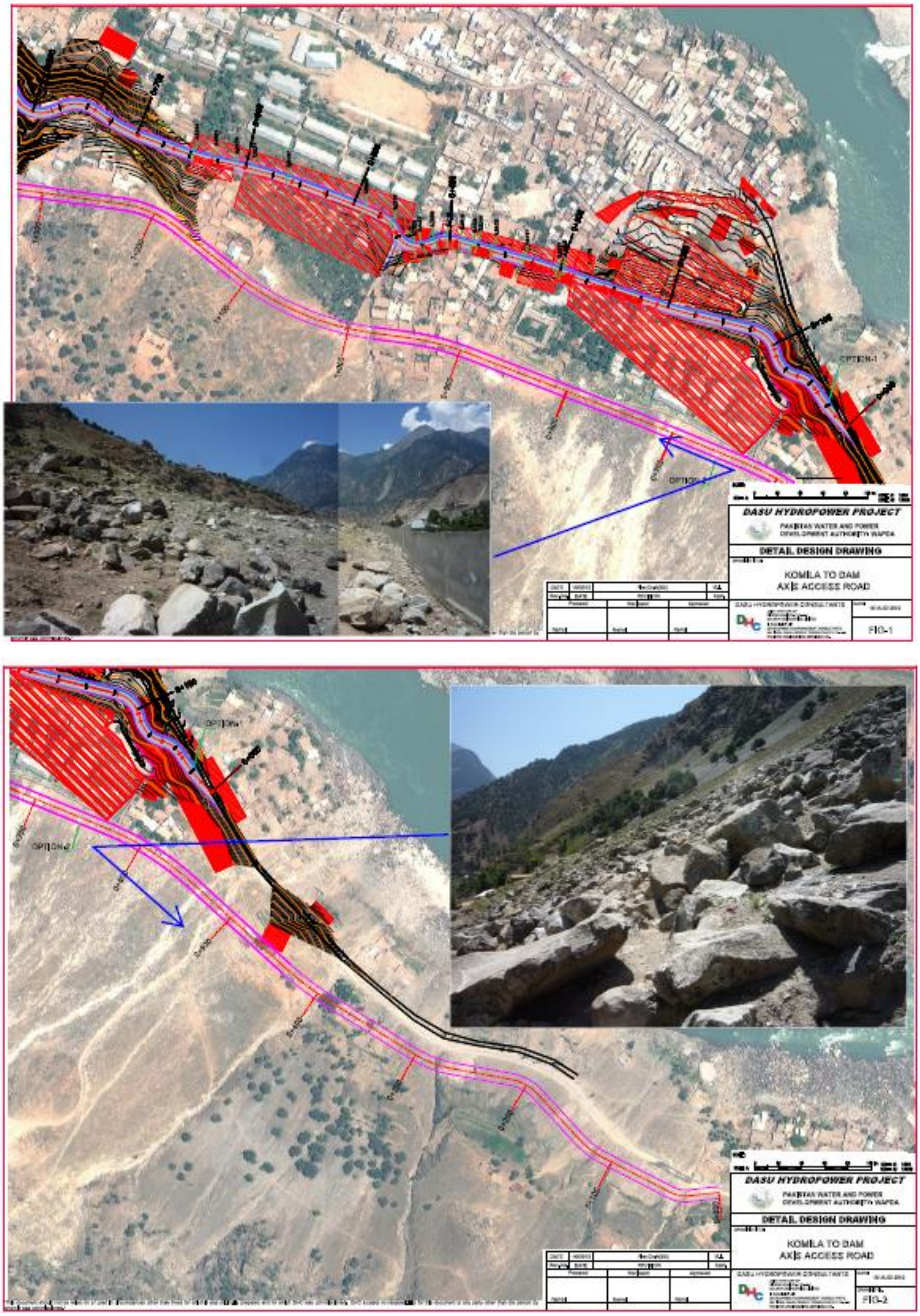


Figure 5.10: Alternatives for Dam Site Location in Detailed Design

5.13 ALTERNATIVE FOR RELOCATION OF KKH

During the feasibility study, two alternative alignments were studied for relocation of KKH. The Option 1 is located along the right bank and starts from Komilla and crosses river Indus at Chore More (about 11 km south of Shatial) to meet the existing KKH. The total length of Option 1 is about 69.5 km. The Option 2 follows the current alignment of the KKH on the right bank and located above the reservoir level. This alignment starts about 3 km north of Dasu town and joins the existing KKH near Chore More. Length of this alignment is about 63 km. Locations of both Options 1 and 2 are shown in Figure 5.11: Options 1 and 2 for KKH Relocation . The key aspects of both of the above options are given in 15.

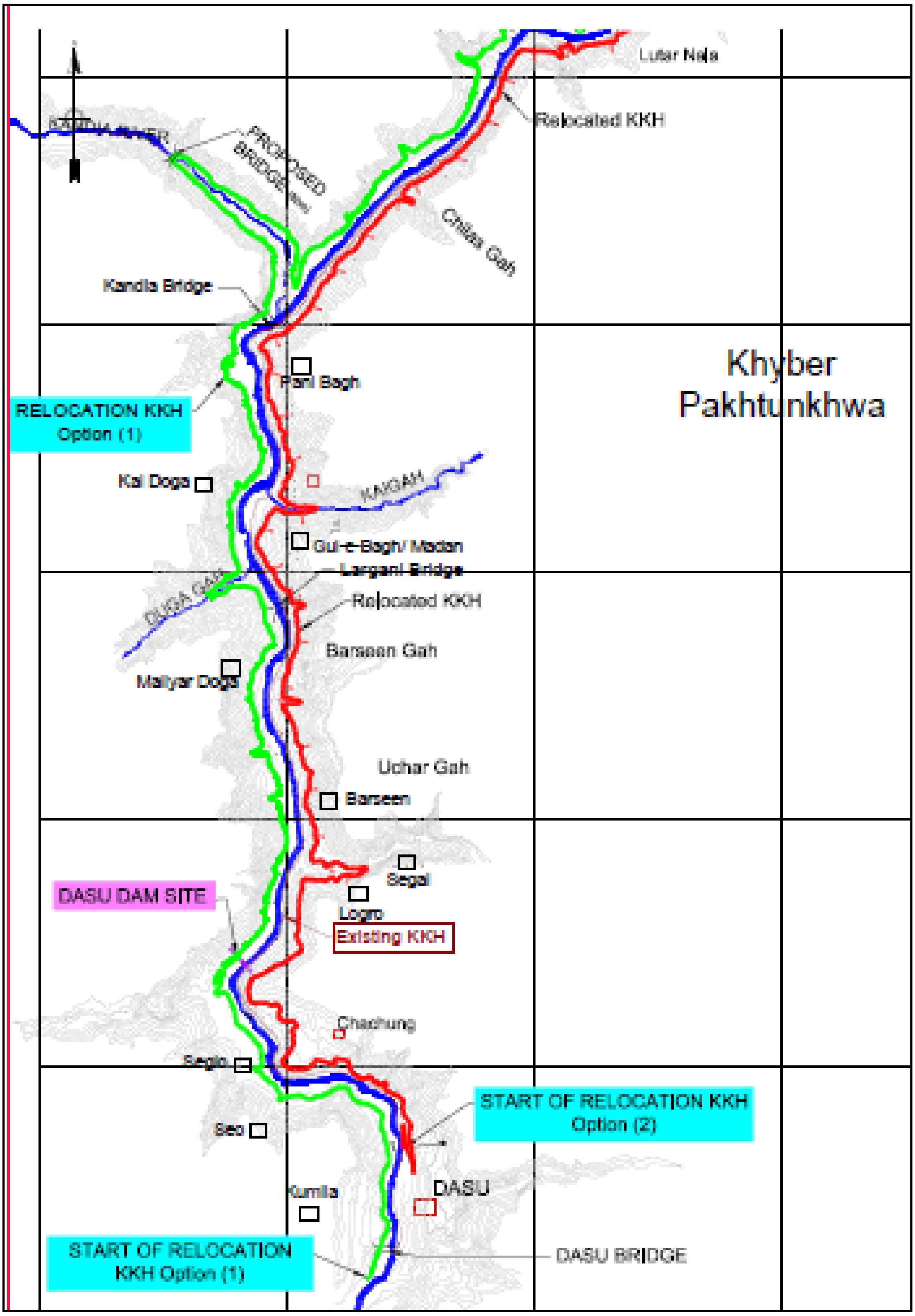


Figure 5.11: Options 1 and 2 for KKH Relocation

Table 5.15: Comparison of Options 1 and 2 for KKH Realignment

	Option 1	Option 2
Length	69.5 km	63 km
Indus Crossing	Needed	Not needed
Construction cost	About 3 million USD costlier than option 1	Less expensive than Option 1
Construction schedule	About one year longer than option 1	Shorter construction schedule than Option 1
Resettlement Issues	Significant (at Komilla)	Not significant (no major settlements would be disturbed)
Environmental Issues	More significant because of construction of greater length of highway and a large bridge over the Indus River	Less significant because of the shorter length and not needing to construct a large bridge over Indus.

5.14 ASSESSMENT OF ALTERNATIVES FOR OTHER TECHNICAL COMPONENTS

5.14.1 Alternatives for Water Ways (Intake & Tail Race Tunnels)

Three alternatives were considered for waterways (power and tail race tunnels) in the feasibility study and an alternative that produces significantly greater energy than the other alternatives was recommended. However the feasibility study did not evaluate the impact of Khoshe fault on the location of the power house and its stability – though Khoshe fault which is crossing at the mid of the tailrace tunnel is not an active fault and would not be seriously weak nor fractured. During detailed design, the feasibility study alternative (Alternative 1) is further compared with 3 more possible alternatives. Since Khoshe fault is not active and found to be only a contact, final alternative was chosen based on economic evaluation. Alternative 4 is preferable since it is more economical than alternative 1 with shorter and straight tunnels. Detailed analysis of these alternatives is presented in Annex 5.1.

5.14.2 Alternatives for Sediment Management and Flushing Frequency

About 200 million tons of sediments pass every year at the dam site and without any mechanism for release of sediments through flushing; the LLOs and power intake will be filled within 20-25 years. Details of sedimentation are further discussed in Chapter 7. According to the feasibility study of DHP, the flushing of Dasu is not required until 50 years since Basha will be constructed first and flushing of Basha will begin after 40 years – and Dasu flushing is required ten years later.

But with Basha now likely to be completed after Dasu, the question is what flushing regime is required during the first few years of Dasu operation, before Basha is commissioned. After studying various options, the design team finally considered following three feasible options.

- Option-1: no flushing up to 15 years and starts annual flushing under “Pre-Basha”

- Option-2: Every year flushing after impounding under “Pre-Basha”
- Option-3: No flushing under “Pre-Basha” and “Post-Basha”

A comparison of these three options in terms of their energy production is presented in Table 5.16. Under worst case scenario, assuming there will be no Basha, the flushing regime of Option 1 (flushing from 15 years) is recommended. If Basha will be there, Option 3 will provide more power generation and the flushing may not be required for 50 years.

Table 5.16: Comparison of annual energy production for three options

Options	Items	Periods (years) after commissioning of Phase 1 and No. of units operated			
		0-5 years	5-10 years	10-15 years	15-20 years
		3 units	6 units	9 units	12 units
Option 1	Status	Under "Pre-Basha'			
	Flushing	No flushing			Flushing
	Annual energy (GWh)	8,058	12,225	15,544	13,584
Option 2	Status	Under "Pre-Basha'			
	Flushing	Every year flushing after impounding			
	Annual energy (GWh)	6,561	9,371	11,631	13,584
Option 3	Status	Under "Pre-Basha'		Under "Post-Basha"	
	Flushing	No flushing			
	Annual energy (GWh)	8,058	12,225	18,730	21,485

Source: DHP Detailed Engineering Design, 2012

Chapter 6

CLIMATE CHANGE IMPACTS AND RISKS

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6. CLIMATE CHANGE IMPACTS AND RISKS

6.1 SCOPING

A climate change study was conducted under the environmental assessment process with the following objectives:

- mainstreaming climate change impacts and risks in the DHP planning and design
- assess greenhouse gas (GHG) emissions resulting from the Project activities during construction and operation stages;
- help WAPDA manage or reduce the potential risk posed by the impacts of climate change to the project and contribute to climate change action;
- provide relevant stakeholders with information that will assist their broader climate change action;
- help decision makers to address climate change implications in a risk management context;
- provide assurance to the public that the future climate change impacts are being appropriately considered in the design of the proposed project; and
- propose monitoring, follow-up, and adaptive management in both GHG emission reductions and climate change impact related risks during the implementation and operation of the project.

The following two approaches are considered for incorporating climate change in the EIA:

- GHG Considerations: where the proposed project may contribute to GHG emissions and climate change
- Impacts Considerations: where climate change may affect the proposed project

Figure 6.1 provides an outline of the climate change considerations followed in the DHP study.

6.2 DATA, INFORMATION COLLECTION AND METHODS FOLLOWED

6.2.1 GHG Consideration

DHP will have GHG emission contributed from various activities during construction and operation phases. These include but may not be limited to, (a) Equipment usage during construction, (b) Project related vehicular traffic on, (c) Onsite fuel combustion for space and water heating, landscape maintenance equipment, and fireplace/stoves, (d) Offsite emissions at sites preparing construction materials for the project activities, and (e) Functioning of hydropower reservoir (Figure 6.2).

GHG emissions are calculated in accordance with the revised 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories. Methodology followed for emission calculations are given in Annex 6.1. IPCC basis for Post-flooded methane (CH_4) and carbon dioxide (CO_2) emissions can occur via the following pathways (Figure 6.3):

- Diffusive emissions, due to molecular diffusion across the air-water interface; this is the major pathway for CO_2 emissions;
- Bubble emissions, or gas emissions from the sediment through the water column via bubbles; this is a very important pathway for CH_4 emissions, especially in temperate and tropical regions; this is a very minor pathway for CO_2 emissions;
- Degassing emissions, or emissions resulting from a sudden change in hydrostatic pressure, as well as the increased air/water exchange surface after

reservoir waters flow through a turbine and/or a spillway; this is a very important pathway for CH_4 emissions from young tropical reservoirs.

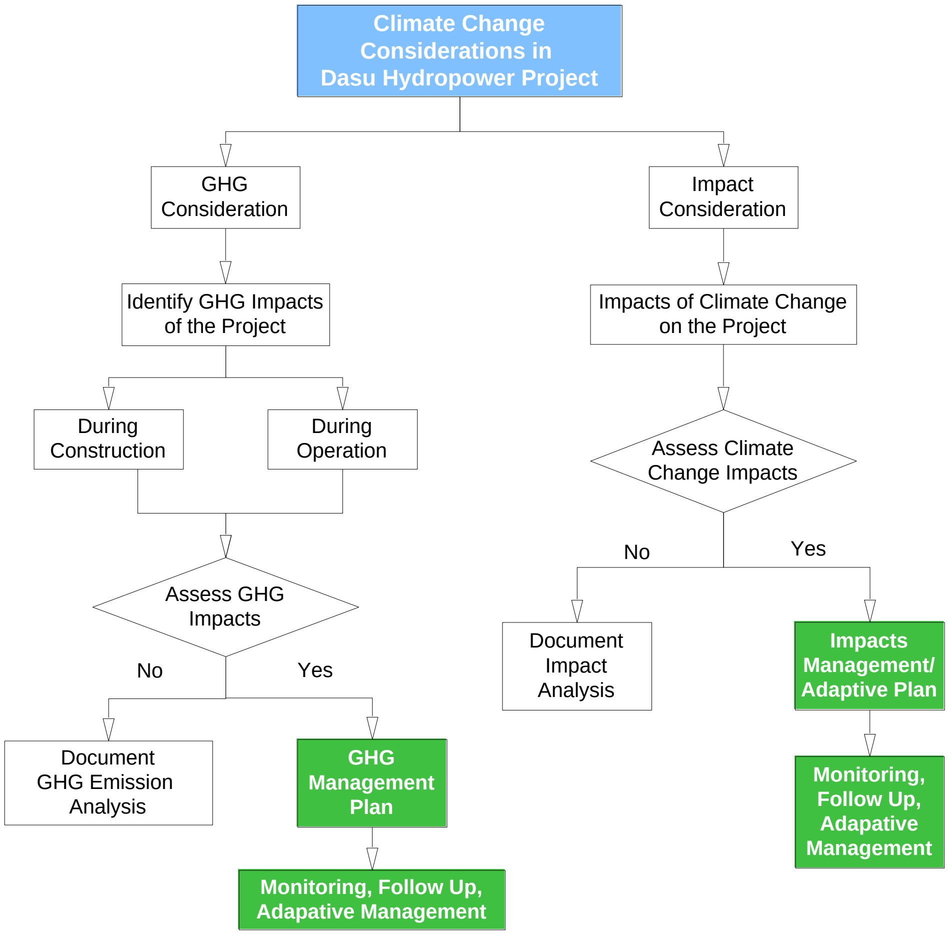
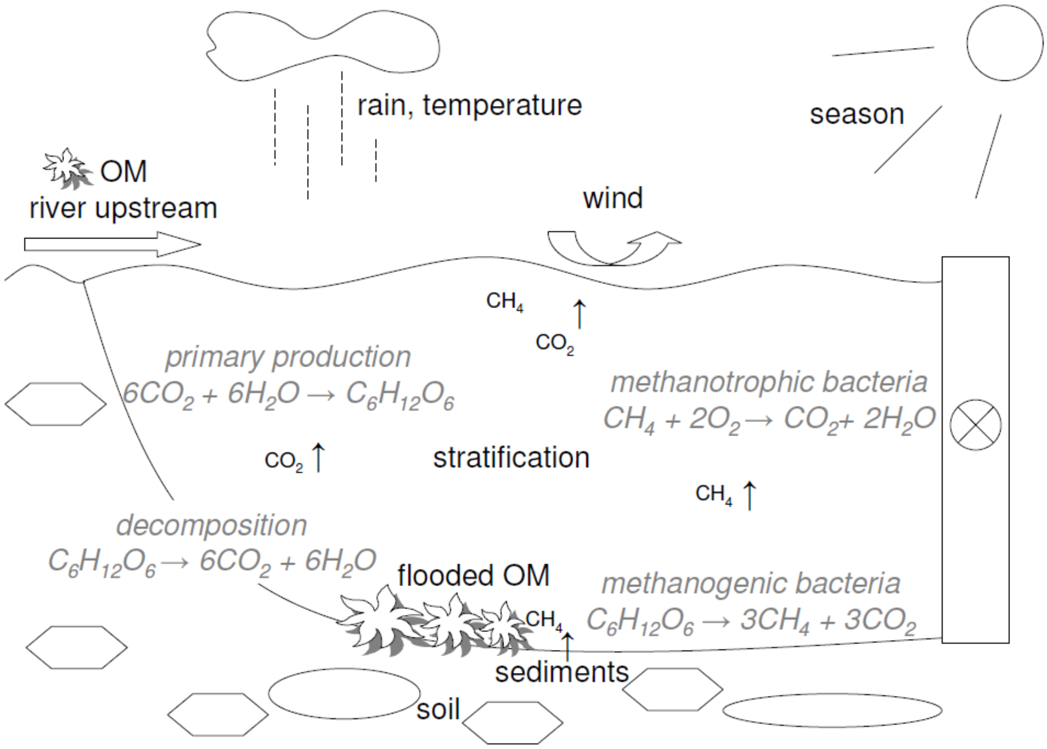


Figure 6.1: Scoping of Climate Change Considerations in DHP

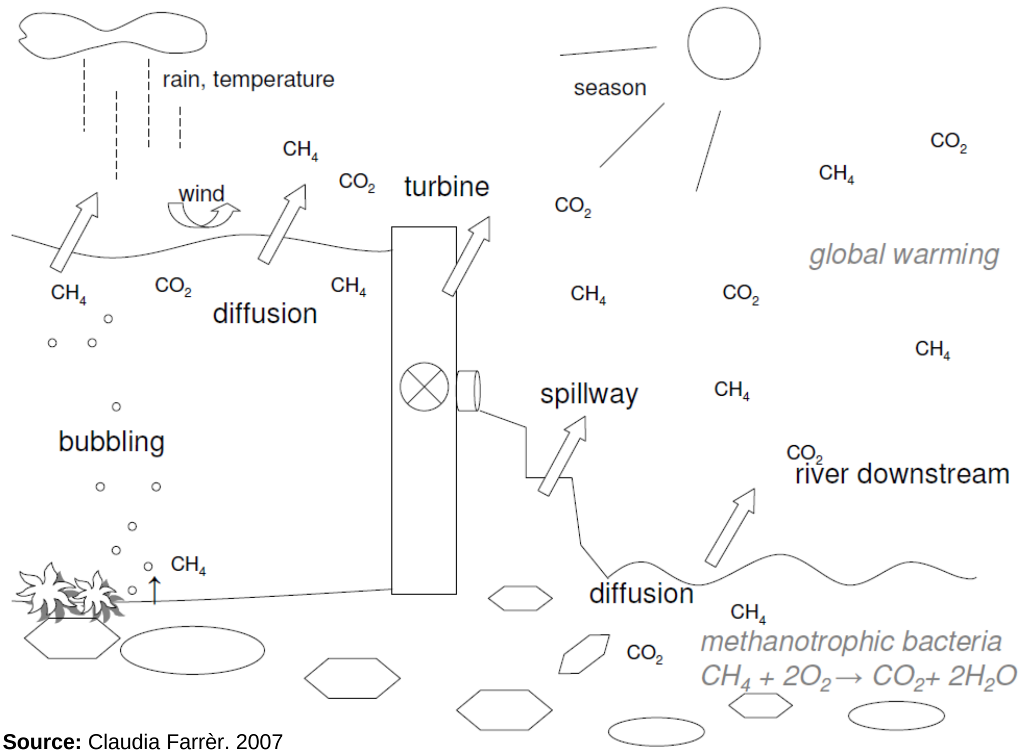
6.2.2 Impacts Consideration

The impacts consideration assessed the hydro-meteorological parameters that are directly and indirectly exposed to climate change phenomenon for facilitating the detail design and environmental assessment process. In this regard, the study assessed the effects of climate change on the river hydrology, snow and glacier melting in the Hindu Kush-Karakoram-Himalayan (HKH) mountain ranges at the proposed dam site. Projecting the impact of global climate change on water resources therefore requires the ability to represent climate processes on a variety of spatial scales, from global (300km x 300km) down to regional (50km x 50km). In this regard, under the current scope of works, neither any Global Circulation Model (GCM) or Regional Climate Model (RCM) nor any hydro-dynamic simulation was conducted; rather raw data available from existing climate and hydro-metric observatories and regional projections from different sources (GCICS, 2009 and Planning Commission, 2009) were used.



Source: Claudia Farrèr. 2007

Figure 6.2: Production of GHG emission in a Hydroelectric Reservoir



Source: Claudia Farrèr. 2007

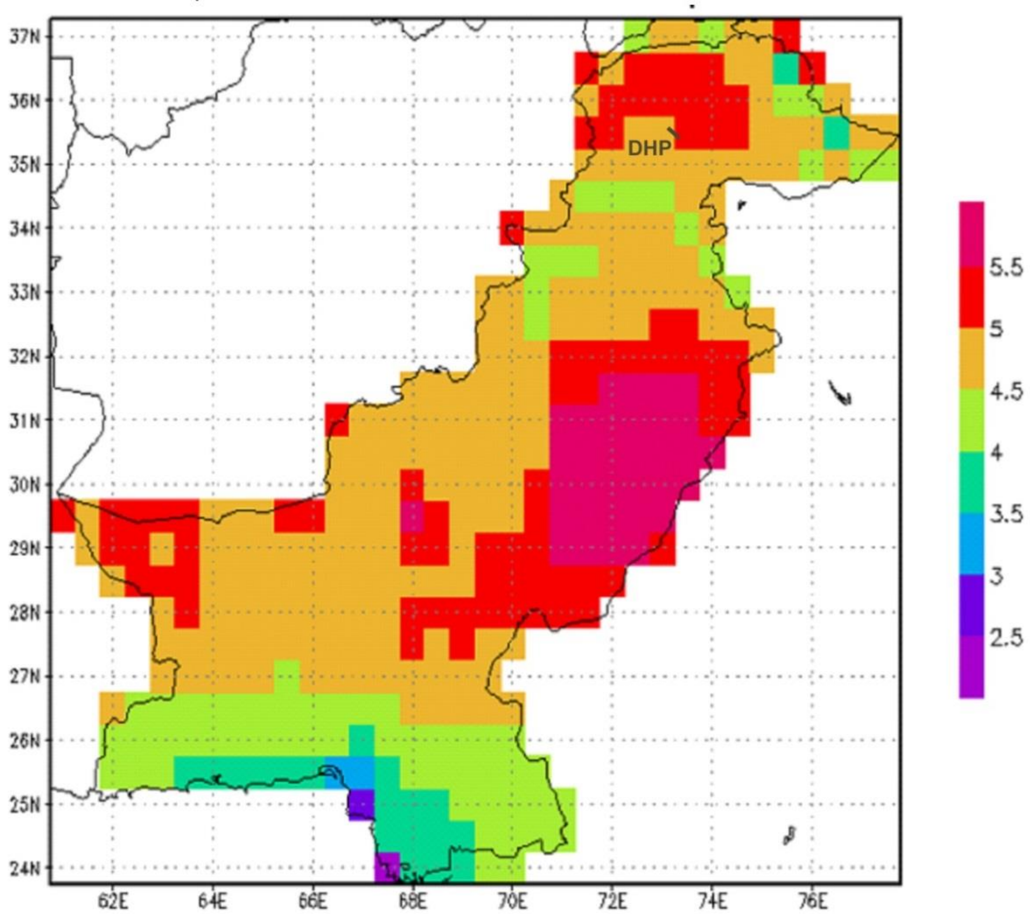
Figure 6.3: The fate of CO_2 and CH_4 in a hydroelectric reservoir

6.3 CLIMATE PROJECTIONS

6.3.1 Temperature Projection

Global Climate Change Impact Study Centre (GCISC) has been conducting climate change studies in Pakistan (GCISC, 2009). In these studies, 13 IPCC AR4 Global Circulation Models (GCMs) for the A2 scenario and 17 GCMs for the A1B scenario, have been used. According to AR4, the average global surface temperature is projected to increase in A2 and A1B scenarios by 3.4°C and 2.8°C, respectively during the 21st century. The following outputs are derived for Pakistan:

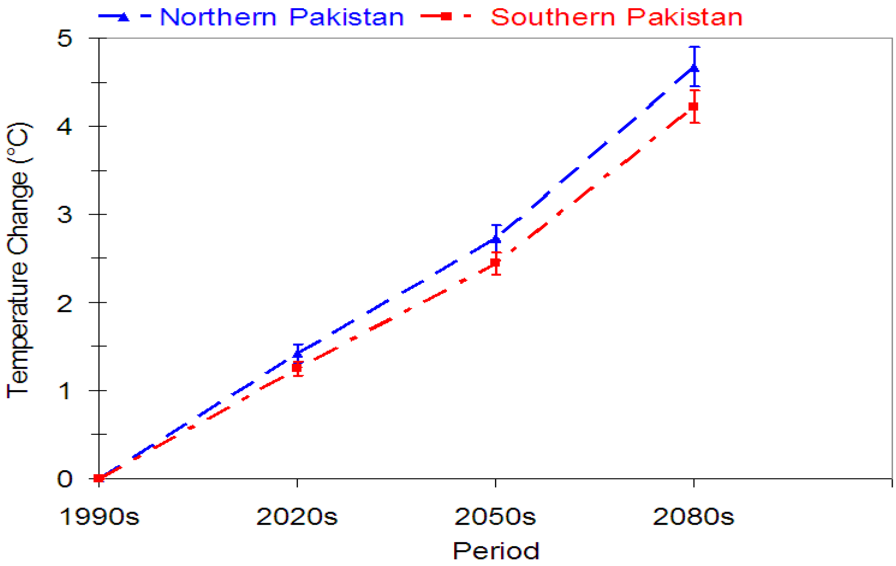
- The temperature increase throughout the Northern Pakistan as well as in Southern Pakistan is higher in A2 scenario than in A1B scenario.
- In each scenario the temperature increase in Northern Pakistan is larger than that in Southern Pakistan, in line with the IPCC global scenarios which show higher temperature increase over Central Asia than that over South Asia.
- The temperature increase in both Northern and Southern Pakistan in each scenario is higher than the corresponding globally averaged temperature increase (for A2 scenario, the projected temperature increases in 2080s in Northern and Southern Pakistan are 4.67°C and 4.22°C, respectively (Figure 6.4 and
- Table 6.1) compared to 3.4°C average global temperature increase for 2090-2099 period relative to 1980-1999; for A1B scenario, the corresponding values are 4.12°C, 3.73°C and 2.8°C, respectively). The current annual average temperatures for Northern and Southern Pakistan are about 19°C and 24°C, respectively).



Source: GCISC, 2009

Figure 6.4: Projected Temperature Change for 2080s (A2 Scenario)

For Pakistan as a whole the temperature increase in 2020s, 2050s and 2080s are respectively 1.31°C, 2.54°C and 4.38°C in A2 scenario and 1.45°C, 2.75°C and 3.87°C in A1B scenario. In northern Pakistan, where the Project is located, the change in temperature in the year 2080 will be 4.67°C for A2 scenario and 4.12°C for A1B scenario, respectively (Figure 6.5).



Source: Planning Commission, 2009

Figure 6.5: Projected Changes in Average Temperature (A2 Scenario)

Table 6.1: Projected changes in temperature in 2080s for A2 and A1B Scenarios.

	Average Temperature Change (°C) in 2080s		
	Pakistan	**Northern Pakistan**	**Southern Pakistan**
	A2 Scenario		
Annual	4.38 ± 0.44	4.67 ± 0.23	4.22 ± 0.18
Summer (JJAS)	4.13 ± 0.26	4.56 ± 0.28	3.90 ± 0.26
Winter (DJFM)	4.47 ± 0.20	4.72 ± 0.24	4.33 ± 0.18
	A1B Scenario		
Annual	3.87 ± 0.20	4.12 ± 0.23	3.73 ± 0.18
Summer (JJAS)	3.70 ± 0.23	4.07 ± 0.26	3.50 ± 0.22
Winter (DJFM)	3.92 ± 0.21	4.11 ± 0.24	3.81 ± 0.19

Note: JJAS: June, July, August & September; DJFM: December, January, February & March

Source: Planning Commission, 2009

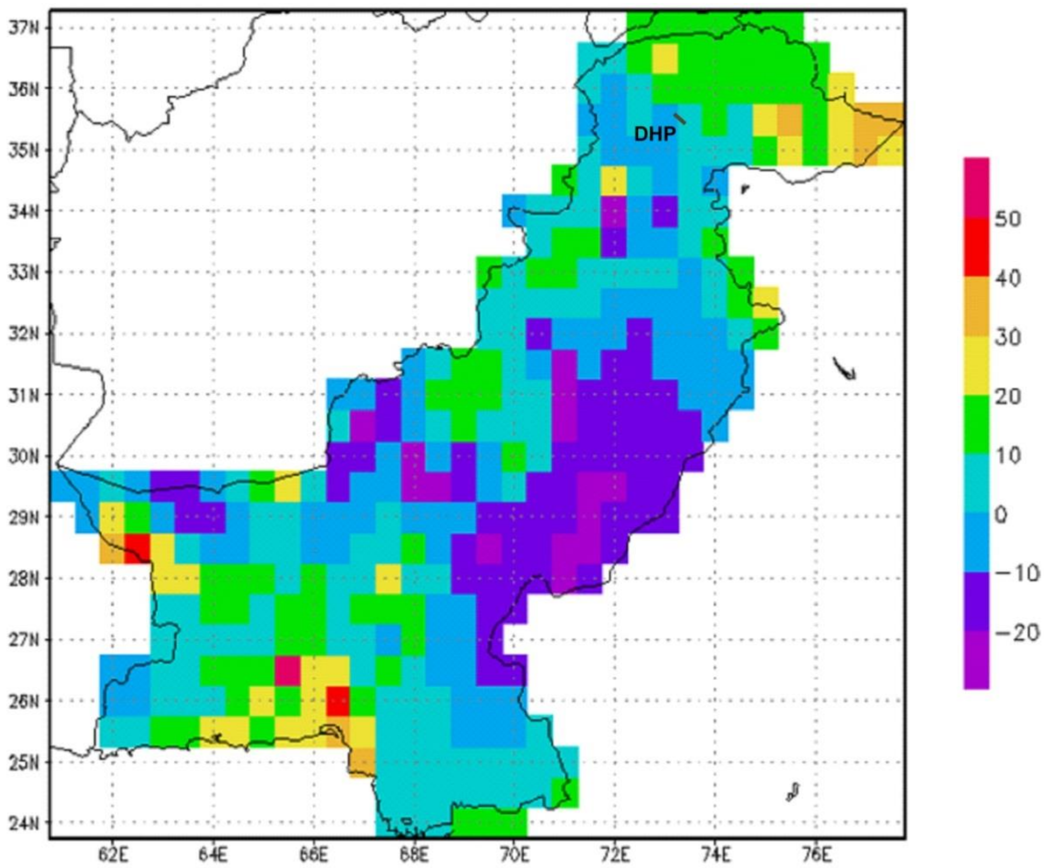
6.3.2 Precipitation Projections

GCM ensemble based precipitation projections are much less certain than those for temperature due to the limitations of the current generation of Global Circulation Models for modelling precipitation. Although the precipitation projections by various GCMs vary a great deal, the analysis conducted by Global Change Impact Studies Centre (GCISC) using the ensemble outputs of 13 GCMs for the A2 scenario and 17 GCMs for the A1B scenario indicate that precipitation is likely to increase in summer and decrease in winter in both Northern and Southern Pakistan (GCISC, 2009), with no significant change in annual precipitation in either part.

Table 6.2: Projected changes precipitation (%) in 2080s

	Average Precipitation Change (%)		
	Pakistan	**Northern Pakistan**	**Southern Pakistan**
	A2 Scenario		
Annual	3.48 ± 5.78	1.13 ± 3.95	4.28 ± 9.46
Summer (JJAS)	12.16 ± 8.91	7.08 ± 8.35	51.07 ± 39.78
Winter (DJFM)	-5.12 ± 4.78	-2.24 ± 4.10	-20.51 ± 9.05
	A1B Scenario		
Annual	-0.4 ± 4.36	-0.73 ± 3.08	-0.89 ± 7.91
Summer (JJAS)	3.89 ± 6.89	1.98 ± 5.74	37.6 ± 34.0
Winter (DJFM)	-6.32 ± 3.58	-4.10 ± 3.10	-15.1 ± 7.61

Source: Planning Commission, 2009



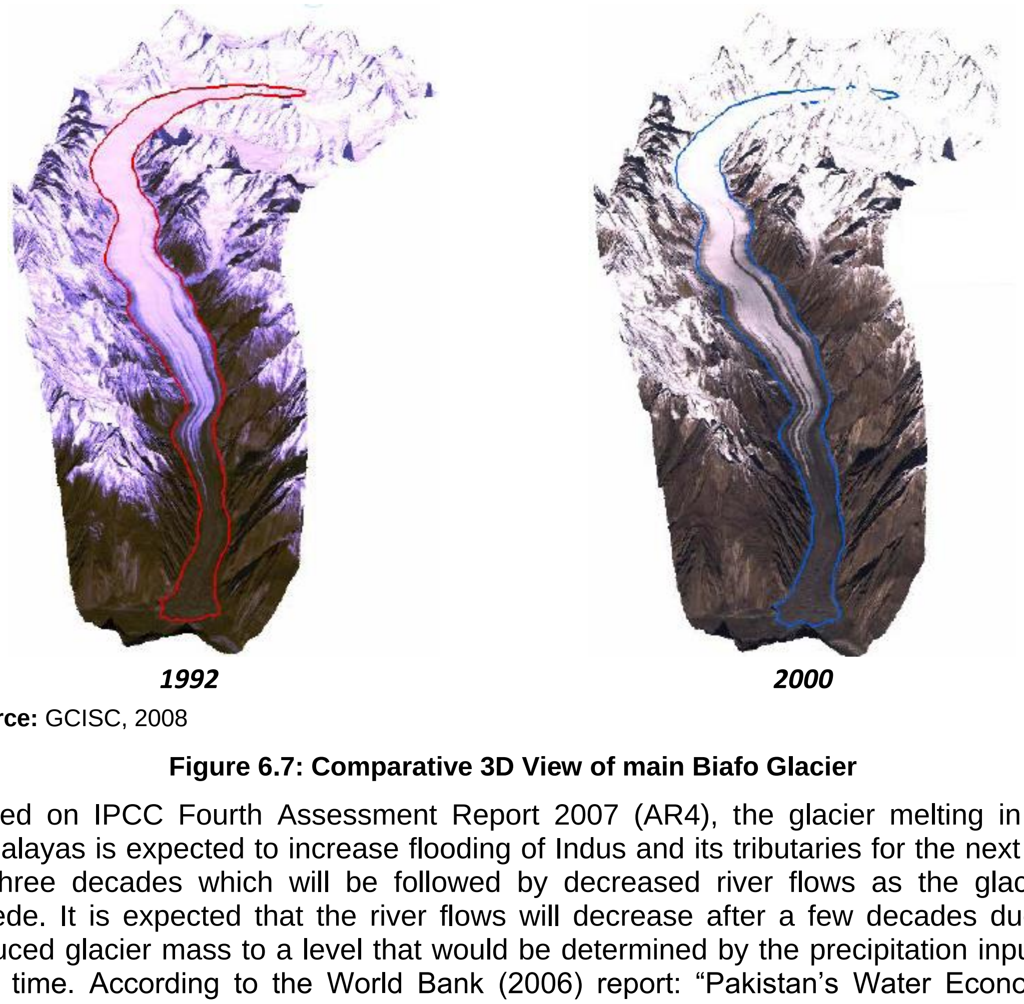
(Source: GCISC, 2009)

Figure 6.6: Projected Precipitation Change (%) for 2080s (A2 Scenario)

6.3.3 Melting of Glaciers

About 50-80% of the 174 BCM (141 million acre feet) average river inflows in the Indus River System (IRS) is fed by snow and glacier melt in the Hindu Kush-Karakoram (HK) part of the HKH mountain ranges. After the Arctic/Greenland and Antarctic glaciers, the HKH represent the third largest ice mass on the earth. The HK mountains receive most of their precipitation during winter under westerly winds and act as a reservoir, capturing snow and rains, holding the water and releasing it in summer into the IRS. In the Upper Indus Basin (UIB) there are more than 5,000 glaciers which cover a total glaciated area of about 15,000 sq. km. These glaciers constitute about 2,700 BCM of stored volume of ice (Roohi, 2005), equivalent to about 14 years of average IRS inflows.

Over the past century, the trend of worldwide glaciers are receding, the HKH glaciers are receding faster than in any other part of the world and it is expected that if the present rate of recession continues, the HKH glaciers might disappear by 2035 (Rees, G. and D.N. Collins, 2004). The thermal regime of HKH glaciated region has in general warmed up and the frequency of occurrence of moderate as well as severe heat waves have also increased significantly (PMD, 2009). Preliminary analysis of the time series data on flows of the Indus and its tributary rivers did not indicate any large melting of glaciers so far (GCISC, 2009). Based on the studies available so far, it looks most likely that the HKH glaciers are receding under the influence of the global warming and that the melting will increase in the summer temperature. This will have very serious implications for the water flow and its pattern in the IRS. However, a study on Western Karakoram glaciers (Hewitt 2009) concluded that some of them are even surging recently. Figure 6.7 presents a time series 3D view of Biafo glaciers of HKH with overlaid digitized boundary of the Glacier, which supports the theory of glaciers recession.



Source: GCISC, 2008

Figure 6.7: Comparative 3D View of main Biafo Glacier

Based on IPCC Fourth Assessment Report 2007 (AR4), the glacier melting in the Himalayas is expected to increase flooding of Indus and its tributaries for the next two to three decades which will be followed by decreased river flows as the glaciers recede. It is expected that the river flows will decrease after a few decades due to reduced glacier mass to a level that would be determined by the precipitation input at that time. According to the World Bank (2006) report: "Pakistan's Water Economy: Running Dry", the western Himalayan glaciers will retreat for next 50 years causing increase in Indus River flows and then the glacier reservoirs will be empty, resulting in decreases of 30% to 40% in river flows in the Indus Basin. Similarly, a three-year modeling study by the Centre for Ecology and Hydrology, Wallingford, UK and Alpine Glacier Project, University of Salford, UK covering the 100-year time horizon starting from 1991 reports that in the Upper Indus the mean river flow will increase between 14% and 90% followed by flow decreasing to between 30% and 90% of baseline by the last decade of the 21st century (Figure 6.8) (Rees, G. and D.N. Collins, 2004). A recent simulation modelling conducted by GCISC on Indus flows for a scenario, where the temperature will rise by 3°C and the glaciers to shrink to half their present size, not only the overall annual flow would reduce by about 15%, the monthly flow pattern would also change considerably, with more water coming in spring and early summer and less water in the later part of summer (Figure 6.9). This scenario used in this model (3 °C and 50% glacier recession) will truly represent the future scenario of DHP, whose life time will be minimum up to 2060, and can be considered in planning and design of the DHP.

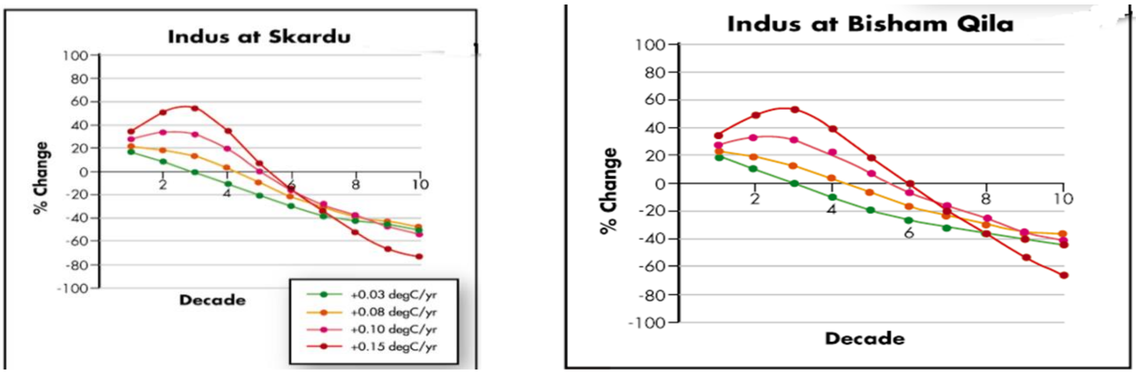
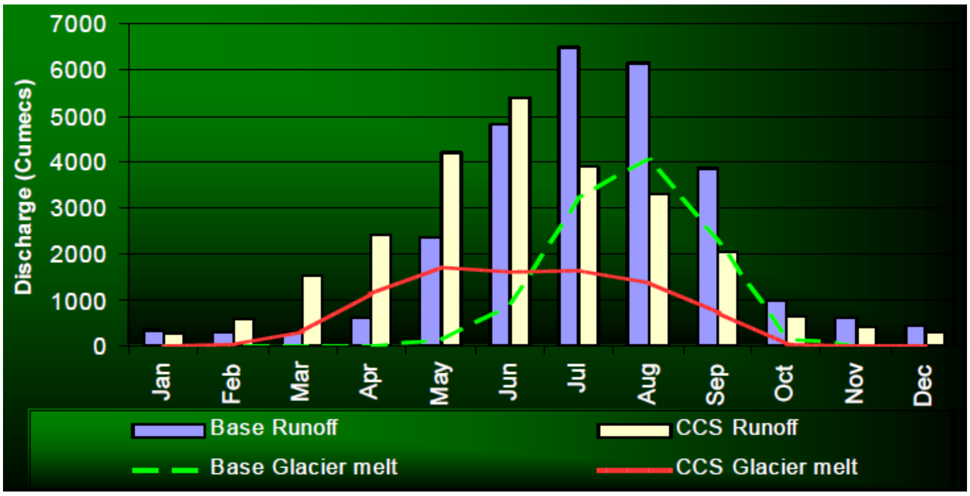


Figure 6.8: Predicted Changes in Indus Flow



(Source: GCISC, 2009)

Figure 6.9: Present Base Flows (1995-2004) and Future Flows in Indus at Bisham Qila for a scenario of 50% glacier recession and 3°C of temperature increase

6.4 ANALYSIS OF ENVIRONMENTAL EFFECTS

6.4.1 GHG Considerations

6.4.1.1 Net GHG Emissions for Stage 1

Net greenhouse gas (GHG) emissions from Stage 1 implementation of DHP (12,225 GWh/year) are estimated using the World Bank "Guidance Note: Greenhouse Accounting for Energy Investment Operations, Ver 1.0, June 2013 (hereinafter "Guidance Note") and IPCC 2006 guidelines. The emissions from the Project and baseline emission of the nearest least-cost alternative (CCGT) estimated over 50 year.

<u>Project GHG Emissions</u>

Four sources of emissions are considered for accounting GHG from the Project. The sources and the estimates are given below.

1. Reservoir Emissions. When a river is dammed, the flow dynamics are changed, riverine sediment and organic material are trapped, and terrestrial ecosystems are flooded. This alters the previous cycle and fluxes of CO_2 and other GHGs within the reservoir area. The main contributions to emissions are decomposable parts of flooded soil and vegetation in terrestrial zones and removed sinks from cleared biomass growth. GHG emissions from new aquatic systems will occur during the full lifetime of the reservoir, but will exponentially decrease as the flooded organic material is decomposed and as biochemical conditions change.

The power density of the Project in Stage I is 91 MW/km^2. The Guidance Note includes a methodology to estimate default emission factor from reservoirs based on three key parameters: power density, plant factor and climate. From Table 4B1 of the Guidance Note, reservoir emissions for plants with power densities greater than 40 MW/km^2 located in temperate areas are negligible and can be assumed to be zero.

However, according to IPCC guidelines, the flooding of lands in warm temperate dry areas produce a median CH_4 emissions of 0.044 kg/ha/day and CO_2 emissions of 5.2 kg/ha/day. These diffusion values are considered for reservoir emissions of the Project. The emissions of CH_4 are converted to CO_2 equivalents using a global warming potential of 72. Annual CO_2e emissions from DHP reservoir are 7284.6 tons.

According to the World Bank Guidance Note reservoir emissions are assumed to have a standard 100 year time horizon. But reservoir emissions from the DHP are expected to be limited to first few years due to (i) run-of-river nature of the project, (ii) 60 percent of the reservoir area is barren, and (iii) large volume of water inflow with respect to limited reservoir area (which limit the residence time of inflowing water in the reservoir, 1 to 6 days during high flow season and about 19 days during low flow season). Hence a time horizon of 10 years is considered reasonable for the Project. Hence, Total Project Reservoir Emissions are estimated as 0.073 million tCO_2e.

2. Emissions from Land Clearing for Civil Works. Construction of dam, power facilities, access roads, offices, and some other project facilities require permanent land clearing. Emissions from land clearing can be calculated as a one-time emission of CO_2 based on the available dry biomass carbon for the total cleared areas for construction, according to IPCC guidelines. According to IPCC guidelines, Temperate dry climate has 100 tons/ha of dry biomass, of which average carbon content is 47 percent. Total land clearing emissions for 6 km^2 are 0.103 million tons CO_2e.

3. Embodied (Life Cycle) emissions in construction materials. The construction of Project consumes about 400,000 tons of cement, 60,000 tons of steel, metals, and other electro mechanical equipment. All of these materials have embodied emissions as a result of the energy used to produce them, meaning that the implementation of the Project creates some upstream emissions in the manufacture of the materials used. The Guidance Note recommended a mean value of 2.9 kgCO_2e/MWh per hydropower as a default factor if no other information is available. Thus Total Embodied (Life Cycle) Emissions are estimated to be 1.772 million tCO_2e.

4. Emissions from Energy Use in Construction. Diesel fuels are mainly used by the construction vehicles and equipment. GHG emissions from Project vehicles and equipment are estimated by EIA during 88 months of construction period. Total Construction Emissions are 0.158 million tCO_2e (source: Table 6.3**Error! Reference source not found.**).

The total Project emissions from all the above four sources is 2.11 million tCO_2e.

Table 6.3: GHG Emission during Construction of DHP

Year	GHG Emission (tons)			
	CO_2	CH_4 (CO_2e)	N_2O (CO_2e)	Total CO_2e
2015	20,953.0	65.4	358.3	21,376.7
2016	21,248.2	67.9	371.6	21,687.8
2017	21,248.2	67.9	371.6	21,687.8
2018	21,189.7	67.8	370.8	21,628.3
2019	20,953.0	65.4	358.3	21,376.7
2020	20,980.2	65.5	358.6	21,404.4
2021	20,980.2	65.5	358.6	21,404.4
2022	6,993.40	21.83	119.53	7,134.80
Total Project:	**154,545.90**	**487.23**	**2,667.33**	**157,700.90**

1. CO_2e - Carbon Dioxide Equivalent
2. GWP values for CH_4 and N_2O from IPCC 2007 Fourth Assessment Report (pg. 212) using 100 year time horizon

Source: The Consultant's Estimate, 2012

Baseline Emissions

Two sources of emissions are considered for estimations of baseline emissions.

1. Baseline Generation Emissions. These are GHG emissions resulting from same amount of electricity generation using other alternate feasible energy sources. This feasible alternative should be realistic in terms of economic, technical, financial, legal and regulatory aspects. The economic and least cost analysis of the Project described CCGT is the most feasible alternative to the Project. Emission Factor for CCGT is 367.56 gCO_2/kWh (Table 5.3). Total Baseline Generation Emissions for 50 years are 224.67 million tCO2e.

2. Baseline Construction Emissions. According to the 'Guidance Note', the default value for one-off emissions for thermal gas power is 503 $kgCO_2e$/kW of installed capacity. The corresponding plant factor is 85 percent. For the installed capacity to produce 12,225 GWh/year requires 1,642 MW of thermal gas power. Total baseline construction emissions are 0.83 million tCO_2e.

Therefore, the total baseline emissions from above two sources are 225.50 million tCO_2e.

Net Emissions

The net emissions (Project Emissions minus Baseline Emissions from CCGT) of DHP are minus 223 million tons of CO_2 equivalent.

6.4.1.2 Power Density of Dasu

Reservoirs in some occasions are at risk from excessive GHG emissions. Scenarios have been established which show that in cases where the power density (i.e., generation capacity per unit area of inundation) of the hydropower project is less than 0.1 W/m^2 of reservoir area then there is a risk that the GHG emissions may exceed the thermal emissions avoided (WCD, 2000). Where values exceed 0.5 W/m^2 the scenarios show that the possibilities of reservoir emissions putting at risk the benefits of CO_2 emissions avoided by hydropower are reduced (Rosa et. al., 2002). For DHP, power density is 450 times greater than the threshold value of 0.1 W/m2 (Table 6.4).

Table 6.4: Power Density Calculations for various dam Configurations

Phases /Turbines	Capacity (MW)	Flooded Area[1] (km^2)	Power Density (W/m^2)
Phase 1/ 3	1,080	23.85	45.28
Phase 2/6	2,160	23.85	90.57
Phase 3/9	3,240	23.85	135.85
Phase 4/12	4,320	23.85	181.13

According to UNFCCC 2012 guidelines, hydropower projects with power densities higher than 5 W/m^2, but less than or equal to 10 W/m^2 are eligible for CDM projects, but with project emissions equal to 100 g CO_2/kWh. Power densities greater than 10 W/m^2 are eligible and project emissions can be neglected. UNFCCC notes from a database of 245 hydro plants in operation in the world with at least 30 MW of installed capacity, it finds the average power density is 2.95 W/m^2. Dasu with a power density of 181 W/m^2 is the highest in the world among hydropower projects of such large capacity (Table 6.5).

Table 6.5: Power Densities of World's Largest Hydropower Dams

Rank	Hydropower Dam	Country	River	Installed Capacity (MW)	Area flooded (km^2)	Power Density (W/m^2)
1	Three Gorges	PRC	Yangtze	22,500	1,045	21.53
2	Itaipu	Brazil	Paraná	14,000	1,350	10.37
3	Guri	Venezuela	Caroní	10,200	4,250	2.40
4	Tucuruí	Brazil	Tocantins	8,370	3,014	2.78
5	Grand Coulee	USA	Columbia	6,809	324	21.02
6	Longtan	PRC	Hongshui	6,426		
7	Krasnoyarskaya	Russia	Yenisei	6,000	2,000	3.00
8	Robert-Bourassa	Canada	La Grande	5,616	2,835	1.98
9	Churchill Falls	Canada	Churchill	5,428	6,988	0.78
10	Bratskaya	Russia	Angara	4,500	5,470	0.82
11	**Dasu**	Pakistan	Indus	4,320	23.85	**181.13**

Source: Compilation of data from Wikipedia (data was not available for Longtan Dam of China)

6.4.2 Impact Consideration

Climate variability will primarily impact on the hydro-meteorological process and the surrounding environment will be impacted secondarily from the perturbation in the hydro-meteorological phenomenon. Considering the time constrains and sharp deadlines, environmental assessment exercise only considered the climate change impact on the hydro-meteorological processes at the Dasu dam site.

6.4.2.1 Precipitation

Rainfall data of Chilas from 1953-2010 was used in establishing the design rainfall for hydraulic structures for project road of the KKH. Flood frequency analysis with Gumble Extreme Value Type-1 Distribution was carried out on the rainfall data at Chilas of 57 years duration. Rainfall estimate for 100 year return period was estimated as 60mm.

6.4.2.2 Mean and Low Flows

As there were no gauged flows available at the proposed Dasu Damsite, gauged flows of upstream station at Shatial and Bunji/Partab were used as basis to indirectly

[1] The flooded land area for DHP (reservoir area excluding the river) is 18.14 kim^2. In this case the power density will be 238 W/m2. However, for consistency for comparison for other hydro projects, total surface area of the reservoir is considered.

compute and transpose flows at Dasu Dam site. 10-daily (1962-2008) mean, monthly mean and annual mean flows were calculated. Flow duration curve on the basis of 10–daily mean flows is presented in Figure 6.10. 2116 m³/s is the mean annual flow and 291 m³/s is the lowest flow.

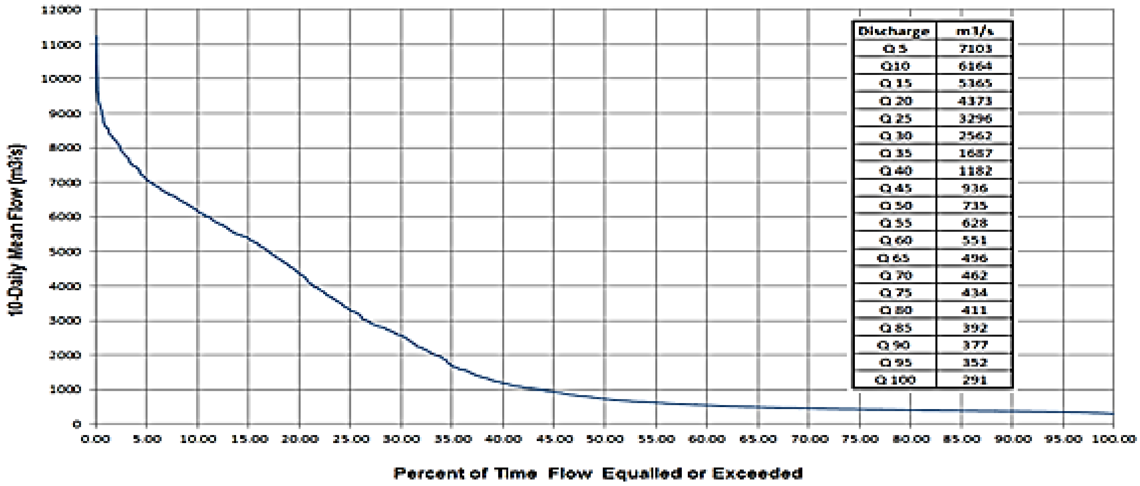


Figure 6.10: Flow duration curve at Dasu damsite on 10-daily basis (1962-2008)

6.4.2.3 Floods

(1) <u>Basic Design Flood</u>

The 10,000 year recurrence interval flood is generally considered as Basic Design Flood (BDF) for large dams and at Dasu it is estimated to be 21,228 m³/s. However, the Glacial Lake Outburst Flood (GLOF) of August, 1929 with a peak of 23,710 m³/s and a 2–day runoff volume of 2.3 BCM was the largest flood event historically recorded and for which detailed information is available. The 1929 flood was considered as flood of record and adopted as the BDF for the spillway design of the project. The flood event included the base flow of 5,350 m³/s, which generally prevails in July and August. This Flood was considered to occur at Diamer Basha damsite. Therefore, peak flood of 23,710 m³/s was transposed to Dasu damsite and computed as 27,932 (m³/s).

(2) <u>Safety Check Flood</u>

For large dams, Probable Maximum Flood (PMF) is generally designated as the Safety Check Flood (SCF). The PMF in the UIB at Diamer Basha damsite was defined to be a flood due to a combination of glacial and snowmelt and superimposed over a flood caused by a natural dam burst in the UIB. Various scenarios were considered and a hypothetical hydrograph representing the great Biafo GLOF with volume of 3.3 BCM, of 18th Century superimposed over a base flow of 5,350 m³/s was adopted. This has resulted a peak discharge of 49,410 m³/s and a 2–day runoff volume of 4.21 BCM, and was considered the most critical of all and was selected as PMF/SCF for the Diamer Basha damsite. This when transposed at Dasu damsite worked out to be of the order of 51,957 m³/s.

6.5 IDENTIFICATION OF MITIGATION/ADAPTIVE MEASURES

6.5.1 GHG Management Plan

A GHG management plan and monitoring measures for CO_2 and CH_4 emissions are recommended during construction and operation stages of the project.

6.5.1.1 During Construction

The following GHG management plan is recommended during construction of the project:

- Implement vehicle exhaust emission controls including the following:
    - Regular maintenance of vehicles, plant and machinery in accordance with manufacturer's specifications.
    - Monthly visual inspections on vehicle and plant exhausts to identify excessive emissions of smoke, and maintenance undertaken where required.
    - Approved pollution control devices to be fitted to equipment and machinery.
    - Transport vehicles shall not be overloaded.
    - Switch off / throttle down all site vehicles and machinery when not in use.
- Avoid unnecessary idling of equipment.
- Plantation development is recommended wherever feasible in the buffer areas of the reservoir, along KKH, and near permanent facilities of the project, WAPDA colony, resettlement villages, etc. Details of plantation development are given in Chapter 9 of EIA.

6.5.1.2 During Operation

The following GHG management plan is recommended during operation stage of the project:

- Ensure that all the vegetation was cleared from the inundation area before the reservoir formation.
- Reduce the biomass and debris quantity in the reservoir which generates GHG emissions. Engineering interventions are included in the project design, such as trash racks at the power intake and flaps at spillway gates to collect and dispose the biomass such as logs and vegetation.

6.5.2 Impacts Management/Adaptive Plan

Based on the climate change analysis presented in the earlier sections, the following climate change adaptations are made to include in DHP Design:

- It is recommended to consider the temperature increase of 3°C to accommodate future temperature rise in the design.
- It is recommended to consider a 15% increase in rainfall for design of hydraulic structures in the Project to accommodate rainfall changes due to climate change.
- Flood volumes will increase due to climate change predictions on temperature increase and thereby melting of glaciers. Flood volumes are designed based on the historical record of flood levels in Indus, possible increase of flows due to climate change and recorded extreme events such GLOFs. The BDF with peak discharge of 24,932 m^3/s and SCF with peak discharge of 51,957 m^3/s at Dasu damsite are considered in the design.
- It is recommended to consider a minimum 20% decrease in the low flows for the design of turbines to accommodate future decreased flows due to climate change. At the same time it is recommended to consider greater water flows over the next few decades. Feasibility study recommended 8 numbers of turbines with a size of 520 MW each. Based on the recommendations from the climate change study and transportation requirement of KKH, the turbine size in detailed design is reduced to 360 MW and the numbers of turbines are increased to 12.

- Continued monitoring of glaciers is crucial for the water security of the country, and useful for developing the knowledge base for the operation of the dam and for planning future hydropower investments in the Indus Basin. A glacier monitoring program was recommended by World Bank under Tarbela IV Extension Project[2]. This program would support the Glacier Monitoring and Research Center (GMRC) under the WAPDA General Manager Planning for monitoring and research on the Upper Indus Basin (UIB) glaciers. This is intended to examine the characteristics and movements of these glaciers, and provide early warning for glacial lake outbursts. The proposed GMRC would have four sections: (a) a field investigations section responsible for establishing and managing field stations. The office is proposed to be established in the upper catchment of the Indus; (b) a remote sensing and modeling section located in Lahore to carry out remote sensing and modeling studies; (c) a forecasting section; and (d) a data management section to maintain and upgrade data management systems and carry out data analysis and research activities. It would also link up with the high altitude meteorological network, surface water hydrology, and the WAPDA hydro-meteorological network. If this Glaciers Monitoring Program is not approved or not included in Tarbela IV Extension Project, it is strongly recommended to include it under DHP.
- A series of flood warning telemetry network is proposed in the Indus basin (Section 6.5.2.1). This will strengthen the flood forecasting system in the country and complement the above Glacier Monitoring Program.

6.5.2.1 Telemetry Network

Floods were worst in the country's history with large amount of damages in human lives, livestock and agricultural destruction. For safety of public and better management of flood waves and safe operation of DHP and other hydropower projects in the country, it is imperative to have an early warning system for these hydropower catchments. Existing flood telemetry network on Indus basin is shown in Figure 6.11, which comprises 45 automatic rain and river level recording stations. There is no existing flood monitoring station in the DHP catchment. Hence it is recommended that the existing network may be extended to the upper catchments of River Indus. This will include installation of River Level sensors (pressure transducers), temperature sensors, and Rain sensors (Tipping Buckets) at flood warning sites and hooking them with reliable telecommunication system, i.e., Meteor burst communication system. 18 telemetry stations are recommended in the missing catchments of Indus Basin, e.g., catchments of UIB, Swat and Chitral rivers. Locations of the new telemetry stations are given in Figure 6.11 and Table 6.6.

Table 6.6: Details of Proposed Telemetry Stations

Sr. No.	Locations	Sensors		
		Rain	Temperature	River Water Level
1.	River Indus at Kharmong	Rain	Temperature	River WL
2.	River Shigar at Shigar	Rain	Temperature	River WL
3.	River Shyok at Yugo	Rain	Temperature	River WL
4.	River Indus at Kachura	Rain	Temperature	River WL
5.	River Indus at Partab	Rain	Temperature	River WL
6.	River Indus at Bunji	Rain	Temperature	River WL
7.	River Gilgit at Gilgit	Rain	Temperature	River WL
8.	River Hunza at Dainyour	Rain	Temperature	River WL
9.	River Gorband at Karora	Rain	Temperature	River WL

[2] Tarbela IV Extension Project Appraisal Document - Sub-component C4: Glaciers Monitoring Program (US$6.0 millionThe sub-component would support works, equipment, consultancy, operations cost and technical assistance and training for establishment of the GMRC in the UIB during the Project period

Sr. No.	Locations	Sensors		
		Rain	Temperature	River Water Level
10.	River Indus at Shatial	Rain	Temperature	River WL
11.	River Hunza at mouth of Shimshal	Rain	Temperature	River WL
12.	River Gilgit at Alam Bridge	Rain	Temperature	River WL
13.	Golan gol at Mastuj Bridge	Rain	Temperature	River WL
14.	River Chitral at Chitral	Rain	Temperature	River WL
15.	River Chitral at Mirkhani Bridge	Rain	Temperature	River WL
16.	River Astore at Doyian	Rain	Temperature	River WL
17.	River Panjkora at Zulam Bridge	Rain	Temperature	River WL
18.	River Swat at Munda Dam	Rain	Temperature	River WL

The works will be executed by the Hydrology & Research Directorate, under the administrative control of the Chief Engineer, Hydrology & Water Management, WAPDA. The operation and maintenance of the project will be handed over to Hydrology and Research directorate WAPDA after implementation, which is scheduled to be completed in one year. New staff will be hired and after proper training, they will be used for operation and maintenance of augmented network in conjunction with old staff. A budget of 2.5 million USD is proposed for implementation and operation of the network for 10 years (Table 6.7).

Table 6.7: Proposed budget for Telemetry Network

Sr. No.	Description of Item	Unit	Quantity	Amount (million USD)
1.	Telemetric Equipment (Procurement of Radio Telemetric equipment complete including sensors, spares, towers, field testing and servicing equipment etc.)	Set	18 +2 spares	1.5
2.	Training (Foreign Training of electronics staff for installation and maintenance of telemetric equipment.)	Number of Staff	4	0.1
3.	Installation of 18 nos. telemetric stations.	Set		0.3
4.	Vehicles (4x4 D/C P/U vehicles)	Number	2	0.1
5.	Staff (Remuneration of staff and operation expenses for about 10 years)	Number	4	0.5
			Total	**2.5**

6.5.2.2 Hydro-meteorological Station

A permanent hydro-meteorological station at dam site is recommended to establish to monitor complete set of hydrometeorogoical parameters such as rainfall, temperature, wind speed/direction, evaporation etc. The budget for the proposed hydro-meteorological station is included in civil works.

6.6 MONITORING, FOLLOW-UP AND ADAPTIVE MANAGEMENT

DHP is designed for a life of at least more than 40 years. A follow-up monitoring and adaptive management mechanism is required to monitor and understand the climate and its impacts on the project and design any adaptation measures if required. For example, the climate change impacts on the geomorphology of the area (landslides and sedimentation) are not known at this stage. WAPDA will monitor the climatic status of the project site by flood warning telemetry stations, a hydro-meteorological station at dam site along with the proposed WAPDA’s Glacier Monitoring Program. The early warning will be utilized to make adaptive arrangements in the dam site and improve the readiness of the operation staff to manage flood water and protect the dam site and other structures and human life.

Resource requirement and budget for setting the flood telemetry network ($2.5 million) is proposed under the DHP. An adaptive management process will also be employed by WAPDA to implement any remedial actions identified as necessary during the follow-up program, as well as incorporate any new lessons learned into normal procedures. Adaptive management can serve as an important learning tool for climate change action, as uncertainty about vulnerabilities and risks can be reduced by experience only if that experience is identified and passed on (to others) to benefit other hydropower projects in Pakistan. Moreover, project and climate change related knowledge, technology, policy and legislation are evolving. For projects of longer design life, it is appropriate to consider these changes as part of the follow-up program.

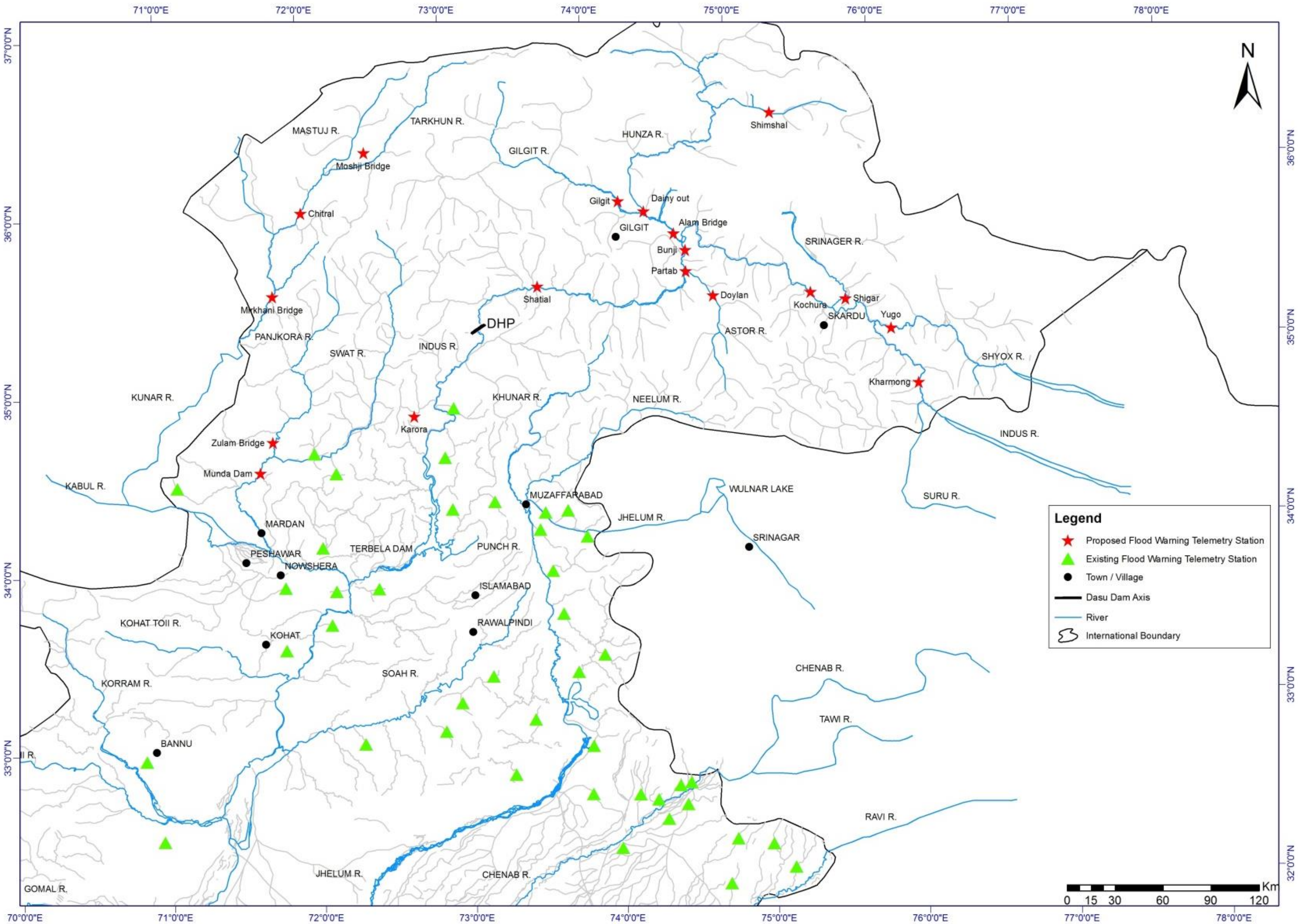


Figure 6.11: Existing and proposed flood telemetry network

Chapter 7
POTENTIAL ENVIRONMENTAL IMPACTS AND THEIR MITIGATION

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7. POTENTIAL ENVIRONMENTAL IMPACTS AND THEIR MITIGATION

7.1 GENERAL

Potential environmental impacts and issues during various stages of the Project development along with the proposed mitigation measures are discussed in this chapter. The general impacts on terrestrial and aquatic ecology, which are not covered in this chapter, are presented in Volumes 3 and 4 respectively. Social impacts associated with the Project activities, such as land acquisition and resettlement, health and safety issues are presented separately in Chapter 8. Significant impacts related to relocation of KKH are detailed in Chapter 10.

The area of impact of DHP includes all those areas that are to be acquired for the reservoir and construction works, housing areas, offices, access roads and realignment of KKH. On the upstream of damsite, the impact area of the project covers the left and right bank areas on both sides of the Indus from the riverbed up to reservoir full supply level of 950 masl. The impact area further extends to 1,000 m elevation to cover buffer areas around the reservoir and realignment of KKH on the left bank and access roads on the right bank. On the downstream of damsite, the impact area extends up to Dasu/Komila town, from where the access roads to the damsite will start. The impact area also includes (temporarily) KKH from Havelian to Gini, which will be extensively used by the Project vehicles for transportation of construction material.

7.2 SCOPING OF IMPACTS

Potential environmental impacts of the Project on various environmental features in the Project area are identified through the following studies:

- Environmental quality baseline monitoring of air, noise, surface water, and soil.
- Detailed review and analysis of primary and secondary data available for all environmental parameters in project areas such as physical, ecological and social resources.
- Review of engineering investigations, studies and designs.
- Analysis of satellite imageries followed by groundtruthing.
- Census survey to assess the extent of land acquisition and resettlement, occupation, income and poverty levels of the affected households.
- Consultations with executing and implementing agencies, local government, affected community, traditional and religious leaders of community.
- Stakeholder consultations workshops at Peshawar, Lahore, Karachi and Islamabad with relevant government agencies at national and provincial level, and international and national NGOs.
- Noise modeling using FHWA TNM 2.5 (Federal Highway Administrators Traffic Noise Model) to predict traffic noise, and FHWA RCNM (Roadway Construction Noise Model) to predict the noise levels due to construction.
- Emission inventories of various criteria pollutants and GHGs using USEPA and IPCC guidelines.
- Air Quality Dispersion Modeling using CAL3QHC to predict the pollutant concentrations.
- Knowledge assimilation of international best practices on environmental assessment of hydropower projects

The Significance of potential adverse effects was assessed using the criteria given in the following sections:

7.2.1 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: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria. The criteria for assessing the magnitude of impacts are given in Table 7.1.

Table 7.1: Parameters for Determining Magnitude

Parameter	Major	Moderate	Minor	Negligible
Duration of impact	Long term (more than 35 years)	Medium Term Lifespan of the project (5 to 15 years)	Less than project lifespan	Temporary with no detectable impact
Spatial extent of the impact	Widespread far beyond project component site boundaries	Beyond immediate project components, site boundaries or local area	Within project components and site boundary	Specific location within project component or site boundaries with no detectable impact
Reversibility of impacts	Impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national limits and or international guidelines	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of impacts occurring	Occurs under typical operating or construction conditions	Occurs under worst case (negative impact) or best case (positive impact) operation conditions	Occurs under abnormal, exceptional or emergency conditions	Unlikely to occur

Source: Petts, 1999

7.2.2 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. The criteria for determining sensitivity of receptors are outlined in Table 7.2.

Table 7.2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very High	Vulnerable receptor (human or terrestrial) with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	Vulnerable receptor (human or terrestrial) with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Medium	Vulnerable receptor (human or terrestrial) with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low/Negligible	Vulnerable receptor (human or terrestrial) with good capacity to absorb proposed changes or/and good opportunities for mitigation

Source: Petts, 1999

7.2.3 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 7.3. Most of the potential impacts can be mitigated by implementation of various types of mitigation measures; however some residual environmental impacts may remain after mitigation. The significance of residual impacts is also assessed using the criteria given in Table 7.3.

Table 7.3: Significance of Impact Criteria

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

7.3 SUMMARY OF ASSESSED IMPACTS

The Project's overall potential impacts and their significance have been assessed using the methodology described in Section 7.2. A summary of these impacts and their significance is presented in Table 7.4. Whilst low significant impacts and general construction related impacts are not detailed in this chapter; however, they are assessed in Chapter 9 with mitigation and management measures. These impacts are mostly localized short-term impacts and can be easily mitigated by (i) the contractors' good work practices, especially those related to the storage of construction materials and cleanliness of the work sites; (ii) cooperation by the local authorities and communities with the contractor in terms of traffic management and use of public space and utilities; (iii) project management's strict enforcement of the adequate construction practices and standards during construction; and (iv) the implementation of mitigation measures identified in the Environmental Code of Practices (Chapter 9).

Table 7.4: Summary of Impacts of the Project and their Significance

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
Pre-Construction/Construction						
Physiography and Geology	Changes in natural topography at construction sites, quarry areas and spoil disposal sites will impair the natural landscape, causes the soil erosion and changes the drainage pattern	Major	High	Major	• Contractors' Management Plans on 'Sediment and Erosion Control' and 'Decommissioning and Landscaping' plans based on ○ ECP 6: Erosion and Sediment Control ○ ECP 8: Topography and Landscaping ○ ECP 9: Quarry Areas Development & Operation	Low
	Increased risk of landslides due to excavation of slopes	Moderate	High	Major	• Drainage management • Preventive measures in high risk areas • Emergency Preparedness Plan • Permanent monitoring in potential landslide areas	Negligible
	Increased risk of landslides during reconstruction of KKH	Moderate	High	Major	• Construction of retaining walls • Drainage management	Negligible
	Geological hazards of tunneling through Koshe contact	Minor	Low	Negligible	• Controlled blasting and excavation	Negligible
	Excessive groundwater dewatering will lead to significant delay in construction of tunnels and effect groundwater environment	Moderate	Medium	Moderate	• Groundwater control methods are included in the technical design and construction process	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
	Disposal of about 20 MCM of excavated rock as spoils	Major	High	Major	• Minimize generation of spoils by using excavated rock as aggregates for concrete and road fills • Contractors management plans on spoil management and landscaping of spoil disposal sites	Moderate
Water Quality	Increased turbidity in Indus and tributaries from discharges of construction activities	Moderate	High	Major	• Diversion of discharges from the construction areas to settling basins before releasing to Indus • Installation of silt fences and sediment traps • Contractors management plans based on ECP 3: Water Resources Management	Negligible
	Waste water form batching plants, construction yards, material storage sites, and other construction areas, and workers camps	Moderate	High	Major	• Drainage facilities for storage, collection and treatment of waste water • Sewage system for workers camps and colonies • Water quality monitoring and compliance with NEQS	Negligible
Air Pollution	Dust and air pollution from access roads of construction traffic	Moderate	Medium	Moderate	• Vehicle exhaust compliance with NEQS • Paving of access roads in construction areas	Negligible
	Dust and air pollution from construction equipment and construction areas	Moderate	Medium	Moderate	• Contractors management plan on pollution control based on ECP 10: Air Quality Management • Air quality monitoring and compliance of NEQS • Maintain air quality in the tunnels in accordance with best international	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
					practices	
	emissions of greenhouse gases from construction equipment	Minor	Medium	Low	• Minimize greenhouse gases emissions accordance with EMP sub-plan 6: GHG Management Plan	Negligible
	Dust from quarry and crushing activities	Moderate	Medium	Moderate	• Water supply system for control of dust and fugitive emissions from quarry areas • Compliance with NEQS	Negligible
	Air pollution, traffic congestion and safety from use of 700 vehicle trips per day for transport of aggregates from Kaigha quarry to batching plant area (10 km)	Moderate	High	Major	• Conveyor belt for transportation of material • Dust suppression	Negligible
	Air pollution, traffic congestion and safety from use of 400 vehicles for transport of excavated rock to spoil disposal area	Moderate	High	Major	• Conveyor belt for transportation of material • Dust suppression	Negligible
Noise and Vibration	Noise along KKH and access roads from construction traffic	Moderate	Medium	Moderate	• Vehicle noise compliance with NEQS (85 dBA at 7.5 m form source) • Regular monitoring at sensitive receptors	Negligible
	Noise from construction activities at dam site and relocation of KKH	Moderate	Medium	Moderate	• Contracts management plan for noise attenuation in accordance with ECP 11: Noise and vibration management • Noise monitoring at sensitive receptors	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
					and compliance with NEQS	
	Noise from quarry activities at Kaigha	Moderate	Medium	Moderate	• Excavation from southern end of Kaigha quarry and maintaining natural berm towards sensitive areas • Noise monitoring at Kaigah village and conservation area	Negligible
	Noise from quarry activities at Gini	Moderate	Medium	Moderate	• Excavation from eastern end of Gini quarry and maintaining natural berm towards settlements • Noise monitoring at Gini village	Negligible
	Vibration from blasting	Moderate	High	Major	• Chose optimum size of blasting per event to avoid any impacts on nearest receptors • Compliance with international standards • Notification in advance	Negligible
Waste	Pollution through solid waste and waste effluents	Moderate	Medium	Moderate	• Contractor waste management plan in accordance with ECP 1: Waste Management and ECP 2: Fuels and Hazardous Goods Management • Waste water collection and treatment; solid waste management	Negligible
	Spills from storage and handling of hazardous waste and fuels and site contamination	Moderate	High	Major	• Storage in designated sites • Proper design of site • Spill control procedure	Negligible
	Risk of water pollution of reservoir area and site pollution due to improper decommissioning of contractors facilities and	Moderate	Medium	Moderate	• Contractors' management plans for decommissioning • Pre-fill reservoir cleaning and filling • Removal of potential sources of	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
	waste				pollutants from reservoir area	
Flora	Loss of about 21,000 trees and shrubs from construction areas and reservoir submergence area	Minor	Medium	Low	• Planting of trees (5 new trees per each tree cut) near resettlement villages and reservoir buffer areas • Rejuvenation of forest at higher altitudes	Moderate (beneficial)
	Loss of 280 ha of grazing land	Minor	Medium	Low	• Livelihood restoration (SRMP Vol. 6: RAP)	Negligible
	Pressure on forest resources due to increased demand for forest products	Moderate	Medium	Moderate	• LPG market development • Non timber fuels for cooking and heating	Negligible
Fauna	Construction related impacts such as dust, noise and night lighting on fauna	Moderate	Medium	Moderate	• ECP 13: Protection of Fauna	Negligible
	Impact on birds due to high noise from drilling and blasting activities	Moderate	Medium	Moderate	• Noise attenuation measures to reduce noise levels • Deter the birds from construction areas	Negligible
	Noise and vibration impacts on animals at Kaigah community game reserve due to quarry/crushing activities and reconstruction of KKH at Kaigha	Moderate	Medium	Moderate	• Choosing of optimum blast size per event to ensure compliance with international standards • Noise monitoring at game reserve and compliance with NEQS • Development of facilities for tourists	Negligible (adverse) Moderate (beneficial)
	Risk of poaching	Moderate	High	Major	• Access restriction to community game reserve • Training of staff on wildlife protection • Public awareness programs	Low
Aquatic	Impact on aquatic habitat	Moderate	Medium	Moderate	• Control of waste water and sediment	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
Ecology	due to construction activities in river and waste water releases to river				releases to river • Water quality management protocols in ECPs	
	Impact on fish habitat due to construction of bridges in tributaries	Moderate	Medium	Moderate	• Design of single span bridges to avoid any construction of piers in the tributaries	Negligible
	Fish entrainment in the diversion tunnels due to upstream and downstream movement of fish	Minor	Medium	Low	• Fish deterrent devises or exclusion screens on both ends of diversion tunnels	Negligible
Physical Cultural Resources	Impact on Shatial rock carvings through vandalism	Minor	Medium	Low	• Protection of Shatial rock carvings through its procurement from private owners and development of site	Major (beneficial)
	Impact on historical Seo mosque due to dust and noise pollution from construction activities	Minor	Medium	Low	• Dust control and noise attenuation protocols in ECPs • Termite protection and provision of water and sanitation facilities	Moderate (beneficial)
	Inundation of 400 year old mosque in Seer Gayal	Major	High	Major	• Disassembling and rebuilding at new resettlement village • Termite protection and provision of water and sanitation facilities	Moderate (beneficial)
	Submergence of 17 graveyards	Major	High	Major	• Protection of graves with civil works to avoid collapse of graves	Negligible
	Chance find procedures	Moderate	Medium	Moderate	• Chance find procedures in the contract documents	Low
Land Acquisition and Resettlement	Acquisition of 4643 ha of land by WAPDA	Major	High	Major	• Compensation for lost assets of affected households and persons according to eligibility matrix of Resettlement Action Plan (RAP)	Low to Moderate

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
	Resettlement of 767 households, totaling 6,953 people	Major	High	Major	• Compensation, resettlement and livelihood restoration of affected households/persons according to Resettlement Action Plan	Low to Moderate
	Relocation of shops/commercial establishments	Moderate	Medium	Moderate	• Compensation for lost assets and commercial enterprises. • Assistance and livelihood restoration of affected persons according to Resettlement Action Plan	Low to Moderate
	Loss of civic amenities (7 schools, 2 BHU, etc.)	Moderate	Medium	Moderate	• Rebuilding of civic amenities by project	Negligible
	Loss of 143 ha agricultural land	Moderate	High	Moderate	• Compensation for lost land, crops and fruit trees according to Resettlement Action Plan • Agricultural and Livestock Development Plan (Vol. 6: RAP)	Low to Moderate
Communi-cation Facilities	Inundation of 52 km of KKH	Major	Very High	Critical	• Realignment and construction of 68 km at higher level (including 6 km of bypass)	Negligible
	Loss of dolleys (manual cable cars connecting left and right banks of Indus) and hence loss of access to KKH and Komila market by the right bank community	Major	High	Major	• Right bank access roads along the reservoir from Komila	Negligible
	Loss of Kandia and Larghani bridges connecting left and right bank	Major	High	Major	• Building of new bridge (7 km upstream of existing Kandia bridge) along with access roads (from Komila to Kandia through damsite) before dismantling the existing bridges	Negligible
Social and	Social conflicts due to influx	Major	High	Major	• Management plan for in-migrant	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
Cultural Issues	of about 4,000 in-migrant workers (in addition to about 3,000 construction workers)				workers (SRMP Vol. 8: Management Plan for Construction related Impacts) • Grievance mechanisms to address complaints	
	Lack of respect of local cultural norms and values	Moderate	Medium	Moderate	• Awareness campaign • Code of conduct for construction workers and employees • Grievance mechanism	Negligible
	Impacts from increased human activities	Minor	Medium	Low	• Code of conduct for workers and employees • Awareness raising	Low
	Increased load on local services and suppliers	Moderate	Medium	Moderate	• Local area development plan under SRMP • Contractor to procure camp supplies in a manner not affecting availability of essential commodities. • Contractor to provide religious and cultural facilities for workers.	Negligible
	Employment generation	Moderate	Medium	Moderate (beneficial)	• Preference local workers and technicians • Vocational training	Moderate (beneficial)
	Increased economic activity	Moderate	Medium	Moderate (beneficial)	• Establishment of new businesses and commercial enterprises; • Local employment	Moderate (beneficial)
Health and Safety	Occupational health and safety issues and increased risk of accidents due to rough terrain and difficult	Moderate	High	Major	• Contractors OHS management plan in accordance with World Bank EHS guidelines and ECP 18: Workers Health and Safety	Low

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
	work conditions				• OHS staff with contractor, consultant and PMU • Contractors follows IFC Performance Standards • Safety training for workers	
	Health and safety at the construction camps	Moderate	High	Major	• ECP 16: Construction Camp Management	Negligible
	Reduced safety and health risks by interaction workforce with local residents	Moderate	Medium	Moderate	• Public Health and Safety Plan (SRMP Vol. 8) • Safeguards and awareness rising against communicable diseases.	Negligible
Traffic	Impact on KKH and its traffic due to additional 200-300 vehicles construction traffic	Moderate	High	Major	• Traffic management plan • Establishment of traffic management units along KKH • Upgrading of KKH by NHA	Low
	Safety hazards due to increased traffic for children and elderly people	Moderate	High	Major	• Traffic management plan addressing general access • Safety and security actions and procedures to protect local community	Negligible
Operation and Management						
Hydrology	Loss of reservoir life and reduced power generation due to sedimentation	Major	Very High	Critical	• Studies on sedimentation control through integrated watershed management • Annual flushing of sediments after 15 years of first impounding	Moderate
	Changes in reservoir water quality	Minor	Medium	Low	• Temperature and dissolved oxygen measurements	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
					• Operational protocols for simultaneous release of water from LLOs and spillways	
	Reduced flows between damsite and tailrace during low flow season	Moderate	Medium	Moderate	• Release of environmental flows (tentatively recommended as 20 m^3/s from dam/LLOs and 222.5 m^3/s from tailrace)	Low
	Reduced flows on downstream of tailrace during low flow season of peaking operation	Moderate	Medium	Moderate	• Operation of at least one turbine during peaking operation	Low
	Tailrace flow surges due to stop and start of turbines	Moderate	Medium	Moderate	• Operational protocols for gradual starting of turbines • Warning through sirens and loudspeakers	Negligible
	Impacts of first filling of reservoir on safety of people and livestock and stability of slopes	Major	High	Major	• Awareness campaign and warning signs • Slow rate (2 m/day) of filling • Permanent monitoring of weak slopes	Negligible
	Impact of first filling on the reservoir downstream irrigation requirement	Minor	Medium	Low	• Filling of reservoir in high flow season	Negligible
Aquatic Ecology	Effect on upstream fish habitat (river and tributaries) due to formation of reservoir	Moderate	Low/ Medium	Low to Moderate	• Compensation hatchery with native cold water species in combination with open water stocking in the affected tributaries and reservoir • Maintenance of spawning areas Further studies on aquatic biology during	Negligible

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
					pre-construction and regular monitoring during operation	
	Fish migration across the dam	Minor	Low/ Medium	Negligible to low	• Study fish migration and establish baseline data • Develop fish hatchery and restock in upstream and downstream areas	Negligible
	Fish entrainment in the outlet structures due to downstream movement of fish during normal operation and flushing	Minor	Medium	Low	• Placing of screens or fish deterrent devices of outlet structures if required •	Negligible
	Fish stranding and mortality during flushing	Minor	Medium	Low	• Development of site specific ramp down criteria • Flushing during high flow season (in early summer)	Negligible
	Impact of flushing and drawdown on reservoir fish production	Moderate	Medium	Moderate	• Fisheries Management Plan • Monitoring and study	Low
	4.4 km length of river habitat between plunge pool and tailrace outlet will be lost or impaired during low flow season	Moderate	Medium	Moderate	• Studies on requirement of environmental flows to maintain fish habitat (tentatively recommended as 20 m^3/s from dam/LLOs and 222.5 m^3/s from tailrace)	Low
	River habitat impairment on downstream of tailrace during peaking operation	Minor	Medium to high	Low to Moderate	• Continuous operation of one turbine to release 222 m^3/s of water	Negligible
Fauna	Risk of bird collision and electrocution with transmission cables	Moderate	Medium	Moderate	• Maintaining 1.5 m spacing between energized components and grounded hardware; covering energized parts and hardware	Low

Component	Impact	Magnitude	Sensitivity	Significance Prior to Mitigation and Enhancement	Mitigation and Enhancement Measure	Residual Significance
					• Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters	
Risks	Reservoir Induced landslides	Major	High	Major	• Continuous monitoring of landslide prone areas • Stabilization of landslides • Control of drawdown and filling rates	Moderate
	Earth quake damage to dam	Major	High	Major	• Design of dam in compliance with ICOLD and WB OP 4.37 Safety of Dams • Review of designs by Panel of Experts • Seismic monitoring program	Negligible
	Reservoir induced earth quakes	Negligible	High	Negligible	• Seismic monitoring program	Negligible
	Floods from GLOFs damage dam and human life	Major	High	Major	• Design of dam in compliance with international standards • Telemetry network for GLOF monitoring • Downstream warning system	Low

7.4 IMPACTS DURING PRE-CONSTRUCTION AND CONSTRUCTION STAGE

7.4.1 Physiography and Geology

The Project requires large scale excavation at the project sites and quarry areas. Impacts of excavation are discussed in this section.

7.4.1.1 Changes in Natural Topography

Potential Effects: Topography poses a challenging work environment for construction. There are very limited flat or mildly sloping areas where construction yards can be setup and equipment can be erected. As a result, large areas will have to be leveled in terrace form. Locations of all project facilities, including quarry areas and access roads, will be subjected to topographic changes through excavation and blasting. Changes in natural topography will impair the natural landscape and induce a series of impacts related to changes in slopes such as soil erosion, landslides and changes in drainage pattern. Soil erosion from the disturbed areas and excavated rock stock piles will increase the sediment load of surface water.

Mitigation Measures: Land excavation and leveling will be carried out only in the designated areas, and alternative excavation methods, such as controlled explosive use and cutting with excavator, will be used wherever possible. Surface excavation for common and weathered rock will be performed by a combination of bulldozer, giant breaker, crawler loader and dump trucks. Rock excavation will be applied by bench cut method. The bench size will be decided to meet the total requirement of depth or excavation quantities. The topography of the final surface of the leveled lands shall be conductive to enhance the natural draining of rainwater and floodwater. The contractor shall prepare a landscaping and re-vegetation plans which shall include (i) restoration of cleared areas, quarries which are no longer in use, spoil areas, and any areas temporarily occupied during construction of works shall be undertaken using landscaping, provision of adequate drainage and revegetation; (ii) all areas disturbed by construction activity, including temporary access roads shall be landscaped to reflect natural contours, restore suitable drainage paths and encourage re-establishment of vegetation; and (iii) spoil heaps and excavated slopes shall be compacted and protected to prevent erosion.

Kaigah quarry is located within the future submergence area of the reservoir and hence no restoration or landscaping is expected. However if any quarrying activities extended beyond the submergence area, the contractor’s landuse plan shall cover those areas. The quarry site at Gini will be expected to be used by the Basha Project and hence no restoration activities are required at this site. However, the contractor’s landuse plan shall also cover this site and will be implemented if required.

7.4.1.2 Landslides

Potential Effects: Landslide is natural and common phenomena in the Project area. Natural landslides and slope failures can occur due to active geomorphology of the region and due to lubrication of rock support structure by rainfall or water seepage. During construction, excavations and the use of explosives to break the rock will have the capacity to generate the localized vibrations which can have potential of triggering a land slide.

Mitigation Measures: Landslide prone areas in the project area have been identified and classified on basis of potential risks. Any blasting activities in these areas will be controlled and contained within defined limits. Special attention will be paid to the blasting areas, where rock mass conditions are poor (e.g. portal areas of flushing tunnel) due to presence of shear zones. Careless blasting could increase the requirement of slope stabilization measures in the area. During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down the slope. After blasting a riser, it will be stabilized by pre-designed support systems such as shotcrete, mesh and rock bolts prior to drilling the next riser for excavation. Where there are confinement issues, cushion blasting will be the method applied. Extreme care will be taken in designing the blasting pattern and blasting will be controlled so as to avoid disturbance of nearby slopes where stability is in a critical condition.

Near the damsite, a major landslide near the tail race tunnel is found to be dormant without any sign of recent movement or activity and appears to be stable. This landslide prone area will be monitored for displacement by installing crack gauges to check the status of landslide movement for the first five years. The frequency of monitoring for the rockslide will be at least once a month. It may be adjusted depending on slope conditions, ongoing status of the landslide and the deformation structures (roads), meteorological change (rainfall and snowmelt), and earthquake. If any new deformation is observed to be due to landslide movement, structural measures will be considered. The conceivable measures are (i) Partial removal of the rockslide materials from the upper slope, and (ii) Concrete retaining wall to support the toe part of the rockslide.

Surface water management is considered as a major mitigation factor for increasing the stability of potential landslides and thus prevention of landslides. Temporary drainage systems will be installed to prevent water entering in to these areas with adequate maintenance and monitoring. Seasonal aspects such as snow melting and flooding periods will be considered while planning and maintaining the drainage system. Further, slope stabilization techniques (berms, biomats, vegetation, etc.) to prevent erosion, and further triggering of landslides will be applied.

Early warning systems will be introduced that will indicate when cracks appear and allow any widening to be monitored. The system will use numbered, glass strips positioned strategically across key areas. These will be monitored on a weekly basis for any breakage. Should a breakage occur, the gap will be measured and monitored for any widening that will provide an early warning of a potential landslide. During the monsoon season there will be extra vigilance during excessive rainfalls to identify any potential risk of rock stability or landslide in the borrow areas.

7.4.1.3 Geological Hazards of Tunneling through Khoshe Contact (Khoshe Fault)

The Khoshe Contact is a normal geological contact or an inactive, ductile deformation zone, no seismic hazard is thus expected to cause excavation instability and subsequent tunnel collapse. In addition, the contact at depth consists of sound mylonized amphibolite, no fine-grained fault gouges were found at depth. Accordingly, instability of the excavation face, overbreak and deformation from squeezing and swelling fault rocks is not expected to occur during tunnel excavation.

Water inflow within the contact will be expected to be encountered but is considered to be of limited amount because the surface spring survey shows a limited spring amount along the contact. In addition, the temperature of these springs is around 20 degrees at ground surface and therefore no hot water inflow is expected to be encountered during tunneling.

7.4.1.4 Groundwater Dewatering

Potential Effects: Groundwater flow is expected to occur during tunneling works at underground power house and tailrace tunnels due to the presence of groundwater strata at these locations. The depth of tail race tunnels below the groundwater table range from approximately 20 to 100m. Thus a large amount of dewatering is expected during tunnel construction. The tunnels generally obliquely or perpendicularly cross the dominant joints and shears which control the flow of water, groundwater flows into the tunnels through drilling holes, joints, shears and blasting cracks. In addition, the tunnels are below the present river water level of the Indus River. A large quantity of surface water seepage will also be anticipated during tunnelling. The water inflow may come from surface water through the joints and shears occurring in the granulite and amphibolite bedrocks and therefore is anticipated to decrease with excavation progress due to small porosity of the joints and shears within the bedrocks. The locations of water inflow are likely to be mainly the Khoshe Contact, shears and foliation joints within amphibolite bedrocks.

Groundwater can form a significant obstacle to construction of tunnels. Poorly planned groundwater dewatering can lead to significant delays and cost increases during construction or can lead to operational and maintenance problems during the life of tunnel. Further large scale dewatering has significant impact on the groundwater environment through reduction of groundwater resources.

Mitigation Measures: Following groundwater control methods are recommended, and included in the technical design and construction process, to effectively reduce the dewatering requirements to a minimum:

- To dewater ahead by using horizontal drainage boreholes drilled through the excavation faces in those sections where high water inflow is expected.
- To install weep holes drilled through the shotcrete lining where large quantities of inflow were measured and observed.
- To excavate a trench or channel along each side of the tunnels and cavern out of the way of excavation and transportation system.

7.4.1.5 Spoils

Potential Effects: About 10.25 million cubic meters of spoils will be generated from the excavation activities of the Project (excluding from relocation of KKH). About 7.2 million cubic meters will be generated from the first phase (first 6 years of construction) and remaining 3.05 million cubic meters will be generated during subsequent phases. Main sources of spoils during first phase are excavations for dam foundation and underground tunneling works. Potential impacts from spoils and its disposal are (i) land acquisition for disposal of such huge quantities of spoils, (ii) conversion of those land areas in to a permanent dumping area, (iii) potential erosion from the spoil areas and moving of spoils in to the river, and (iv) aesthetic impacts.

Mitigation: The first step towards addressing the impacts of spoil is to minimize the generation of spoils by recycling the excavated rock to the maximum extent possible by using them as aggregate material in the concrete works. An analysis of spoils have been carried out to understand the material type and their potential reuse as aggregates, and presented in Table 7.5. Surface excavations in the river bed and tunnel portals mostly consist of river deposits or loose materials and are not expected to meet the requirement of aggregates (however, this will be confirmed during construction and if found suitable can be used as aggregates). Whilst granulate material is mostly expected to meet the requirement of aggregates based on the testing carried out on these material during design stage. Excavations from deep underground structures are also expected to meet the criteria of fine aggregates. Suitability of Amphibolite material for aggregates (excavated rock from tailrace tunnels on downstream of Koshe contact) is not known and to be assessed during construction stage.

Based on the above discussion, it can be safely assumed that nearly 50 percent of the excavated material (3.6 million cubic meters) can be easily used for aggregates. This volume will be roughly equal to 6.5 million tons. However, the exact magnitude of usage of material will be confirmed after necessary testing for the suitability of excavated material. Contractors will carry out the necessary tests immediately after excavation, as and where required, to assess the suitability of excavated material for aggregates manufacturing. All suitable material will be transported to the crushing site at Kaigah for further processing. Contractors will carefully plan both excavation and quarrying activities to maximize the use of excavated rock as aggregates.

Table 7.5: Spoils (Excavated Rock) Quantity in Phase 1

Sr. No	Excavation from	Material Type	Quantity (m^3) in Phase 1	Suitability for Aggregates
1	Dam Foundation	River deposit (boulders) & Granulates	2,000,000	Partly suitable
2	Plunge pool	*do.*	500000	*do.*
3	Power intake	Granulates	800,000	*do.*
4	Power Tunnel	*do.*	150,000	Mostly suitable
5	Power house	*do.*	500,000	*do.*
6	Transformer cavern	*do.*	500,000	*do.*
7	Surge chamber	*do.*	100,000	*do.*
8	Diversion tunnels	*do.*	1,410,000	*do.*
9	Flushing tunnels	*do.*	650,000	*do.*
10	Tailrace tunnel	Granulates & Amphibolite	300,000	Partly suitable
11	Tailrace outlets	Amphibolite	300,000	Not known
Total			**7,210,000**	

The unsuitable spoils will be disposed at the disposal site located 3 km downstream of the damsite (Figure 3.12). The contractors will be responsible for efficient use of the available space through proper dumping. A dumping mechanism will be devised to dispose different grades of materials in different locations. Various contractors working under various components the Project and the local governments will be provided free access to use these materials with the approval of PMU.

Contractor will be responsible to prepare and implement spoil disposal plan for proper disposal of spoils, stabilization through compaction, protection of spoils from erosion and landscaping through plantation, bioengineering and engineering techniques. The spoil disposal area will be fenced on the riverside so that there will be no rock or sediment laden flows into the river.

7.4.2 Environmental Quality

7.4.2.1 Water Quality

Potential Effects: There will be some changes in the natural river flows during construction phase. Initially coffer dams will be placed on the upstream of the dam site and water will be diverted through the diversion tunnels to make the river bed area dry between the two coffer dams. This will help in construction of dam and spillway plunge pool. Surface water quality will be affected by the construction activities in the river (coffer dams, starter dams and main dam), discharges from the tunnels, quarry sites, batching plants, various construction yards and construction camps. Details of potential sources of water quality contamination are:

- Water turbidity as a result of coffer dam construction: The construction of coffer dam will involve dumping of lot of rocky and soil material which will increase the turbidity of downstream water;
- Runoff from crushed aggregates wash and rock material from drilling, blasting and quarrying;

- Runoff from aggregate stock piles at the quarry and crushing areas and spoil disposal sites;
- Sewage flows from the workers colonies;
- Storage and use of hazardous and toxic materials (lead acid batteries; explosive material and fuse material; acids; varnishes and paints; and hydrocarbons including: petrol; diesel; and lubricant) can pollute the water if improperly handled;
- Washing of vehicles and other machinery can pollute the river water with oils, grease and other mud material;
- Chemical additives to concrete and the empty containers: The chemical additives to concrete are for setting-time retarders. These are polymers compounds; and
- The construction of tunnels will invariably release large quantity of seepage water on continuous basis. To keep the tunnel dry this water will be pumped out continuously.

Mitigation Measures: Any discharges to the surface waters will be properly treated (can be achievable mostly by sedimentation/settling tanks) before discharging. The discharge waters shall meet the NEQS. it is required that management of water quality during construction will be based on the application of best management practices, and good site 'housekeeping' to prevent contaminant releases at the outset. The key mitigation measures are:

- Design drainage for the quarry and batching plant area to direct runoff into a sump/basin for inspection for pollutants prior to discharge;
- Silt fences, sediment barriers or other devices will be provided to prevent migration of silt during construction within streams and river.
- Discharge of sediment-laden construction water directly into surface watercourses will be forbidden. Sediment laden construction water will be discharged into settling lagoons or tanks prior to final discharge. Settling basins will be periodically cleared so as to ensure adequate water storage.
- Open surface will be covered by grasses and creepers to reduce wash-away material;
- All fuel and oil storage sites will be surrounded by a catcher drain and oil water separators to capture the spills. Hydrocarbons will be stored away from rivers and dry gorges within the bunded areas; and
- Sewage system will be established in the colonies and wastewater treatment system through septicization; for isolated work areas septic tanks will be provided

Regular water quality monitoring will be taken up for waste water discharges to ensure discharge waters compliance with NEQS. Water quality of the Indus will also be monitored at the downstream side of coffer dams to assess the impact of in-water construction on water quality.

A water quality laboratory will be established by the contractor at the site for analysis of water quality for key parameters (DO, TOC, turbidity, TSS, TDS, petroleum products); along with potable water quality equipment such as conductivity, pH and turbidity meters.

7.4.2.2 Air Quality

Potential Effects: Main sources of air quality pollution are emissions from construction related traffic and equipment, tunnel construction, rock blasting and excavation aggregate mixing plants and road construction. The construction activities will also generate airborne dust and particulate matter. Dust raised from the above activities will have impacts on crops, animals and houses. Details of major sources of air pollution and discussed below.

Air Quality Along KKH and Access Roads From Construction Traffic

Materials from Islamabad will reach by road and material from Karachi will reach Havelian by rail and then by road. About 200-300 vehicles are expected to use KKH from Havelian to the Project site. In addition, about 30 vehicles are expected to use from Gini to the damsite daily to transport pozzolan. These additional traffic will affect the ambient air quality in the area by increasing the particulate matter (PM) and carbon monoxide (CO) in the air quality. Table 7.6 shows the PM concentrations, both the baseline and predicted, at various receptor locations along KKH from Havelian to damsite. The values were modeled using Breeze Roads – Caline 4 software for normal traffic and projected traffic increase due to construction activities. As can be seen from the table, PM concentration levels are well within the standards and construction traffic will only cause a slight increase in PM levels.

Table 7.6: PM Emissions - 24 Hour Average Concentration (μg/m^3)

S/N	Receptor Location	Coordinates		PM in Ambient Air Quality (Baseline)	PM during Construction
		Latitude	Longitude		
1	Siglo	35.31167	73.185	37.20	37.20
2	Seo	35.30833	73.1867	37.20	37.26
3	Komila-2	35.25902	73.21743	29.50	29.67
4	Komila-1	35.26092	73.21703	29.50	29.61
5	Dasu-2	35.27688	73.22395	30.60	30.60
6	Dasu-1	35.27387	73.22528	30.60	30.60
7	Pattan	35.11032	73.00322	78.20	78.26
8	Palas	35.1035	72.99984	78.20	78.26
9	Dubair	35.03745	72.89804	78.20	78.26
10	Besham Qilla	34.93524	72.87841	78.20	78.26
11	Shang	34.87987	72.88564	78.20	78.20
12	Maira-2	34.84227	72.98576	78.20	78.26
13	Maira-1	34.83326	72.99171	78.20	78.26
14	Dandai	34.81171	72.94376	78.20	78.20
15	Thakot	34.79987	72.93218	78.20	78.20
16	Battal	34.58273	73.14423	78.20	78.20
17	Icherrian	34.4947	73.25104	78.20	78.20
18	Shinkiari-2	34.47415	73.27019	78.20	78.31
19	Shinkiari-1	34.47188	73.27117	78.20	78.26
20	Mansehra -2	34.33742	73.19881	78.20	78.26
21	Manshehra-1	34.32553	73.19454	78.20	78.31
22	Qalandarabad	34.26361	73.23647	78.20	78.31
23	Ferozabad	34.23422	73.23442	78.20	78.26
24	Abbottabad	34.14608	73.21645	78.20	78.26
25	Havelian	34.05532	73.1515	78.20	78.20
NEQS					**150**

Table 7.7 shows the CO concentrations at various receptor locations along KKH. As can be seen from the table, CO concentration levels are well within the standards and construction traffic will only cause a slight increase in CO levels.

Table 7.7: CO Emissions - 8 Hour Average Concentration (μg/m^3)

S/N	Receptor Location	Coordinates		CO in Ambient Air Quality (Baseline)	CO during construction
		Latitude	Longitude		
1	Siglo	35.31167	73.185	1,860	1,860
2	Seo	35.30833	73.1867	1,860	1,860
3	Komila-2	35.25902	73.21743	2,280	2,280
4	Komila-1	35.26092	73.21703	2,280	2,280
5	Dasu-2	35.27688	73.22395	1,640	1,640
6	Dasu-1	35.27387	73.22528	1,640	1,640
7	Pattan	35.11032	73.00322	2,520	2,549
8	Palas	35.1035	72.99984	2,520	2,520
9	Dubair	35.03745	72.89804	2,520	2,549
10	Besham Qilla	34.93524	72.87841	2,760	2,760
11	Shang	34.87987	72.88564	2,520	2,520
12	Maira-2	34.84227	72.98576	2,520	2,520
13	Maira-1	34.83326	72.99171	2,520	2,520
14	Dandai	34.81171	72.94376	2,520	2,520
15	Thakot	34.79987	72.93218	2,520	2,520
16	Battal	34.58273	73.14423	2,520	2,520
17	Icherrian	34.4947	73.25104	2,520	2,520
18	Shinkiari-2	34.47415	73.27019	2,520	2,520
19	Shinkiari-1	34.47188	73.27117	2,520	2,520
20	Mansehra -2	34.33742	73.19881	2,520	2,520
21	Manshehra-1	34.32553	73.19454	2,520	2,549
22	Qalandarabad	34.26361	73.23647	2,520	2,520
23	Ferozabad	34.23422	73.23442	2,520	2,549
24	Abbottabad	34.14608	73.21645	2,520	2,520
25	Havelian	34.05532	73.1515	2,520	2,520
NEQS					**10,000**

<u>Emissions from Construction Activities</u>

List of machinery to be used in the construction works and their emission factors are given in Annex 7.1. GHG emissions from automobiles and construction equipment consist of the gaseous product of engine fuel combustion (exhaust emissions) and evaporation and leaks from vehicles (Fugitive emissions). Carbon dioxide (CO_2) and carbon monoxide (CO) emissions are due to the oxidation of fuel during combustion. Diesel fuels are mainly used by the construction vehicles and equipment. The current GHG estimates are based on the consumption of diesel fuel by different vehicles, construction equipment, and the forecasted traffic in KKH. Table 7.8 shows the total emissions of Reactive Organic Gases (ROG), CO, NO_x, SO_x, PM, CO_2, CH_4 and N_2O from construction equipment usage for the construction period. The emissions will affect the ambient air quality and the public health. Air quality in underground construction areas will be deteriorated due to lack of oxygen supply. It is estimated that about 0.129 million tons of CO_2 will be emitted during the six years of construction period from all the construction activities (Table 7.9).

Table 7.8: Total Emissions from Construction Equipment Usage

Construction Period	Emissions (tons)							
	ROG	**CO**	**NO_X**	**SO_X**	**PM**	**CO_2**	**CH_4**	**N_2O**
Year 1	29.4	121.7	194.1	0.2	12.0	20,953.0	2.6	1.2
Year 2	30.5	124.8	197.0	0.2	12.3	21,248.2	2.7	1.2
Year 3	30.5	124.8	197.0	0.2	12.3	21,248.2	2.7	1.2
Year 4	30.5	124.5	196.5	0.2	12.2	21,189.7	2.7	1.2
Year 5	29.4	121.7	194.1	0.2	12.0	20,953.0	2.6	1.2
Year 6	29.5	121.9	194.3	0.2	12.0	20,980.2	2.6	1.2
Total Project:	**179.9**	**739.4**	**1,172.8**	**1.4**	**72.7**	**126,572.4**	**16.0**	**7.3**

Table 7.9: GHG Emission during Construction

Construction Period	GHG Emission (tons)			
	CO_2	**CH_4 (CO_2e)**	**N_2O (CO_2e)**	**Total CO_2e**
Year 1	20,953.0	65.4	358.3	21,376.7
Year 2	21,248.2	67.9	371.6	21,687.8
Year 3	21,248.2	67.9	371.6	21,687.8
Year 4	21,189.7	67.8	370.8	21,628.3
Year 5	20,953.0	65.4	358.3	21,376.7
Year 6	20,980.2	65.5	358.6	21,404.4
Total Project:	**126,572.4**	**400.0**	**2,189.2**	**129,161.6**

Note: GWP values for CH_4 and N_2O from IPCC 2007 Fourth Assessment Report (pg. 212)

Emissions from Quarry Activities

Potential impacts from the operation of quarry are air pollution and dust generation associated with excavation, rock blasting and aggregate crushing. In addition to the construction activities at the quarry sites, the crushing material will be transported to the concrete batching plant located about 13 km from the quarry site. This transportation will require operation of about 700 vehicle trips per day (dump trucks), About 30 vehicle trips per day are required to transport the pozzolan material from the quarry site to the damsite. In addition about 400 vehicles trips are required for day for transport of excess excavation material to the disposal sites. The emissions from the aggregates and spoil transport vehicles will adversely affect the air quality and public health.

Mitigation Measures: To mitigate deterioration of air quality and generation of dust, following measures will be taken:

- All access roads in the construction area that will be used by the project will be paved
- The construction and road machinery used during the construction process shall comply with NEQS requirements with respect to emission and noise pollution. Maintaining the construction equipment and vehicles as per manufacturer's recommendation will reduce the emissions from the equipment and vehicles.
- All dust raising locations shall be kept wet with water sprinkling. Fugitive dust emissions will be minimized by appropriate methods such as spraying water on material where required and appropriate. Water supply system will be developed for controlling dust from the quarry area;
- Continuous air monitoring will be carried out near the sensitive receptors to ensure they do not exceed ambient levels and NEQS.
- To mitigate the impacts associated with the use of daily 700 vehicles for transport of aggregates from quarry site to the batching plant, the Project will have a belt conveyor system and avoid use of vehicles for material transport. Dust controlling system will be extended to the conveyor belt system. A belt conveyor system is also recommended for transport of spoils from the

construction areas (temporary stockpiles on left and right bank of damsite) to disposal site to avoid usage of 400 vehicle trips per day for transportation of spoils.

- Mitigation measures to reduce greenhouse gases are given in Section 6.5.1: GHG Management Plan.
- Material such as pozzolan and cement will be covered with tarpaulin during transportation. covering of stock piles to minimize the amount of airborne dust generated from the site.
- Air quality in the tunnels will be maintained in accordance with technical specifications. The quantity of fresh air pumping from outside to inside the tunnel will be boosted such that a wind velocity of 1 m/s is maintained at a minimum; and
- Construction materials will be stored away from the residential areas and will be properly covered.

7.4.2.3 Noise

Potential Effects: Noise will be generated from vehicular movement, excavation machinery, concrete mixing, construction activities and blasting during the construction phase. Main sources of noise pollution are from construction related traffic and equipment.

Noise Along KKH and Access Roads From Construction Traffic

The noise impact on receptors along KKH due to additional construction traffic was assessed using FHWA TNM 2.5 (Traffic Noise Modeling) software. Leq noise levels were modeled for normal traffic and projected traffic increase due to construction activities. The modeling results in Table 7.10 show that there will only be a marginal increase in the noise level due to the additional traffic. Noise levels at Seo, Komila and Dasu may exceed the national standards. However, the existing noise levels at these receptors have already exceeded the NEQS during the normal traffic phase and increased construction traffic will only have a slight impact.

Table 7.10: Traffic Noise along KKH

S/N	Receptor Location	Coordinates		Leq [dBA]	
		Latitude	Longitude	Baseline	Construction Phase
1	Siglo	35.311667	73.185	53.2	53.7
2	Seo	35.30833	73.1867	60.3	60.8
3	Komila-2	35.259024	73.217427	67.8	68.3
4	Komila-1	35.260917	73.217031	58.3	58.6
5	Dasu-2	35.276879	73.223949	67.8	68.3
6	Dasu-1	35.273872	73.225275	47.7	47.8
7	Pattan	35.110323	73.003217	42.8	43.4
8	Palas	35.103497	72.999838	34.3	34.9
9	Dubair	35.03745	72.898039	52.4	53
10	Besham Qila	34.935236	72.878406	51.1	51.9
11	Shang	34.879867	72.885636	43.1	43.7
12	Maira-2	34.84227	72.985764	39.2	39.8
13	Maira-1	34.833255	72.99171	46.6	47.3
14	Dandai	34.81171	72.943758	42.4	42.9
15	Thakot	34.79987	72.932176	50.2	50.8
16	Battal	34.582726	73.144225	41.7	42.3
17	Icherrian	34.494704	73.251035	34.1	34.8
18	Shinkiari-2	34.474151	73.27019	43.8	44.5
19	Shinkiari-1	34.471875	73.27117	39.6	40.3

S/N	Receptor Location	Coordinates		Leq [dBA]	
		Latitude	Longitude	Baseline	Construction Phase
20	Mansehra -2	34.337418	73.198808	49.2	49.9
21	Manshehra-1	34.325525	73.194544	50.7	51.4
22	Qalandarabad	34.263611	73.23647	49.8	50.4
23	Ferozabad	34.234217	73.23442	42.7	43.3
24	Abbottabad	34.146078	73.216446	38.7	39.4
25	Havelian	34.055315	73.1515	38.7	39.3
NEQS					**Day time:55 Night time:45**

Noise from Construction Activities

Noise levels from construction activities will have impacts on the nearest receptors. The nearest receptor at dam site is Seo village and nearest receptors to quarry site are relocated village of Kaigha and a community conservation area (CCA). The impacts of construction activities on the Kaigah CCA are further discussed in detail in Section 7.4.3.2 (2). Cumulative noise levels resulting from various construction activities near the damsite and quarry areas are assessed and their impact on nearby villages is presented in Table 7.11. Night time noise levels at Seo and Kaigah villages are expected to exceed NEQS. Impacts on noise pollution on the workers are discussed separately in Section 7.4.8.

Table 7.11: Noise Impact from Construction Activities

S/N	Receptor Location	Noise Impact from Construction Activity Leq[1h] (dBA)				Cumulative Noise Impact Leq[1h] (dBA)
		Plant Site	Dam Site	Power House	Quarry Site	
1	Seo	44	47	50	10	52
2	Komila Bazar	15	27	29	9	32
3	Dasu	17	30	32	9	34
4	Kaigah	18	26	29	49	49
NEQS						**Day time: 55 Night time: 45**

Mitigation Measures: Contractors will monitor the noise levels regularly at the nearby villages and other sensitive receptors to ensure they do not exceed NEQS. Contractors will adopt appropriate noise attenuation measures to reduce the noise generation from construction activities. The noise attenuation measures will include, (i) fitting of high efficiency mufflers to the noise generating equipment; and (ii) keeping acoustic enclosures around drilling equipment. The construction activities, near the settlements, will be stopped during night times if high noise values are observed. All vehicle used in the construction activities will comply with NEQS exhaust and noise standards (85 dBA at 7.5m from the source).

Additional mitigation measure applicable to the Kaigah quarry is excavation will be started from southern end and shall be progressed towards north, thus always maintaining a natural berm on northern and eastern side to act as acoustic shields and to avoid impacts on Kaigah village and CCA. Material stockpiles will also be used as acoustic shields around high noise generating equipment and crushing plants, and also along the boundaries of quarry area.

Additional mitigations applicable for Gini site are: excavation will be started from the eastern side and will proceed to the western side; excavation will be carried out in a way that there will be a narrow strip of area along KKH and Gini village are maintained to act as natural berm to reduce noise and dust.

7.4.2.4 Vibration from Blasting

Potential Effects: The environmental effects most often associated with blasting operations are ground and air vibrations. The intensity of ground vibrations, which is elastic effect measured in units of peak particle velocity, is defined as the speed of excitation of particles within the ground resulting from vibrating motion. Air vibration, or air blast, is a pressure wave travelling through the air produced by the direct action of the explosive on air or the indirect action of the a confining material subjected to explosive loading. Air vibration is measured as decibels in the linear mode (dBL). This differs from noise (above 20 Hz) which is measured in dBA. Ground vibration and airblast levels will be generated from any blasting activities associated with the Project. At low to medium levels, ground vibrations and airblasts can result in general community annoyance. At higher ground vibration and airblast levels there is potential for building structural damage. Pakistan has no standards on the vibration levels. International standards on air and ground vibrations are given in Table 7.12.

Important factors influencing air and ground vibration levels from blasting are the Maximum Instantaneous Charge (MIC) used in the blast and the distance to the receiving location. Other factors such as stemming depth, type of initiation and meteorological conditions also affect these values, and result in variation above or below the predicted overpressure and peak particle velocity values. Using simplified equations, ground vibrations and air blasts for various quantities of blast size at different distances are estimated and presented in the Table 7.12.

Table 7.12: Air and Ground Vibrations from Blasting Operations

Blast Size (kg)	Distance from Source					
	500 m		1 km		3 km	
	Air Blast	Ground Vibration	Air Blast	Ground Vibration	Air Blast	Ground Vibration
	(dBL)	(mm/s)	(dBL)	(m/s)	(dBL)	(mm/s)
250	118	3.7	111	1.5	100	0.32
500	121	6.1	114	2.6	102	0.51
1,000	123	9.8	116	3.8	105	0.83
International Standards						
USA	133	25	133	25	133	25
Canada	128	12.5	128	12.5	128	12.5
Australia	115	5	115	5	115	5

Note: The above calculations are approximate and based on equations developed by Crum et al. 1995, and Heilig 2006[1]

Based on Table 7.12, an instantaneous blasting up to 1,000 kg is not expected to create any impact up to 1km. However, it is difficult to accurately predict potential ground vibration and air-blast impacts for a new site as their propagation is so dependent upon local geology, terrain, meteorological conditions, and type of initiation. Normally a series of small trial blasts are carried out in order to calculate site laws based on measured vibration and airblast levels.

Mitigation Measures: It is recommended that the contractor shall carry out trail blasts with various charge amounts and record vibrations levels at the nearest receptors and finally chose the optimum amount of blasting per event.

[1] PPV = 443 $(D\sqrt{W})^{-1.38}$ (Crum et al. 1995). Where ppv = ground vibration, w = maximum exposure weight per delay period and d is the distance from blast.
dBL = $164\text{-}24\times\log(D/3\sqrt{W})$ (Heilig 2006, where dBL = air blast (air vibration), w = maximum exposure weight per delay period and d is the distance.
The numbers used in the above formulas are the approximate constants, which are generally site specific and exact numbers (constants) are to be estimated during trail blasts

The Contractor shall install and operate a siren of sufficient volume to be easily heard above the general site noise from all points within a radius of 1 km of surface blasts. The Contractor shall also present to WAPDA, local government, the surrounding villages, and police station nearest to the Dasu weekly schedule of his blasting operations in a written form.

7.4.2.5 Waste

Potential Effects: Construction works are expected to generate excess material from construction sites (concrete, steel cuttings, discarded material), and wastes from including garbage, recyclable waste, food waste, and construction debris. The offices, residential colonies and contractor camps at the peak time of construction are estimated to produce about 1821 kg of solid waste per day (0.3 kg/capita/day). In addition small quantities of hazardous waste will also be generated mainly from the vehicle maintenance activities (liquid fuels; lubricants, hydraulic oils; chemicals, such as anti-freeze; contaminated soil; spillage control materials used to absorb oil and chemical spillages; machine/engine filter cartridges; oily rags, spent filters, contaminated soil, etc). It is imperative that such waste is responsibly disposed to avoid adverse environmental, human health and aesthetic impacts.

Mitigation Measures: The contractor will be required to prepare Waste Management Plans, in accordance with the ECP 1 Waste Management, ECP 2 Fuels and Hazardous Goods and ECP 15 Construction Camp Management – before mobilization. The plans will set out the designated waste disposal site(s) and associated management controls. The Plans will be submitted to PMU for their review and approvalThe solid waste management system will include (i) segregation of solid waste at source, (ii) storage & primary collection of waste from project colonies, offices, guest houses, labour colonies/sheds, markets, community center, Hospitals, workshops, canteen/mess, schools, garden, parks etc.; (iii) waste transportation mechanism; (iv) waste storage depots/enclosures; and (v) waste processing and disposal. The landfill site will be determined by the contractor in consultation with the relevant stakeholders. The excess material such as steel will be recycled or will be sold to the vendors.

Further, the contractor will (i) provide refuse containers at each worksite, (ii) maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal, and (iii) train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process.

7.4.2.6 Fuel and Hazardous Material Spills

Potential Effects: Fuel and hazardous material storage sites and their handling are the potential sources for soil and water pollution. Improper siting, storage and handling of fuels, lubricants, chemicals and hazardous materials, and potential spills from these will severely impact the soil and water quality and cause safety and health hazards.

Mitigation Measures: Siting of any fuel and hazardous material storage sites, including refuelling operations, asphalt plants and construction are to be located within the construction yards.

These sites are to be designed, by the contractor, such way that any spills from these goods will not pollute the soils and water. As a minimum, these sites are to be bunded on all sides on top of an impermeable layer (e.g. concrete lined) by providing absorbent and containment material (e.g. absorbent matting) and without any drainage provision. The bunds are to be designed to hold at least 110% of the container capacity. If more than one container is stored within the bund, the bund must be capable of storing 110% of the biggest container's capacity or 25% of their total capacity, whichever is greater. All the associated equipment such as filling and off-take points, gauges, etc. shall be located within the bund. Accumulated rainwater in bunds will be pumped out of the bund to either drains or the ground if uncontaminated or to the oil water separators if contaminated. Oil booms and oil spillage pods shall be maintained onsite to enable a rapid and effective response to any accidental spillage or discharge. All the personnel involved in the handling of these sites are to be properly trained. Firefighting equipment such as fire extinguishers will be kept in the site.

Fuelling stations will be established on both the banks for refueling of vehicles and equipment. All fuel / hydrocarbon dispensing nozzles are to be of a drip control design and securely locked when not in use. Refueling will always be carried out with the correct equipment (i.e. nozzles of the appropriate size), and only by suitably trained and experienced Refueling Operators. Fuel supply equipment will be regularly revised to prevent leakage due to inappropriate condition of refueling equipment. Vehicle maintenance, cleaning, degreasing etc. will be undertaken only in designated areas. Hazard warning signs will be posted at these sites.

7.4.3 Terrestrial Ecology

Potential impacts of the Project on the terrestrial ecosystem are low and insignificant due to limited biodiversity in the Project impact area (construction areas and reservoir submergence area). However, there was a significant biodiversity on the higher altitudes (with location of forests above 2,000 masl and location of wildlife habitat above 3,000masl) away from the project impact area, and can be indirectly affected by the construction workers.

7.4.3.1 Flora

The vegetation is diverse but scattered throughout the study area. There are no threatened, endemic or rare plants species recorded during field surveys or were reported in the literature. The impacts on flora will result from land acquisition for project facilities and reservoir submergence area, and resettlement of the affected people. The key impacts on vegetation are: loss of about 21,000 trees and shrubs, and loss of about 280 ha of grazing land consisting of various grasses and herbs.

(1) Loss of Trees

Potential Effects: About 21,000 trees will have to be cut for siting of project facilities and from reservoir submergence area before flooding in order to reduce anoxic conditions and greenhouse gases emissions. The tree numbers to be cut was estimated from GIS mapping of satellite imagery followed by groundtruthing surveys. Generally these trees, located on the steep slopes of the Indus valley, are not very well developed and often consist of stunted trees. They do not represent much natural, other than as a source of firewood and fodder. These trees also do not serve the purpose of primary habitat for wildlife species.

Details of major types of trees to be affected are given in Table 7.13. Generally all these species are very commonly available and widely distributed throughout the study area including downstream of dam axis.

Table 7.13: Affected Tree Species

Sr. No.	Village name	Habitat types	Tree Species
1	Dooga Gah	Steep rocky slope	*Quercus baloot, Olea ferruginea* and *Cotinus coggygria*
2	Choochang	Rocky steep to moderate slopes	*Olea ferruginea, Quercus baloot,*
3	Khoshi	Gentle slope	*Olea ferruginea* and *Quercus baloot*
4	Siglo	Gentle slope	*Olea ferruginea, Quercus baloot* and *Cotinus coggygria*

Sr. No.	Village name	Habitat types	Tree Species
5	Seer Gayal	Rocky steep to intermediate slopes	*Olea ferruginea* and *Cotinus coggygria*
6	Toothi	Rocky steep slopes	*Qurecus baloot, Cotinus coggygria* and *Olea ferruginea*
7	Seo	Rocky gentle slope	*Olea ferruginea*
8	Malyar	Rocky steep slope	*Quercus baloot* and *Olea ferruginea*
9	Panibah	Rocky gravelly	*Olea ferruginea* and *Quercus baloot*

Mitigation Measures: The loss of trees will be compensated by successful plantation of the native species. The lost trees will be replaced at a ratio of 5:1 in the buffer area of the reservoir on the right bank, resettlement sites, DHP office and residential colony, and at higher elevations for forest regeneration with the support of local community. Suitable species of tree plantation are given in Table 7.14. The community loses on the felling of trees will be compensated by allowing the community to cut and use the wood (in addition to the monetary compensation).

Table 7.14: Recommended Species for Tree Plantation

Sr. No.	Family	Tree species	Local Name
1.	Anacardiaceae	Cotinus coggygria Scop.	Khakoh/Shini
2.	Anacardiaceae	Pistacia chinensis Bunge	Kangar
3.	Anacardiaceae	Rhus mysurensis Heyne.	Kasudur
4.	Fagaceae	Quercus baloot Griffith	Bani/Jaand
5.	Oleaceae	Olea ferruginea Royle	Kao

(2) Loss of Grazing Areas

Potential Effects: About 280 ha of grazing land consisting of various grasses and herbs will be lost. Ecologically there is no significance for their loss; however it will affect the livestock grazing in winter months. Since the availability of grazing areas are limited in the Project area, the loss of 280 ha of winter grazing land (below 1,000 masl) may affect the livelihood of the herders or forcing them moving in to other areas in search of grazing. Further, winter grazing land between 1,000 m to 1,500 m elevation will be subjected to increased grazing pressure due to relocation of affected villages in to these areas. However, the loss of 280 ha of grazing land comprises only 2.5 percent of the total grazing area (including higher/summer) available to the community (Section 7 of SRMP Vol. 6: Resettlement Action Plan).

Mitigation Measures: In order to mitigate impacts associated with loss of grazing areas, an adequate livelihood restoration program through development of grazing areas at lower and higher altitudes is recommended in order to sustain and improve livestock herding. Government of KP launched a 'Barani Area development Project-II in Kohistan (2004-2009) for Mot Grass cultivation at pilot scale and since 2009 onwards Kohistan Area Development Project is going-on to promote new varieties of Mot Grass. The program can be used as a model to develop the grazing areas in the lands owned by the local community and develop grazing management system.

(3) Pressure on Forest resources

Potential Effects: Forests, though essentially located on high elevation well away from project construction areas, are the most important natural resource of the area. Forests are quite a significant source of income for local community due to timber production through government leasing, with 80 percent of income goes to local community. In addition, selling of fire wood is an important business in the project area and a common practice along KKH mainly in winter season and also partly in summer season. People harvest oak, wild olive and other fuel wood trees from forests and store in the form of wood toll on main KKH. The daily sale of firewood is very high and the people earning a large amount; the local selling rate of the firewood is Rs.260/- per 50 Kg. It is expected that the Project will attract about 9,000 in-migrants (construction workers, their families and service providers). This will create a huge demand for firewood due to increased energy requirements for cooking and space heating during winter, and will finally increase the pressure on forest resources, which is already under heavy pressure from local communities for commercial harvesting, firewood and grazing.

Mitigation Measures: The Project will support the local government to establish market for supply of non-timber fuels such as LPG for cooking and heating to reduce the pressure on firewood. Contractors also shall provide non timber fuels such as LPG to the construction staff for cooking and heating purposes. The Project will also support local community's forestry management, and carry out afforestation and forest regeneration programs. Further studies will be carried out during pre-construction and construction stage on forest resources assessment and design of the recommended programs.

7.4.3.2 Fauna

Construction activities such as drilling and blasting create high noise and vibrations, which may have potential to disturb the birds and wildlife on higher altitudes. Potential sources of effects on wildlife during various construction activities are summarized in Table 7.15.

Table 7.15: Sources and Types of Potential Effects on Wildlife

Source of Construction Activity	Potential Effects
Dam Construction	Dust, noise and night lighting from construction areas
Tunnel Construction	Noise and vibration from blasting activities
Quarrying of Kaigah	Dust, noise and vibration from drilling and blasting activities may have potential effect on Markhor Community Conservation Area (CCA) at Kaigah
Construction of KKH and access roads	Dust, noise and vibration from construction activities. Relocation of KKH from lower altitudes (800-950masl) to higher altitudes (950-1000masl) and construction of access roads at these elevations may provide increased access to wildlife

(1) <u>Impact on Birds</u>

Potential Effects: Indus valley is a migratory route for wintering birds. Hundreds of thousands of birds from northern countries spend entire winters in different wetland of Pakistan, which are distributed almost throughout the country from the high Himalayas to coastal mangroves and mud flats in the Indus delta. After successful wintering they go back to their native habitats for breeding purposes. About 58 species of terrestrial birds and 39 species of aquatic birds were observed in the Project area.

Noise generated through drilling and blasting during construction activities have potential to impact on the birds' hearing and behaviour. The noise impacts on the birds can be classified into the following three categories:

a. Hearing Damage: Generally birds are more resistant to both temporary and permanent hearing loss or to hearing damage from acoustic overexposure than are humans and other mammals. Birds are able to regenerate the sensory cells of the inner ear, thereby providing an avenue for recovering from intense acoustic over-exposure. However, a permanent hearing loss occurs if the intensity and duration of the noise is sufficient to damage the delicate inner ear sensory hair cells.

b. Temporary Threshold Shift (TTS): A TTS is a temporary hear loss that lasts from seconds to days depending on the intensity and duration of the noise to which the bird was exposed.
c. Masking: Continuous noise of sufficient intensity may mask signals of birds that are used to communicate between conspecifics or recognize biological signals, and impairing detection of sounds of predators and/or prey.

California Department of Transportation (2007) has recommended interim noise guidelines for potential impact on birds from noise sources from construction and operation of highways. These noise standards are presented in Table 7.16. Drilling and blasting activities during construction will generate noise levels in the range of 110 to 140 dB and these activities may cause permanent hearing damage to the birds if they located very close to the noise source. It is noticed that many resident birds build nest along KKH despite of noise from high volume of traffic. Hence noise may not have major impact on the breeding and nesting species. These species are found to be very adaptable in different conditions and their populations are commonly found in stable conditions. They are likely to readjust their breeding ranges in nearby areas due to their remarkable adaptive ability.

Table 7.16: Interim Guidelines for Potential Effects on Birds from Different Noise Sources

Noise Source Type	Hearing Damage	TTS	Masking
Distance to the Source	Very Close	Close	Far
Single Impulse (e.g., blast)	140 dB(A)	NA	NA
Multiple Impulse (e.g., jackhammer, pile driver)	125 dB(A)	NA	ambient dB(A)
Non-Strike Continuous (e.g., construction noise)	None	93 dB(A)	ambient dB(A)
Highway Noise	None	93 dB(A)	ambient dB(A)
Alarms (97 dB/100 ft)	None	NA	NA

Source: California Department of Transportation, 2007

Mitigation Measures: To reduce noise levels from drilling activities, acoustic enclosure will be placed to cover the equipment. During migratory bird season; if there is concentration of birds near high noise generation activities, the contractor can deter the birds from those areas by using light reflective devises, waterfowl simulation gunshots, bird deterrent distress and alarm calls, etc. Noise standards given in Table 7.16 will be considered as performance indicators for the environmental monitoring of the Project.

(2) Impact of Project on Kaigah Community Conservation Area

Permanent Impacts

The permanent impacts on the game reserve are (i) Loss of a strip of land (estimated at some 31 ha) from the game reserve due to construction of the new alignment of KKH; and (ii) Loss of land (estimated at some 51 ha) from the game reserve due to submergence by the reservoir. Thus about 1.6% of total area of the game reserve will be permanently affected by the Project. Location of the game reserve, reservoir submergence area, quarry site and KKH realignment at Kaigah is shown in the **Error! eference source not found.**.

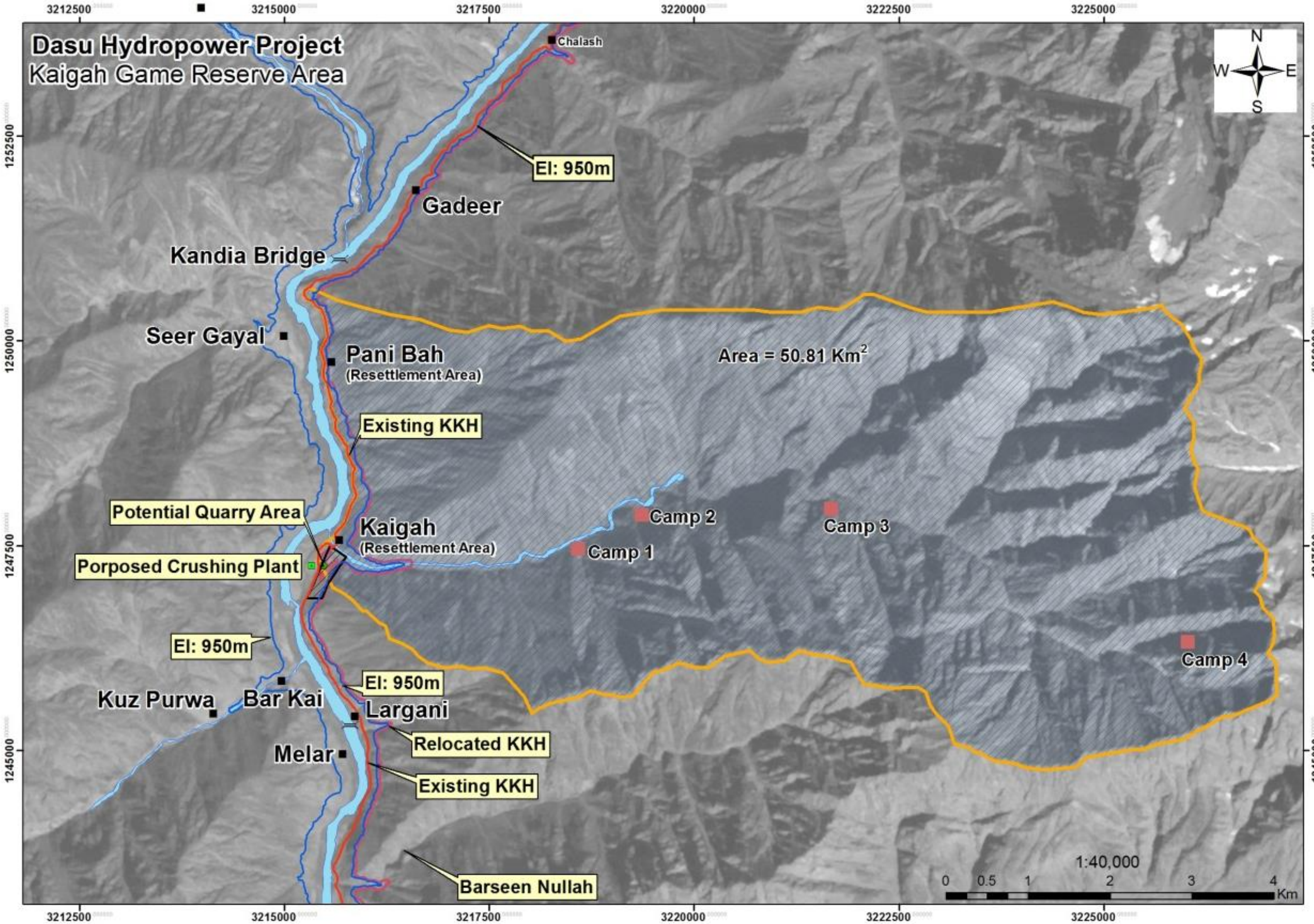


Figure 7.1: Location of Location of Kaigah Game Reserve and Project Facilities

There are four camps (tourist facilities with bed rooms, toilets, etc.) in the game reserve, which are established near the Markhor habitats.. The distance between existing KKH to first camp and distance between other camps are given below:

- Distance from existing KKH to Camp I is 3 km
- Distance from Camp I to Camp 2 is 1 km
- Distance from Camp 2 to Camp 3 is 3 km
- Distance from Camp 3 to Camp 4 is 5 km

Markhors are mainly present in Camp 1 area during winter months of December and January; in Camp 2 during March and April; in Camp 3 during summer months of May, June and July; and in Camp 4 during August to November.

The lower elevations of the game reserve that will be permanently affected by the Project are mainly inhabited the community of Kaigha village. No wildlife habitat will be affected by the project.

Temporary Impacts

Construction activities in the proposed quarry site at Kaigha (for 2.75 years) and relocated KKH within the game reserve (for about 10 months) may have potential impacts on the wildlife in the game reserve. Blasting and aggregate crushing operations are the major and nearest sources of disturbances to Kaigha CCA. The environmental effects most often associated with blasting operations are ground and air vibrations (Section 7.4.2.4). At low to medium levels, ground vibrations and air-blasts result in annoyance, but at higher levels, it would be expected that wildlife may move away from their habitats to further higher elevations.

Mitigation and Compensation Measures: As a compensation measure to the loss of the land, the project will carry out further studies and develop two community conservation areas in the project area and support strengthening of conservation activities in the Kaigha game reserve. Ground vibrations and air blasts for various quantities of blast size at different distances are estimated and presented in the Table 1.7. Similarly noise from quarrying and aggregate crushing operations at this location is given in Table 7.18. Generally a maximum blasting size of 100 kg to 250 kg will be used for such large scale quarrying activities. Based on these tables it can be noted that, an instantaneous blasting up to 1,000 kg produce an air blast of 105 dBL and a ground vibration of 0.83 mm/s at the nearest wildlife habitat of Kaigah CCA. These values are well within the international standards and also within the levels studied by some researchers to understand the impacts of blasting on wildlife[2]. Hence the blasting is not expected to create any impact on the Kaigah CCA. However, it is difficult to accurately predict potential ground vibration and air-blast impacts for a new site as their propagation is so dependent upon local geology, terrain, meteorological conditions, and type of initiation. Normally a series of small trial blasts are carried out in order to calculate site laws based on measured vibration and airblast levels. It is recommended that the contractor shall carry out trail blasts with various charge amounts and record vibrations levels at the first camp of the CCA and finally chose the optimum amount of blasting per event. Similarly noise levels are also to be monitored and if it exceeds the national standards, acoustic enclosures for noise attenuation are

[2] Hall et al. 1988 conducted a study on effects of nearby (as close as 500 ft) blasting noise and vibration on wild animals. At an airblast level of 130 dBL and ground vibration of 6.35 mm/s (0.25 in/s), the tested animals noticed the first blast or two; however, they quickly acclimated to the noise and vibration. In their final conclusions, the researchers found that the tested animals experienced no long-term negative effects from the levels of noise and vibration produced by the construction blasting. The study was conducted at the Washington Park Zoo in Portland, Oregon and the animals studied are black rhinos, naked mole rats, elephants, spotted owls, snow leopards, red pandas, white tailed deer and several other species. In a different study (Gordon, 2006), where blasting regularly occurred near within 1,000 ft of a dairy cows (that produced vibrations of 128 dBL and 2.03 mm/s), despite initial concerns by the dairy operators, all involved parties have finally concurred that blasting did not disturb the cows.

recommended for crushing plant or its operation to be limited to day time. Contractors shall employ appropriate methods to control dust from the blasting, quarrying and crushing activities.

Table 7.17: Air and Ground Vibrations at the Nearest Wildlife Habitat of Kaigah CCA

Blast Size used at Kaigah quarry (kg)	Air Blast (dBL)	Ground Vibration (mm/s)
250	100	0.32
500	102	0.51
1,000	105	0.83
International Standards		
USA	133	25
Canada	128	12.5
Australia	115	5

Source: Table 7.13

Table 7.18: Noise Levels at the Nearest Wildlife Habitat of Kaigah CCA

Activity	Leq (1hr) dBA
Quarrying	43
Crushing	47
Equivalent Noise	45
Standard (NEQS)	Silence Zone: 50 dB(A) for day time and 45 Leq (1hr) at night time

(3) Risk of Poaching

Potential Effects: Construction of realigned KKH along left bank and access roads along the right bank (within 1,000 masl) will not interfere with any wildlife corridors. However, they may provide increased access to hunting and poaching.

Mitigation Measures: Poaching from construction workers can be affectively curtailed by conducting wildlife awareness programs. Temporary access roads will be decommissioned after completion of the Project. The Project can support the district wildlife authorities in conducting awareness programs on wildlife conservation and taking up conservation projects similar to Kaigah CCA. This would also reduce the hunting and poaching pressure and provide some job opportunity to locals.

7.4.4 Aquatic Ecology

7.4.4.1 Impact on Fish Habitat at the Damsite

Potential Effects: At the damsite coffer dams will be placed upstream and downstream of the work areas for construction of the dam and spillway plunge pool (Figure 3.4). Habitat in the riverbed work area will no longer exist; that stream segment will be kept dry by diverting water through tunnels from just upstream of the upper coffer dam to a release point downstream of the lower coffer dam. Aquatic biological production will be eliminated from approximately 980m of stream length, part of which (the dam footprint) will be removed for the life of the dam.

Pre-construction and construction activities have potential to adversely affect aquatic biota by release of high concentrations of sediment, fuels/oils and other toxic compounds, and solid waste and use of explosives.

Sediment concentrations above natural levels can cause mortality of biota directly; for fish, damaged gills and sediment clogging of gill chambers eventually leads to death. Indirectly, sediment deposition downstream can affect biota by altering habitat features for example by covering previously clean rock habitat used for spawning or feeding, causing impairment of those areas including smothering and mortality of freshly laid eggs or newly hatched larvae and reduced benthic production and food abundance for herbivorous fish such as snow carp and fish preying on algae-feeding invertebrates. Toxic compounds can have direct lethal and sub-lethal effects on organisms or have indirect effects for example by reducing food-organisms. Solid wastes can be ingested causing injury or death and can impair habitat. Explosives can kill aquatic organisms immediately or cause sufficient damage to internal organs even at long distances that death will eventually occur.

Mitigation: Mitigation measures proposed in Section 7.4.2.1 to control sediment releases in construction areas will minimize potential adverse effects on aquatic resources. Similarly measures outlined in environmental management plans in Section 7.4.2.6 regarding use and handling of fuels, explosives and other hazardous materials and control and disposal of solid waste will also minimize potential adverse effects on aquatic biota. No explosives are planned for underwater during construction.

Additional mitigation measures include: avoidance of coffer dam placement during the start and middle of low flow winter season when fish may be using pool areas as refuges and sediment levels are seasonally low; for diversion tunnel construction, not undertaking initial activation during the winter low flow season; ensuring construction material, including from the diversion tunnel, is not dumped into the river and is transported to designated disposal areas; clearing all residual material and accumulations of sediment and debris from construction sites before flooding.

7.4.4.2 Impact on Fish movement at the Damsite

Potential Effects: Fish is limited in Indus during high flow season due to turbulent flows, high water currents and high sediment load. In low flow season fish can be seen in Indus near the confluence areas. Snow carps are the short distant migrants and migration takes place within the tributaries, not along Indus. Fish movement in Indus during low flow season could be impaired during the construction phase with placement of coffer dams and operation of the diversion tunnels and continue with dam construction and operation. Fish upstream of the dam potentially will be entrained in the diversion tunnels during dam construction. Fish drawn into the upstream end of the diversion tunnel will be subject to high water velocity and possible abrasion along the tunnel walls as they pass along the 900-1200m tunnel lengths. Survival of some fish is possible though if fish try to maintain a position facing up-current or seek slow-current areas along the tunnel walls high rates of weakened and injured fish likely will occur.

Mitigation Measures: Fish moving downstream from Siglo Creek similarly should be able to move into the Indus River near the lower coffer dam though at times could be deterred by high flows from the diversion tunnels. Measures proposed to minimize fish entrainment are provisions of upstream intake screens to diversion tunnels or installation of fish deterrent devices:

7.4.4.3 Impact on Mahaseer

The endangered golden mahaseer (*Tor putitora*) reportedly do not ascend beyond approximately Thakot-Besham, 70-80 km downstream of the dam site. Hence there will be no impact on the Mahaseer.

7.4.5 Physical Cultural Resources

7.4.5.1 Shatial Rock carvings

Potential Effects: Though the rock carvings at Shatial are located on the river bank on the upstream side of the proposed Dasu dam site, none of the rock carvings will be submerged under the reservoir. This is confirmed by a detailed topographic survey conducted using `Total Station'. The lowest elevation at the rock carving site is 967.8masl, while the maximum reservoir level under probable maximum flood is 959.46masl. Hence it is concluded that the rock carvings will not be submerged under the reservoir. The rock art complex near Shatial is part of a much larger complex stretching over 100 km distance upstream from here, with more than 30,000 petroglyphs. Most of them will be flooded by the proposed reservoir of the Diamer-Basha dam. It is proposed in Diamer Basha Project to set up a museum at Chilas with three dimensional life size replicas and documentation of important petroglyphs, and relocation carvings (subjected to feasibility). Hence it is important to note that rock art complex at Shatial is the only art complex left in its original position in Pakistan after completion of Diamer-Basha Project.

As explained in EMAP Vol 5: Physical Cultural Resources, the natural weathering process and vandalism are threat to the rock carvings. Further the site is located in a private land and not guarded with fencing and security and hence it is easily exposed to vandalism. The potential for vandalism may increase due to increase of traffic along KKH due to construction traffic of the Project.

Enhancement Measures: The protection of rock complex at Shatial is recommended as it will be the only site portraying the original and authentic specimens of rock art in the face of the fact that all such petroglyphs at the Diamer Basha Dam would be submerged in water leaving no trace of genuine antiquity at that site. This can be done by procurement of the land from the private owners, fencing the area, treatment of the weathered carvings and protection from further weathering, and development of tourism facilities. This may provide a good opportunity to expand business and commercial activities and to promote tourism and hotel accommodation. These activities will also stimulate local employment in an area with few economic activities.

Directorate of Archaeology and Museum (DOAM) of KP has designated about 25 acres of land for procurement and protection of the rock carving site under Antiquities Act, 1975. DOAM has submitted an application to local government in Dasu for purchase of this land. However, non-availability of funds with DOAM has hindered any progress in this direction. DOAM has officially requested the DHP for its support in funding the amount for land acquisition. KP DOAM will be responsible for procurement of the site and developing these facilities with the support of the Project. KP DOAM will also be responsible for documenting the importance of rock carvings and their translations in to Urdu and English. Further, no construction areas and construction activities will be carried out near the rock carvings site that will have direct impact on the rock carvings.

7.4.5.2 Mosques

(1) Impact on Mosque at Seo

Potential Effects: Due to cultural and religious importance of Seo mosque in the region, the dam site was originally selected, from various possible alignments, to avoid submergence of Seo mosque and Seo village. Details of alternative assessment on selection of damsite are given in Section 5. However, the mosque can be indirectly affected by dust, noise and vibration from the construction related activities such as operation of machinery/transport, and blasting.

Mitigation and Enhancement Measures: The impacts from dust, noise and vibration can be mitigated by strict implementation of mitigation measures proposed in Section 7.4.2.

Enhancement measures will be carried out to keep the mosque in good state of preservation and a living monument to serve its original purpose. The mosque will be protected against hazards of termite attack, decay and the danger of fire. This will be done by injecting of anti-termite chemical into the ground surrounding the mosque structure at regular intervals. Fire extinguishers will be made available for emergency firefighting. Water supply and sanitation facilities will be developed near the mosque to meet the requirement of visitors of the mosque.

(2) Impact on Seer Gayal Mosque

Potential Effects: The historic Seer Gayal mosque will be submerged under the proposed reservoir. It is common that local community have their attachment to the mosque for centuries. The sentimental value of this attachment will be hard to be cut off suddenly for the concerned population when they see it submerge into the reservoir. It is also more important to save the structure of this mosque as it represents a typical style of wood construction and decoration in the area, along with the other important mosque at Seo.

Mitigation and Enhancement Measures: The mosque will be disassembled carefully and re-erected at a place of the choice of the local people, according to the original plan and design through the use of the original and authentic material dismantled. Additional facilities such drinking water, sanitation and termite protection measures will also be provided to the mosque.

7.4.5.3 Graveyards

Major grave yards at Seer Gayal and Barseen will be submerged under the reservoir along with 15 other small graveyards. Local communities have requested the protection of graveyards from the collapse of graves under water and floating of human remains. A fatwa (a religious injunction) was also issued by local religious leaders on protection of the graves that will be submerged under the reservoir. The graves shall be protected with civil works (mud plastering) to withstand the impact of water.

7.4.5.4 Chance Finds

Throughout the pre-historic and historic periods caravans, merchants, pilgrims and armies have used the Indus valley bottom and /or lower slopes on the way to cross the mountain ranges from the Central Asia and the Sub-continent to China and vice versa. Most of the settlements are exclusively located at the valley bottom. At these places older and newer human settlements and the continuous passage of men and animals on these crossroads must have left traces behind. Therefore, it might be expected that with construction activities at the hydraulic structures and roads there might be so-called “chance finds” of cultural and historic sites and objects. Unknown archaeological sites and objects might be accidentally damaged during project activities (earthwork, rock blasting, drilling operation etc.). As a mitigation measure for these types of impacts clear chance-find procedures, described in Section 5 of Antiquity Act of 1975, are included in the contact documents. These are:

- Sub-section (1): Whoever discovers, or finds accidentally, any movable antiquity shall inform the Director General within seven days of its being discovered or found and preserve it for the period specified in sub-section (2).
- Sub-section (2): If, within seven days of his being informed under sub-section (1) of the discovery of moveable antiquity or of a moveable antiquity having been found the Director General decides to take over the antiquity for purposes of custody preservation and protection the person discovering or finding its shall hand over to the Director General or a person authorized by him in writing.
- Sub-section (3): Where the Director General decides to take over an antiquity he may pay to the person by whom it is handed over to him such cash reward as the Advisory Committee may deem fit.
- Sub-section (4): If any person who discovers or finds any movable antiquity contravenes the provisions of sub-section (1) or sub-section (2), he shall be punishable with imprisonment for a term which may extend to three years, or with fine or with both or\and the court convicting such person shall direct that the antiquity in respect of which such contravention has taken place shall stand forfeited to the Federal Government.

7.4.6 Pre-Fill Reservoir Area Cleaning

The proposed submergence area under the reservoir contains some structures or facilities belonging to the community and local government. Some new structures and facilities will be built by the DHP contractors during construction. All these structures will be decommissioned before filling the reservoir to avoid contamination of reservoir water. An inventory of such assets has been presented in Table 7.19.

Table 7.19: Details of structures to be decommissioned before reservoir filling

No	Structure to be Decommissioned	Description	Remarks
I	**Public Infrastructure**		
1	Largani Bridge	This is suspension Bridge, single lane and for light traffic.	
2	Kandia Bridge	This is a suspension Bridge having two lanes and for light traffic.	
3	Electrical Power Lines	2 Km of local distribution line from local micro hydropower station will be affected.	Owners will relocate the facilities
4	Micro Hydropower Stations.	There are 10 micro hydropower stations located in reservoir area, mainly in Barseen, Largani and Kaigah. They consist mostly of a set of pipes, turbine and coupled alternator.	Owners will relocate the facilities
5	Roadside Impact Barriers.	A total of 66 roadside impact barriers on road bend to be removed. These are made of steel and anchored in ground.	
6	Roadside traffic Signboards	52 Steel traffic sign boards along KKH belonging to NHA	
7	Coffer dam on downstream of damsite	19 m height concrete structure	
II	**Civil Infrastructure**		
1	Police Stations	6 police check posts exist along KKH.	
2	Graveyards	17 graveyards including 2 major one	To be protected with mud plastering
3	Mosques	An historical and beautiful mosque in Seer Gayal	To be relocated to higher elevation
4	Houses	573 houses will be submerged	Affectees will be allowed to salvage the material
5	Civic facilities	7 schools, 2 health centers, 31 mosques	
III	**Construction Contractor's Infrastructure**		
1	Quarry at Kaigah	Contractor's facility at Kaigah Quarry will be submerged	
2	Construction Yards on right and left banks	4 construction yards that contains fuel stations and workshops	
IV	**Others**		
1	Trees	About 21,000 trees will be submerged	Affectees will

No	Structure to be Decommissioned	Description	Remarks
			be allowed to cut the trees.
2	Timber Piles along KKH	Several timber piles adjacent KKH were left there from years due to some local disputes	WAPDA may relocate them with the help of district government.
3	Mechanical timber cable	4 numbers of Logging cable	Owners will relocate the facilities
4	Dolly (cable trolleys)	14 numbers	
5	Martyr Stones along KKH	These are remembrance stones of dead construction workers who laid their life during KKH construction.	Handover to Frontier Work Organization (FWO)

7.4.7 Traffic Management on KKH

Potential Effects: KKH is the most important highway connecting northern areas of Pakistan with the south. Generally the traffic along KKH in Project area includes a mix of passenger vehicles, military vehicles, and trucks carrying food supplies. In addition, pedestrians, livestock herds, and cyclists also equally use KKH. About 2590 vehicles per day use the KKH, in which nearly 15% of vehicles are heavy vehicles and trucks. Hourly traffic along KKH is shown in Figure 7.4.

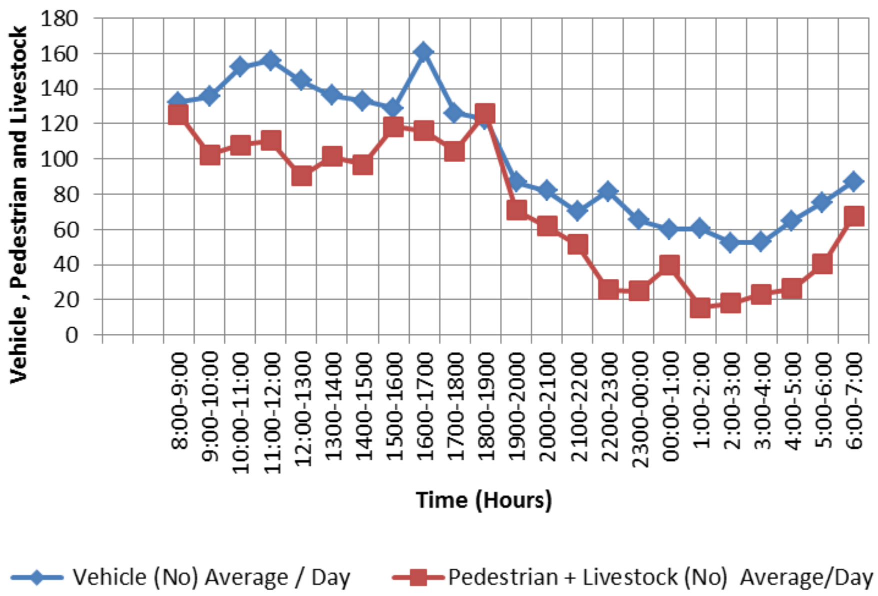


Figure 7.2: Hourly Traffic on KKH (Analysis from 28th April to 11th May 2012)

Construction material such as cement, steel and fuel will arrive to the construction areas through KKH. Materials from Islamabad will reach by road and material from Karachi will reach Havelian by rail and then by road. List of materials to be transported along KKH to the Project sites is given Table 7.20. The additional traffic on KKH by the Project related vehicles may cause traffic congestion and safety hazard for the local population as well as KKH users.

Table 7.20: Construction Material Requirement

Sr. No.	Materials	Quantity, tons	Average Monthly Requirement, tons	Source of Material
1.	Cement	600,000	15,000	Islamabad
2.	Reinforcement steel	100,000	2,500	Islamabad, Hassanabdal, Karachi (or from oversees through Karachi port)
3.	Structural steel	50,000		Karachi (or from overseas through Karachi port)
4.	Fuel	300 million liters	4,000 kilo liters	Islamabad
5.	Explosives	20,000		Wah

Timely delivery of the material is important for timely completion of the Project. Transportation capacity of KKH at some places is weak in terms of its carrying capacity of bridges and requires strengthening. During rains and snow fall, the traffic is susceptible to occasional disruptions due to landslides.

Other important drawback along current KKH is that there are no layby areas along the KKH between Pattan and Dasu, where drivers can stop the vehicles and takes rest. This is one of the common causes for the traffic related accidents along KKH since the drivers falling asleep at wheels.

Construction related traffic along KKH is estimated and presented in Table 7.21. About 200 to 300 construction vehicles per day are expected to use KKH for transport of materials.

Table 7.21: Estimate of Project Vehicular Traffic along KKH

Sr. No.	Materials	Unit	Average Monthly Requirement (from Table 7.20)	Unit Vehicle Capacity	Days of Transport in a Month	Number of Vehicles per day
1.	Cement	tons	15,000	20 (bulk lorry)	10	75
2.	Steel	tons	2,500	20 (heavy cargo truck)	10	13
3.	Fuel	Kilo Litres	4,000	10 (fuel tanker)	10	40
Total vehicles (one way)						128
Total vehicles (round trip)						256
Total vehicles (including miscellaneous Project related vehicles)						≈300

Mitigation Measures: WAPDA will prepare a traffic management plan before start of construction works in coordination with the traffic authorities along KKH, local governments, NHA, FWO, police and the contractors. A one day workshop is recommended during pre-construction stage to identify various options for smooth traffic flow of the construction vehicles. The traffic management plan will include:

1) Traffic control resources, such as signal lights and traffic police are to be strengthened from Hassanabdal to Dasu. DHP will support the local traffic authorities to engage traffic police at the busy junctions.
2) A traffic managemet unit (TMU) will be established by the PMU at Dasu to control the construction related traffic inflow and out flow with sub offices along KKH at Hassanabdal, Haripur, Abbotabad, Chatter plain, Thakot, Besham, Pattan, Komila, and dam site. Dasu office will be connected with telephone,

Fax, mobile phone and internet. These units will be maintained by the dam contractor.

3) The movement of traffic carrying cement or steel will be registered at the traffic unit at Hassanabdal (junction of KKH and GT road). These will travel in small lots of 10 trucks. Hassanabdal will inform the next stations by phone, fax or internet.
4) The weather conditions must be known before the start of the journey from traffic units (which will get relevant information from Met office) and drivers must be briefed before the start of the journey so that cargo may be protected from rain damage and driver may plan the journey accordingly.
5) The receiving stores must be notified, who must prepare for offloading the goods. This preparation includes the location of offloading, labour for offloading together with crane or low lift fork lifters.
6) The load of the trucks must be less than the weakest bridge on the way which as of today stands at 40 Ton. WAPDA will reconfirm the limit and will inform the contractors.
7) Individual contractors shall be responsible, in coordination with the traffic management unit, to obtain the necessary licenses and ensure security facilities for the transport of particularly large and important items such as the generator or transformer units or sensitive materials such as explosives.

Other possible options for traffic management are providing dedicated time slot for the movement of project vehicles, like allowing them to travel only during the night time. The normal travel time along KKH from Abbottabad to Dasu by a car is about 10 hours. One disadvantage of hundred percent night transport will be that the number of trucks arrival rate at Dasu will be high. Large number of trucks arrival may overload the off loading facility at the damsite and may cause longer delays.

Rest and lay-by areas will be established by WAPDA between Besham and Thakot and at Havelian. These rest areas will provide sufficient parking and turning areas for large and heavy trailers and café/restaurant type facilities and accommodation to allow drivers to rest. The lay-by areas shall also be equipped with direct telecommunication facilities to the major construction areas and the Traffic Police to allow daily planning of transport, especially for large or heavy equipment and to minimise disruption of the normal traffic in the areas surrounding the Project

It is also essential that the following steps and measures are to be undertaken by NHA as a priority in advance of execution so that access to site and delivery of the material does not hinder the timely execution of the project.

- Repair of the road as well as that of bridges including routine repair. Up-grading of the KKH has already been initiated to provide the means of transportation for the construction requirements of the Basha Dam project, which was previously planned to be constructed prior to the DHP.
- FWO shall increase the number of road gangs and machinery stationed for immediate removal of landslides and clearance of the road.
- The jurisdictions of the gangs and machinery be reviewed and made shorter for better control and tacking of the problem.

7.4.8 Occupational Health and Safety

The rough terrain and difficult work conditions at the construction areas will create a number of occupational risks and hazards. The construction activities will involve blasting, large scale excavation, underground works, operations of heavy construction machinery and vehicular traffic. These activities may pose health and safety hazards to the workers at site during the use of explosives, use of hazardous substances, lifting and handling of heavy equipment, operating machinery and electrical equipment, working near water or at height and more. Occupational Health and Safety (OHS) aspects will therefore need to be considered in all project activities in order to reduce the risk of accidents and illness.

Mitigation Measures: PMU, construction supervision consultant and contractors will have an OHS specialist in their respective teams to plan and execute OHS related issues and risks. Each contractor will establish a comprehensive OHS Plan aimed at preventing accidents, injuries and work-related diseases. This plan will be submitted to PMU and supervision consultant for review and approval before construction. Each contractor will also prepare an Emergency Response Plan defining procedures to be followed during any emergency. This plan will be submitted to PMU and supervision consultant for review and approval. The following measures will be taken by the contractor to minimize the OHS risks:

- All workers must be provided with and use appropriate personal protective equipment (PPE) such as safety boots, helmets, gloves, protective clothing, goggles, and ear protection. First aid must be provided and there would be procedures in place to access appropriate emergency facilities;
- Contractors will be responsible for developing procedures to address the OHS hazards. Signage related to hazards and risks must be in place at the work sites.
- Management procedures to address temperature stress, for instance in relation to extreme heat will be required;
- Health screening of employees would be a Contractor obligation prior to laborers working on site and living in the temporary accommodation facilities. The health screening would entail normal review of physical fitness and also include a review of appropriate vaccinations. Workers would be given vaccinations where required;
- All employees need to carry out induction health and safety training prior to commencement of work. OHS issues would be part of the employee training plan. Training would include the provision of appropriate written or visual materials to reinforce learning. Where illiteracy levels are high, OHS issues need to be covered more frequently than normal in toolbox talks;
- An emergency response team and plan must be identified. Training and drills based on the accident and emergency preparedness and response plan must be carried out quarterly. Training requirements, including for emergency preparedness, will need to be updated annually;
- It is essential that all personnel likely to be involved in the Project at the construction site undergo a basic training program prior to performing assigned work.
- Standard operation procedures for handling accidents related to electrocution, movement of plant equipment; falls from height, falling objects, working in confined spaces and dealing with hazardous materials

Some parts of the construction area will need extra attention from contactor and project management in view of the increased risk of accidents, unsafe working conditions and health risks. This is especially true for underground work in tunnels and caverns, but also during excavation and construction work. The contractor will follow closely the IFC Performance Standards on Labor and Working Conditions and IFC's EHS Guidelines. Special attention will be focused on safety training for workers to prevent and restrict accidents and the knowledge how to deal with emergencies.

7.5 IMPACTS DURING O&M STAGE[3]

7.5.1 Up-Stream Hydrology

7.5.1.1 Formation of Reservoir

The character of the river Indus and its valley bottom will change from a fast flowing uncontrolled sediment-laden river with steep rocky slopes into a narrow controlled water reservoir (average width 365m) and extending for about 73 km up stream at full supply level (FSL) of 950m. The reservoir profile behind the dam is shown Figure 7.3. In lateral valleys of tributaries the reservoir penetrates several kilometers inland (Table 7.22) and is expected to develop new natural hot-spots at the confluence of tributaries with Indus.

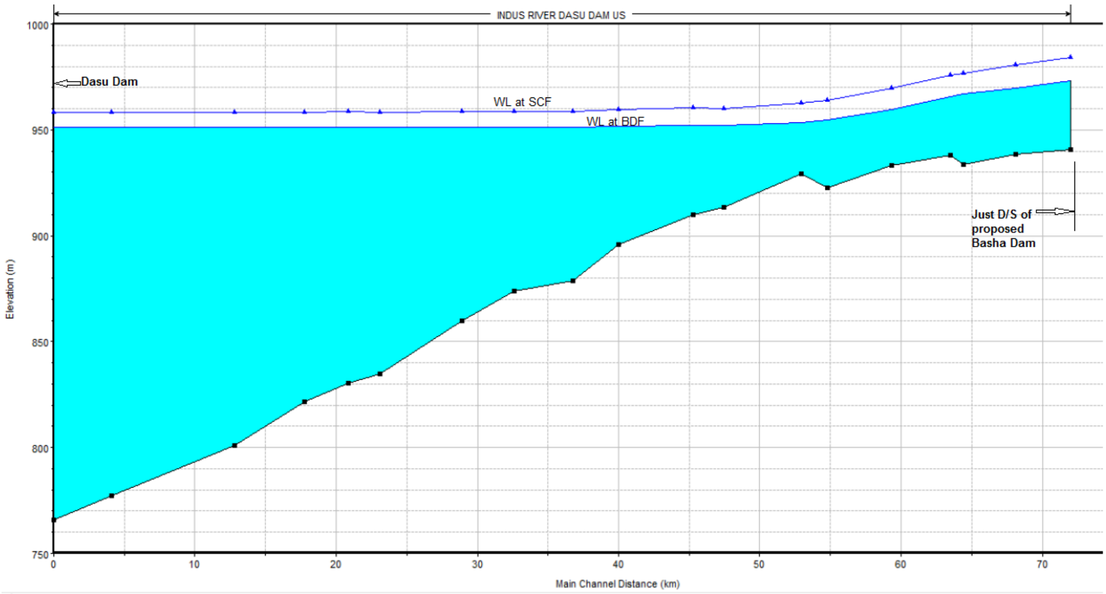
Table 7.22: Reservoir Penetration in to the Tributaries

Sr. No.	Name of Stream	Total Length of Tributary (from its source to Indus) (m)	Length of Tributary that will be submerged by DHP Reservoir (m)
Left Bank Tributaries			
1.	Ucchar	-	1534
2.	Barseen	2902	685
3.	Kaigah	13166	1265
4.	Chilasgah	-	555
5.	Lutar	8723	615
6.	Shori	-	757
7.	Summar	22640	584
8.	Shatial	7736	100
9.	Harban	-	355
Right Bank Tributaries			
1.	Duga	12993	1448
2.	Kandh	-	1050
3.	Kandia	84334	6083
4.	Uthar	-	768
5.	Shaku	-	430
6.	Obar gah	10763	2500
7.	Tanger	46798	995
8.	Darel	37585	464

Source: DHP Engineering Design, 2012

The surface area of the reservoir is very small (23.8 km^2) and storage volume is 1.41 BCM. Maximum depth of the reservoir at the dam site is 185m and the minimum depth at the head of the reservoir is about 10m. The inundated area of the reservoir at FSL 950 m is shown in Annex 3.1.

[3] Hydrological and other information (tables and figures) in this section is drawn from DHP detailed engineering designs and reports



Source: DHP Engineering Design, 2012

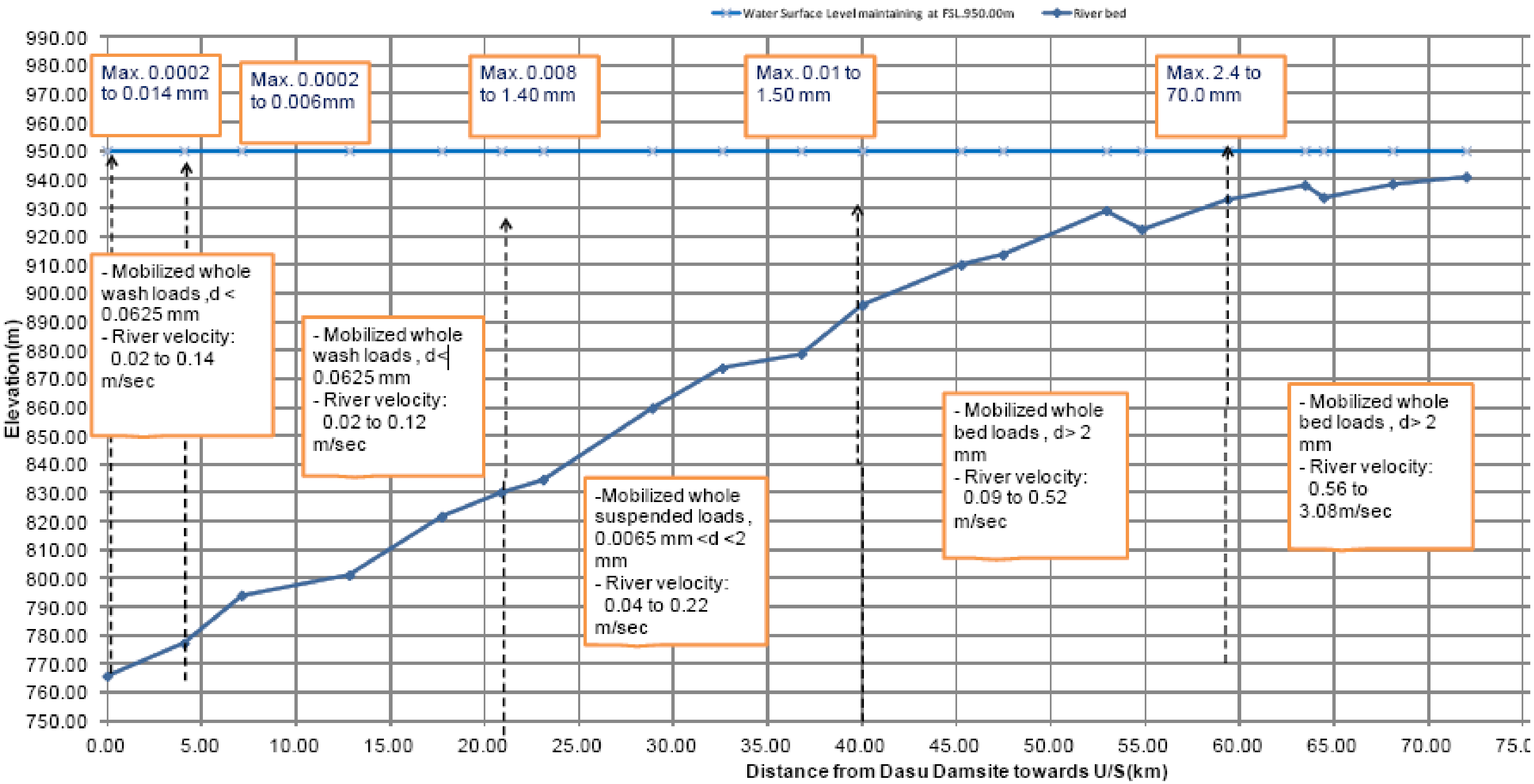
Figure 7.3: Reservoir Profile of DHP

Habitat conditions along the 73km length of the river at FSL will be characterized by a long transition along the former river gradient featuring river-like fast-moving water in the upstream end and deep slower moving water in the downstream end. Reservoir ecology will not be typical of a natural lake environment and will undergo rapid reduction in size caused by rapid sedimentation and changes associated with transition of reservoir operation from run-of-river to peaking (notably, drawdown during cycle of water storage and release for power generation). Relatively high water velocities and narrow width will maintain river-like features along much of the reservoir.

Water velocities along the length of the reservoir will generally be less than pre-reservoir river conditions. Although reservoir features will be lake-like surface water velocities will be high compared to most lakes and storage reservoirs (Figure 7.4). The relatively high water velocities suggest that conditions may be mainly compatible for riverine fish species, particularly along the reservoir shoreline. Water velocities along the length of the reservoir would be relatively high, ranging from 0.56 to 3.08 m/sec at the head of the reservoir and 0.02 to 0.14 m/sec at the dam.

Water velocities in deeper areas close to the dam will be mainly influenced by facility operation:

- 900-950m – relatively high water velocity; determined by intake/spillway use
- 875-900m – relatively high water velocity; determined by intake use
- 810-875m – relatively low water velocity except during periodic flushing; mainly stagnant water upstream - annual/periodic flushing will rejuvenate
- 724-810m – low water velocity; mainly stagnant water upstream

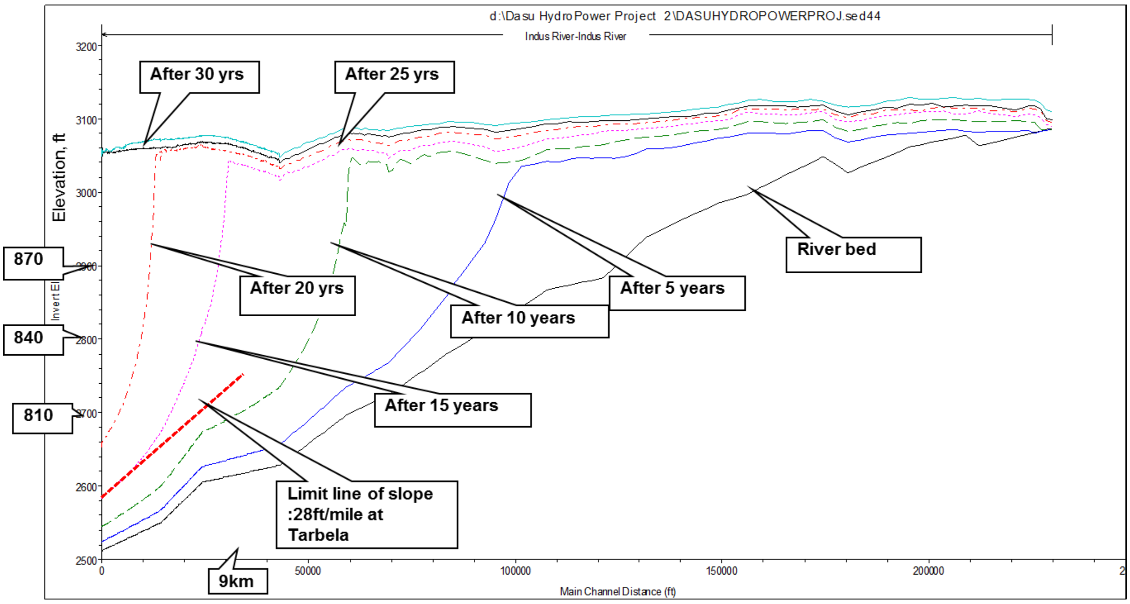


Source: DHP Engineering Design, 2012

Figure 7.4: Reservoir Velocities and Sedimentation (without flushing)

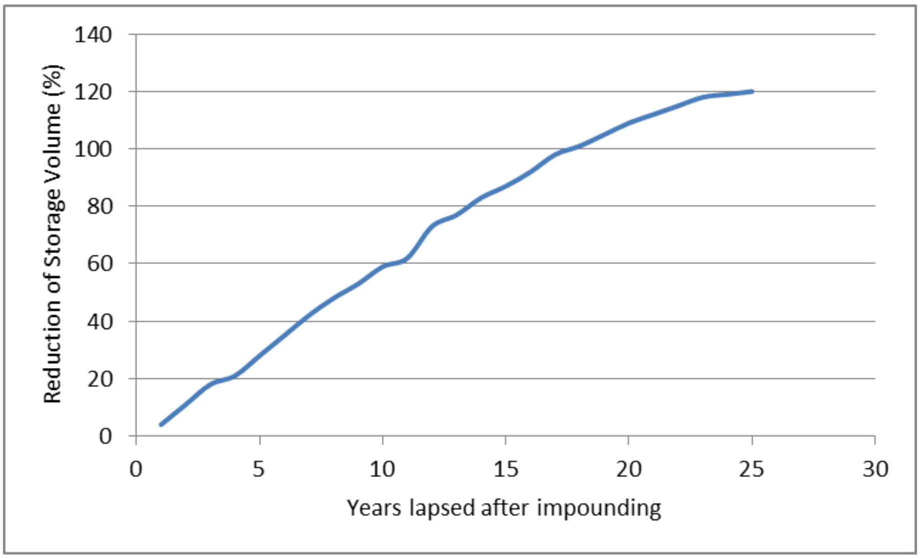
7.5.1.2 Sedimentation

Potential Effects: About 200 million tons of sediment passes every year at the DHP dam site. After construction of the dam, sedimentation process will commence whereby larger sediment fractions sequentially settle along the reservoir length. Hence there will be reduction of reservoir storage over the years due to sedimentation and it is expected that the inlets for LLO and power intake will be filled within 20 to 25 years if there will be no flushing of sediments. Longitudinal sediment profiles after every 5 years of impoundment are show in Figure 7.5. The sedimentation will occur in 73 Km length of the reservoir. Heavy bed load will settle near head reach and the finer material will settle in middle and lower reaches of the reservoir. Reduction of storage volume after dam construction is shown in the Figure 7.6.



Source: DHP Engineering Design, 2012

Figure 7.5: Sedimentation Profiles after every 5 years (without flushing)



Source: DHP Engineering Design, 2012

Figure 7.6: Reduction of Reservoir Storage after Impounding (without flushing)

Based on the engineering analysis carried out during detailed design, it was concluded that flushing of sediments will not be required until 15th year of operation. If Basha dam is constructed by that time, flushing operation is not required further 30 years since Basha dam with enough storage capacity would act as sediment trap. After construction of Basha dam, annual sedimentation inflow will be reduced to 46 million tons (which will also include sediment outflow from Basha dam).

Flushing operation will be carried out every year (either after 15 years or 45 years based on the Basha dam construction) for a period of one month. During flushing, the power generation will be stopped once the reservoir water level is reached MOL 900m. Hence annual generation will be reduced by about 4,800 GWh when there will be flushing after 45 years or by 2,900 GWh if the flushing starts after 15 years (Table 7.23).

Table 7.23: Annual Energy Generation with and without flushing

Lapsed periods evaluated for Sediment (years)	No. of units	Total installed Capacity (MW)	Total turbine discharge (m^3/sec)	Annual energy (GWh/yr) (with no flushing)	Annual energy (GWh/yr) (With Flushing)
5	3	1,081	667.5	8058	6,561
10	6	2,162	1,335.0	12,225	9,371
15	9	3,243	2,002.5	15,544	11,631
20	12	4,324	2,670.0	18,432	13,584

Source: DHP Engineering Design, 2012

Once the drawdown flushing is commenced, about 27% of annual sediment inflow would be trapped in the reservoir and about 73% would be flushed out through the LLO and the flushing tunnels.

Under the drawdown flushing, the maximum sediment particles mobilized at the damsite and flushed out are limited to 0.2 mm. Therefore, the sediment particles exceeding 0.2mm may not be transferred to downstream stretch. Due to decrease of supply of coarse particles exceeding 0.2 mm towards the downstream stretch in Indus may results in the degradation of downstream stretch in Indus.

Mitigation Measures: Sedimentation control is critical to improve the life of reservoir and increase of power generation. Sedimentation inflow to the damsite comes from its overall catchment in Indus Basin. Sedimentation inflow within the DHP reservoir area is negligible compared to overall inflow to the damsite. Hence sedimentation control measures are to be targeted for overall UIB. Integrated watershed management of UIB can be an option, but its feasibility to be assessed. Detailed studies are recommended for planning, design and implementation of integrated watershed management for control of erosion and sedimentation in the UIB.

7.5.1.3 Changes in Reservoir Water Quality

Potential Effects: Generally water quality in reservoirs will be deteriorated due to thermal stratification and depletion of dissolved oxygen at deeper levels. Average water retention time (residence time) in the reservoir is an important determinant of the extent of the change in water quality. Generally, long retention times in the reservoir will affect the reservoir water quality through changes in dissolved oxygen, eutrophication and thermal stratification. Average water retention time in Dasu reservoir found to be very short varying from 1 to 6 days during high flow season, and about 19 days during low flow season. The impacts on water quality are estimated to be minor due to these short retention times.

Mitigation Measures: Temperature and oxygen sensors will be used for continuous monitoring of their levels in the reservoir near the dam. If low oxygen conditions are evident during monitoring prior to flushing, a lead-in period may be required whereby the lower-level outlets are used to draw out low oxygen-concentration lower-elevation water in combination with spillway releases to provide adequate oxygen concentrations in water downstream of the plunge pool.

7.5.2 Downstream Hydrology

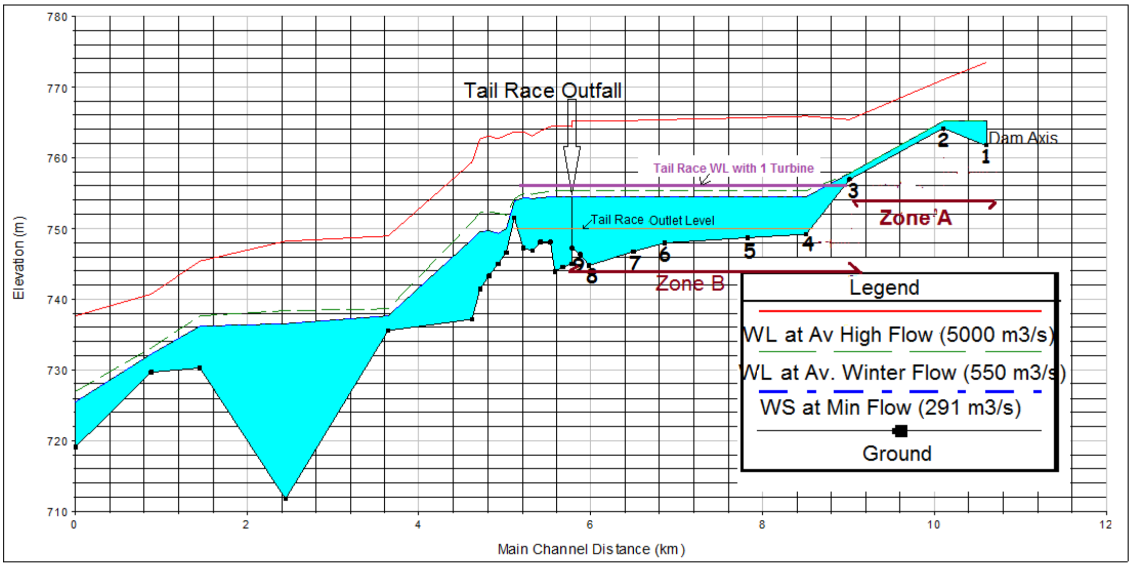
7.5.2.1 Reduced Flows between Damsite and Tailrace Outlet during Low Flow Season

Potential Effects: The river reach between dam-axis to tailrace discharge point is about 4.8 km long. During June to September, when the average river flow is higher than 2600 m^3/s, the excess water will be discharged through the spillways/LLOs. However, during October to May, when the average flow is less than 2,600 m^3/s, there will be no water released downstream of the dam and all the water will be diverted to the power house and will be released to the river through tailrace outlet (or will be stored for some hours during peaking operations in Stage 2). A small tributary, Siglo stream joins the Indus in this reach (about 1.2 km downstream of dam). The average annual runoff from Sieglo stream is 1.7 m^3/s with average runoffs less than 0.5 m^3/s during low flow season, which indicates most part of this section will be dry during low flow season.

The aerial view of 4.8 km section[4] between dam axis and tailrace is shown in Figure 3.3. Nearly 0.4km of this section covers the dam structure and plunge pool. Thus the distance between the plunge pool to tailrace is 4.4km.

The river profile on the downstream of the damsite is presented Figure 7.7. The figure also shows the river water levels for lowest recorded flows (291 m^3/s), average winter flows (550 m^3/s) and high flows (5,000 m^3/s). The river between damsite and tailrace is divided in to 10 cross sections. The river profile can be divided in to two zones based on the extent of backwater flows from tailrace: 1.2 km long Zone A, from cross sections 1 to 3 (excluding 0.4 km dam structure and plunge pool), which is located at an elevation above tailrace level (750m); and 3.2 km long Zone B, from cross sections 3 to 10, which is located at an elevation below tailrace water level.

Thus, out of 4.4 km section between plunge pool and tail race, the 3.2 km section (Zone B) upstream of tailrace will receive water from backwater flows of tailrace and the rest 1.2 km (Zone A) will be dry during low flow season.



Source: River bed profile was drawn based sonic survey data by the DHC.

[4] Nearly 750m of this section (between two coffer dams) was also dry during dam construction period of 6 years.

Figure 7.7: River Profile on the Downstream of Damsite and River Water Level

To compensate the reduced river flow between dam and tailrace, a certain quantity of environmental flows will be released from damsite during low flow season. Environmental flows are the water that is left in a river ecosystem, or released into it, for the specific purpose of managing the condition of that ecosystem (World Bank. 2003). Generally requirements of environmental flows are assessed based on the impact of specific ecosystem component as shown in Table 7.24(World Bank 2003). The ecosystem components that will be affected between dam and tailrace of DHP are also given in the last column of the Table 7.24. The riverine ecosystem component that will be affected between 4.4 km plunge pool and tailrace are aquatic ecosystem and aesthetics.

Table 7.24: Riverine Ecosystem Affected Between Dam and Tailrace, and Requirement of Environmental Flows for DHP

Ecosystem	Explanation of value	Examples of environmental flows required	Applicability to DHP
Aquatic animals	Freshwater fish are a valuable source of protein for rural people. Other valued fauna include: angling fish, rare water birds, or the small aquatic life that forms the base of the food chain.	• flows to maintain the physical habitat; • flows to maintain suitable water quality; • flows to allow passage for migratory fish; • small floods to trigger life-cycle cues such as spawning or egg-laying.	Yes
Riparian vegetation	Stabilizes river banks, provides food and firewood for rural people and habitat for animals, and buffers the river against nutrient and sediment losses from human activities in the catchment.	• flows that maintain soil-moisture levels in the banks; • high flows to deposit nutrients on the banks and distribute seeds.	No
River sand	Used for building.	• flows to transport sand and to separate it from finer particles.	No
Estuaries	Provide nursery areas for marine fish.	• flows that maintain the required salt/ freshwater balance and ocean connection to estuary.	No
Aquifers and groundwater	Maintain the perennial nature of rivers acting as sources of water during the dry season.	• flows to recharge the aquifers.	No
Floodplains	Support fisheries and flood-recession agriculture for rural people.	• floods that inundate the floodplain at the appropriate time of the year.	No
Aesthetics	The sound of water running over rocks, the smells and sights of a river with trees, birds, and fish.	• sufficient flow to maximize natural aesthetic features, including many of the flows mentioned above.	Yes
Recreational and cultural features	Clean water and rapids for river rafting or clean pools for baptism ceremonies or bathing. Also features valued by anglers, birdwatchers, and photographers.	• flows that flush sediments and algae, and that maintain water quality – see also aquatic animals.	No
Ecosystem services	Maintain the capacity of aquatic ecosystems to regulate essential ecological processes, for instance to purify water, attenuate floods, or control	• flows that maintain biodiversity and ecosystem functioning.	Yes

Ecosystem	Explanation of value	Examples of environmental flows required	Applicability to DHP
	pests.		
Overall environmental protection	A wish to minimize human impacts and conserve natural systems for future generations.	• some or all of the above types of flows.	Yes
Irrigation and Drinking	Dependence of local community on drinking and irrigation needs	• flows to maintain drinking and irrigation requirements	No

Source: Modified from World Bank, 2003

Mitigation Measures: 20 m^3/s is recommended to be released from dam as environmental flow in line with other hydropower projects in Indus[5]. In addition it is recommended to always operate one turbine and release 222.5 m^3/s of water from tailrace. Thus Zone A will receive 20 m^3/s of environmental flow and Zone B receives about 242 m^3/s of environmental flow. These amounts can be adjusted when results of further aquatic studies are available. Attempts have also been made to calculate the environmental flows using prescriptive approaches such as hydrological index (Montana Method) and hydraulic rating methods, however these values are not considered due to their low confidence levels (World Bank 2003)[6].

Summary of expected hydrological characteristics between dam and tailrace for proposed environmental flows of 20 m^3/s from dam and 222.5 m^3/s from tail race (post-dam scenario) are presented in Table 7.25. The hydrological characteristics for average low season flow of 550 m^3/s are also given in this table. The release of environmental flows in Zone A represents 4% of average winter flows, 20 to 25% of average winter depth, 34 to 45% average winter wetted perimeter, and 34 to 45% of average winter velocities. While in Zone B, the release of environmental flows represents 44% of average winter flows, 67 to 97% of average winter depth, 72 to 95% average winter wetted perimeter, and 40 to 60% of average winter velocities.

Table 7.25: Hydrological Characteristics Between Dam and Tailrace for Average Winter Flows and Recommended Environmental Flows

Cross section Number	Distance from Dam, m	Pre-Dam Scenario for an average winter flow of 550 m^3/s				Post-Dam Scenario with 20 m^3/s from dam and backwater from tailrace (with one turbine flow of 222 m^3/s)				Remarks
		River width (m)	Average water depth (m)	Wetted Perimeter (m)	Velocity (m/s)	River width (m)	Average water depth (m)	Wetted Perimeter (m)	Velocity (m/s)	
1 (Dam axis)	0	68.84								This section mostly consists of dam structure and plunge pool (412m)
2	508	73.31	2.59	75.37	2.9	34.01	0.59	34.41	0.99	
3	1,598	50.67	2.29	51.37	4.75	20.37	0.46	20.49	2.14	No backwater flows from tail race.
4	2,107	93.94	4.84	100.74	1.21	76.07	3.25	79.71	0.8	Includes baclwater flows from tailrace
5	2,780	57.24	4.76	63.16	2.02	48.14	3.27	51.21	1.2	*do.*
6	3,750	69.74	4.77	74.79	1.65	65.9	3.69	69.54	0.8	*do.*
7	4,120	78.44	5.04	84.59	1.39	64.08	4.91	68.83	0.6	*do.*
8	4,633	85.66	5.3	95.54	1.21	79.42	4.74	86.42	0.5	*do.*
9	4,733	68.98	6.11	73.5	1.3	66.59	5.36	69.93	0.6	*do.*
10 (Tailrace)	4,833	96.62	5.1	100.59	1.12	97.02	5.15	94.72	0.5	*do.*

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[5] Environmental flows recommended/released in other hydropower projects in Indus are given below

No	Project	Average annual flow (m^3/s)	Lowest flow (m^3/s)	Length of Dry Riverbed, (Km)	Environmental Flow (m^3/s)	Remarks
1	Bunji	1796	210	7	21	Designs are ready – Construction is yet to be started
2	Basha	2005	273	1	0	*do.*
3	Tarbela/ Ghazi Barotha	2502	368	54	28	Based on 5 year monitoring by WEC, (WEC 2009), these flows are found to be sufficient

[6] According to Montana (or Tenant, 1976), instantaneous flows should not go below 212 m^3/s (10% of mean annual flow) to prevent severe degradation. See Vol. 4 Aquatic Ecology for details.

7.5.2.2 Reduced Flows on Downstream of Tailrace during Low Flow Season of Peaking Operations

Potential Effects: Operation of DHP as a run-of-river facility will mean no change in hydrology downstream of the tailrace discharge point during low flow season. During storage/peaking operations (in Stage 2), potentially there could be periods of no inflow to this segment of the river during the low flow season which would eliminate productive capability of the associated habitat, followed by a pulse of water that is directed through the powerhouse and eventually enters the river at the tailrace outlets.

Mitigation Measures: During peaking operation of the plant, it is recommended to operate at least one turbine and the additional flows can be used for peaking operation. Operation of 1 turbine will release 222.5 m^3/s and the total flow at tailrace, including environmental flow 20 m^3/s, will be equal to 242.5 m^3/s. This amount will be equal to just above 10% of the average annual flow and 44% of average winter flow. This amount can be adjusted based on the monitoring of impacts on aquatic ecology.

7.5.2.3 Tail Race Flow Surges

Peaking will cause daily fluctuations in flow and water levels in the downstream of tailrace discharge point. The magnitude of water level fluctuation will vary along the river, depending on the river cross section on downstream. In addition, the daily water level variations depend on the number of turbines work on that day. Just at the tailrace discharge point, the water level will change quite suddenly after a start or stop of the turbine.

If the power generation from 1 turbine is increased to 3 turbines, the water level at tailrace (TWL) will be changed from 756.41 m (at Q = 222.5 m^3/s) to 759.24 (at Q = 667.5 m^3/s) with a rise of 2.83m. During power generation with 12 units (phase 4), the rise of water level will be 6.42m from 756.41m to 762.831m (at Q = 2670 m^3/s). However, instantaneous power operation with 12 units are not practical due to constrained load control with the power grid line connected to other power plants in the country.

The time travels in power operation sequence between current and next unit are required for 5 minutes in minimum. The operation time for 3 units will take 15 minutes, the rising rate of TWL would be 0.8 m/minute. Therefore it is judged that, sudden surge wave may not occur at downstream of tailrace outlet.

In case of one turbine operation (225 m^3/s), the TWL is 756.41m. However, load increase operation from 0 to 222.5 will take 5 minutes. The lag time between the turbine and tailrace outlet (2 km) will take 18 minutes (velocity is 1.84 m/sec). Total time to operate first turbine up to tailrace requires minimum 23 minutes. Therefore the rising rate at tailrace outfall is 0.27m/minute. The water level for half unit operation is 0.12m/min. The water level fluctuations will continue further downstream for long distance. However, the fluctuations become smaller and smaller when the major tributaries join the Indus. Repeated daily surges will affect the aquatic ecology (discussed in Section 7.5.3.2 (4)).

Mitigation Measures: Mitigation measures to address the impacts on aquatic ecology are discussed in Section 7.5.3.2 (4). Additional measures during peaking operation are: an operational protocol to be designed to soften the rapid water level and flow variations due to peaking and thereby reduce the downstream impact, a fixed start and stop procedure shall be implemented. This will include: (i) each turbine goes from zero to full level in two or three equal steps separated in time by a few minutes. When a second turbine is started, the same procedure will be followed for each turbine in order. The same procedure will be followed when reducing the load. The start and stop procedure can be further adjusted with the monitoring results. The start and stop procedures will be proceeded by warning signs (Section 7.6.5).

7.5.2.4 Impact on Downstream Flows during First Filling and Flushing Operations

The first filling of the reservoir is expected to start mid- June and about 1.4 BCM water will be stored in the reservoir. This will be roughly equivalent to stopping of about 2% of annual flow at Dasu dam site. Since the reservoir filling is taking place in high flow season, the 2% reduction in water flows is not expected to affect the downstream water flows and irrigation requirement. The storage volume of the reservoir from FSL to LLO is 1.3 BCM (1.9% of total flow at Dasu), which will be released during flushing operations and will be refilled after flushing. Since both flushing and re-filling operations are expected to take place in high flow season, no impacts are expected on the downstream.

7.5.3 Aquatic Ecology

7.5.3.1 Impacts on Aquatic Ecology on Upstream of Damsite

(1) Upstream Ecosystem and Fisheries

Habitat upstream of the dam will be changed from current riverine habitat to lake-like habitat commencing with first-filling of the reservoir once dam construction has been completed. Physical, chemical and biological conditions along the Indus River will be altered from current conditions, though river-like attributes, notably high water velocity in upstream segments of the reservoir, will be retained. Habitat in lower portions of tributaries will be submerged and replaced in some locations by small embayments. Overall reservoir habitat, including newly formed embayments in tributary valleys, will rapidly be reduced due to sedimentation. The spawning habitats located in the tributaries will be affected by the submergence under reservoir.

The loss of the upstream habitat will be compensated by fisheries program, which will include hatchery development with native cold water fish species (snow carps) and stocking of fingerlings in the Indus and tributaries. A single facility could be used to produce juveniles for stocking streams for which spawning populations have been affected by the project (for example using upstream-migrant broodstock captured downstream of the dam to maintain biodiversity characteristics), and additional fish for reservoir-stocking or to supply local grow-out facilities. The facility would require a research and development component to improve local methods and capacity for snow trout hatchery production. Snow carps hatcheries were established in Uttaranchal, India (Garhwal Himalaya) and Nepal (Kali Gandaki A, Plkhra, Trishuli and Godavari). Experience from these hatcheries are to be considered during the R&D program. Spawning areas will be maintained in the tributaries by construction of gravel of beds and ripples.

(2) First Filling of the Reservoir

Habitat upstream of the dam along the Indus River will be changed from current riverine habitat to lake-like habitat over the planned two-month period for first-filling of the reservoir. The reservoir will reach a maximum depth of approximately 185m (the deepest part of the reservoir will be adjacent to the dam). As physical changes take place chemical and biological conditions also will be altered. With reduced water velocities as water depth increases, a sedimentation process will commence whereby larger sediment fractions will sequentially settle along the reservoir length.

No mitigation measures are proposed for the reservoir during first-filling beyond those outlined below for the reservoir routine operations and flushing events.

(3) Periodic Flushing of Sediment

During flushing, water level in the reservoir will drop to an elevation of 842m, approximately 108m below FSL (950 m). Water depth close to the dam will reduce to approximately 78m, meaning the reservoir will extend approximately 7 km upstream from the dam (Figure 7.6), a reduction of 2-3 km from the 9-10km at FSL estimated to exist at year 15. Fish in the reservoir will be compressed into a greatly reduced volume and those reliant on benthic organisms, especially periphyton, for food will find very little to feed upon because benthic production below the productive littoral zone (likely extending to depths of only several meters given the relatively turbid conditions expected in the reservoir) will be poor. The perimeter/shoreline length for fish feeding will be reduced. A substantial number of fish likely would be entrained into the outlet structures and deposited downstream. The number of fish remaining in the reservoir after completion of flushing and reservoir refilling would be lower than before flushing; condition of many remaining fish likely would be poor.

These factors will tend to limit potential for fish production in the reservoir and viability of a reservoir fishery when annual flushing takes place. Water velocities will be relatively high during flushing especially when water elevation reaches minimum levels; safety distances will be needed to keep fishermen at safe distances from the dam spillway and powerhouse intakes.

Mitigation measures include providing fish deterrent devices or screening at the lower level outlet to prevent fish entrainment in combination with fisheries management protocols to minimize fish numbers vulnerable to the effects of extreme drawdown that will occur during each flushing event.

(4) Fish Stranding and Mortality during Reservoir Flushing

Drawdown for flushing sediment from the reservoir will be kept to a rate (3m/day) meant to minimize risk of landslides; the drawdown rate likely will be adequate to prevent excessive stranding and mortality of species in the reservoir. Taxa such as snow carps are benthic feeders with physical adaptations designed for adherence to benthic substrates such as cobbles. They may not respond quickly to a rapid drop in water level and could be vulnerable to stranding.

In the absence of species- and site-specific information a drawdown maximum rate of 5-10cm/hr is recommended until further data are available to minimize stranding. Site-specific ramp-down criteria are often developed for fish downstream from hydropower projects elsewhere and are recommended for DHP. Results of recommended studies (Volume 4: Aquatic Ecology) could be used to develop guidelines and monitoring protocols for drawdown during reservoir-flushing and refine expectations for success of a reservoir fishery.

(5) Upstream Movement of Fish

Fish movement at the damsite is low or negligible. Further studies are recommended to identify fish movement patterns. If upstream movement along Indus is identified, exclusion screens or installation of fish deterrent devices may be required at the tailrace outlet to prevent mortality of adults attempting to enter the tailrace and eventually dying as they succumb to exhaustion.

(6) Reservoir Fishery Development

The slower moving water of the reservoir that will be formed by the dam offers potential for development of a reservoir fishery, though relatively fast water velocities will continue to prevail in the upstream portion of the reservoir particularly during the high flow season and sedimentation will rapidly decrease the reservoir size. Reservoir fishery development can be a potential mitigation measure for the loss of fish and also can be an enhancement measure for fish production beyond that needed to ensure replacement of losses attributed to the reservoir. A reservoir fishery management program is recommended with necessary infrastructure facilities. However, current biological knowledge of endemic/indigenous species regarding habitat use and their artificial propagation is weak and require further studies and a research and development phase to develop and achieve reliable production targets (Section 5 of

Vol. 4 Aquatic Ecology). The reservoir fishery planning shall consider reservoir sedimentation and prohibition zones for fishing due to security concerns (for Tarbela reservoir - fishing is prohibited from 5 km upstream to 3 km downstream of the dam). The planning shall also consider reservoir operations such as sediment flushing and peaking. However, the historical data on fish production from Tarbela reservoir (which is approximately ten times bigger than the Dasu reservoir in terms of surface area) is not encouraging (Table 4.24). The annual fish production from Tarbela reservoir during 2009-2010 was 67 metric tons and the revenue generated from fisheries was PKR 0.5 million (Tarbela 4 EIA, 2011).

7.5.3.2 Downstream of Damsite

(1) <u>Impact Downstream Ecosystem and Fisheries</u>

The ecosystem downstream of the dam will be affected by changes in flow, sediment quantities and water chemistry. During Stage 1 run-of-river operation, habitat potentially will be adversely affected by: greatly reduced flows during first filling; between the dam and tailrace-outlets during routine operation; and, during reservoir refill after flushing. Flows and ecological conditions downstream of the tailrace outlet are not expected to be altered during Stage 1 routine operation. From the dam to tailrace outlet, water will at times be very turbulent in and near the plunge pool and will not be suitable for fish and other biota. From the plunge pool to tailrace outlet, conditions will be similar to existing habitat conditions; at times lower water volumes will provide more favourable conditions for fish and other in-stream biota and likely seasonal intrusion will take place by taxa capable of moving into or using low-energy micro-habitat in the otherwise fast-flowing/turbulent conditions.

During Stage 2 peaking operation, in-stream ecological conditions potentially will be affected downstream of both the dam and tailrace outlet by daily flow reduction in winter during the storage cycle, with effects extending as far as Tarbela Reservoir; without mitigation, cessation of flow would have significant adverse effects on the downstream ecosystem.

It is difficult to estimate the reduction in fish yield. Further studies will show appropriate mitigation measures if the study shows a significant lower in the fish yield. Minimum flows to mitigate effects on ecological features and functions and ramp-rates to minimize fish mortality from stranding have been recommended for flow-change activities.

Changes in downstream sediment quantities are not expected to negatively affect downstream aquatic resources and may favor species that will benefit from reduced amounts of sand and gravel in seasonal deposition and scouring cycles. Changes in temperature, oxygen and total gas pressure may occur short distances downstream of the dam but are not expected to have significant adverse effects. A downstream environmental effects monitoring program will be put in place to enable assessment of changes in ecological components.

(2) <u>Downstream Movement of Fish</u>

Fish that move downstream (possibly when summer high flows begin to decrease after summer and during the low-flow period) or remain in the reservoir but wander close to water release structures may be entrained in the following dam outlet structures:

- Spillway – especially during the high flow season
- Powerhouse Intakes
- Lower Level Outlets during reservoir flushing

If justified by findings of recommended studies, entrainment screens could be emplaced at the spillway, powerhouse intakes and low level outlets to prevent entrainment of fish into those structures. In addition, juveniles of migrant broodstock maintained in the compensation hatchery could be released downstream of the dam to augment recruitment to overwintering migrant populations.

(3) Downstream Flows during ROR Operation

Dam to Powerhouse Tailrace Outlet: This segment of the river, at least downstream from the plunge pool, possibly will be used as an overwintering refuge by fish that spawn and rear in Seglo Creek. Habitat use would be limited to individual fish and other taxa potentially using Seglo Creek or downstream tributaries.

Potential effects during high flow and low flow seasons are:

- *High Flow Season:* Relatively large water volumes will pass over the spillway during the summer high flow season. Flow and habitat conditions downstream of the plunge pool at that time would be similar to existing conditions. The plunge pool will receive water directly from the spillway – highly turbulent conditions will occur during high flows and habitat will be largely unsuitable for fish and other in-stream biota. The plunge pool essentially would be an exclusion zone for fish and fisheries, with habitat potentially useable by fish from downstream end of plunge pool to tailrace outlet.

  Fish access to Seglo creek could be impaired by turbulence immediately downstream of the plunge pool.

  High discharge from the lower level outlets when the reservoir is periodically flushed to remove sediment is expected to create very turbulent conditions along this stream segment. Habitat conditions would be poor at that time with mobile biota likely displaced downstream during initial stages of water release.

- *Low Flow Season:* Potentially there could be periods of no inflow to this segment of the river during the low flow season (e.g., if all flow passes through the powerhouse) which would eliminate productive capability of the associated habitat.

Downstream Powerhouse Tailrace Outlet: Downstream effects on aquatic resources and fishing activity are not expected to be large during Stage 1 (run-of-river) routine operation and may not be measurable/detectable. Run-of-river powerhouse release-flows will reflect natural flow conditions during regular operation (combined powerhouse and spillway flows will meet at the tailrace outlet).

Mitigation: Environmental flows are recommended to compensate the reduced flows between dam and tailrace (see Section 7.5.2.1). Two approaches were followed in developing environmental flows – one on the experience of Ghazi Barotha hydropower project located on Indus on the downstream of Tarbela and other on meeting requirement of aquatic habitat. Ghazi Barotha has a 54 km of dewatered section between barrage and tailrace and it is being compensated by 28 m^3/s, which is found to be adequate through a 5-year monitoring program by WAPDA Environmental Cell. In DHP, an environmental flow of 20 m^3/sec from the dam and 222 m^3/sec from the tailrace is recommended. These environmental flows will maintain a depth of 0.5 m and velocity of 2 m/s at Seiglo confluence which is adequate to maintain winter habitat of snow carps. On average, the recommended environmental flows (242 m^3/s) in most of the dewatered section will represents 44 percent of average winter flows and 72 to 95 percent average winter wetted perimeter. A downstream environmental effects monitoring program will be put in place to enable assessment of changes in ecological components and adjust the environmental flows if required

(4) Downstream Flows During Peaking Operation

Potential Effects: When the Dasu powerhouse begins functioning as a peaking facility, the daily operation cycle potentially would adversely affect the downstream ecosystem.

Dam to Powerhouse Tailrace Outlet*:* Potential seasonal effects on aquatic resources are:

- *High Flow Season:* Effects on aquatic ecology and fish in the dam-to tailrace-outlet segment of the river during Stage 2 will be similar to conditions during Stage 1, though there will be potential for diversion of substantially more flow from the spillway to the powerhouse (more turbines in place). During periods of relatively low natural river flow, especially near the beginning and end of the summer high-flow period, full use of the powerhouse capacity potentially could eliminate flows over the spillway and impair amount and function of aquatic habitat in this stream segment.
- *Low Flow Season:* Again, similar to Stage 1, potentially there could be periods of no inflow to this segment of the river during the low flow season if all flow is directed to the powerhouse which would eliminate productive capability along the associated river-length.

From Powerhouse Tailrace Outlet to Tarbela Reservoir*:* Potential effects on aquatic resources and fishing activity during peaking operations could extend downstream for a substantial distance; currently, it appears doubtful that potential effects would extend to the south end of Tarbela Reservoir (approximately 200km downstream) where the commercial fishery is located. The effects will be minimized when the major tributaries such as Jalkot and Goshali join the Indus on the downstream, Potential seasonal effects are:

- *High Flow Season - May to September:* As with Stage 1, water flows downstream will be the same as those that would occur in the absence of the hydropower project and fish and other organisms should not be affected by flows from the project.
- *Low Flow Season – October to April:* Potentially there could be periods of no inflow to this segment of the river during the low flow season which would eliminate productive capability of the associated habitat, followed by a pulse of water that is directed through the powerhouse and eventually enters the river at the tailrace outlets (described below).

Mitigation: In addition to minimum flow identified for the river segment between the dam and tailrace outlets for Stage 1, measures will be needed for Stage 2 to minimize effects on downstream habitat and biota when flow is reduced downstream during the low flow season. It is recommended to operate at least one turbine and use additional water for peaking operation. This will ensure release of 222.5 m^3/s from tailrace. This will ensure 44% of average winter monthly flows. Release of 44% of average monthly flows generally exceed the standards set by other hydropower projects in the region. For example, WWF India (Assessment of Environmental Flows for the Upper Ganga Basin, 2012) recommended 44% of mean annual runoff for protection of snow carps (which will be about 200 m^3/s at Dasu; and Wildlife Institute of India recommends 20% for Alaknanda and Bhagirathi Basins, Uttarakhand. Downstream monitoring will be carried out during operation phase and the environmental flows can be increased if required

(5) Fish Stranding/Mortality during Flow Shut-off

High mortality of fish from stranding can occur during rapid ramp down of flows downstream from reservoirs. When DHP flows are reduced after the approximate 4-5 hour energy-generation window, there will be potential for fish to be stranded as the downstream shoreline water level recedes when flow is halted.

The distance downstream that peaking flows would be detectable is not known; flows likely would be attenuated to negligible at some point before reaching the southern end of Tarbela Reservoir. A small daily drawdown in the upper end of Tarbela reservoir may take place potentially leading to reduced biological productivity.

Ramping Rates: Flow-reduction rates to protect aquatic biota from stranding and mortality downstream from hydropower facilities have been developed in a number of jurisdictions usually based on detailed background knowledge on the biology of target species and site-specific requirements. Such background information is not available for the species known to occur in the project area-of-influence. The period of greatest vulnerability is likely the winter period.

Ramp-down may be possible in finer increments using turbine intake and release water. If the high release flows are moderated by improved ramp-up protocols then stranding can be addressed through improvement of ramp-down procedures.

(6) Flows during Reservoir Flushing

Potential Effects: The reservoir will be periodically flushed after 15 years (or 45 years) of reservoir operation by releasing water through the lower level outlets. Flow-volumes released during reservoir flushing are not likely to have a sustained negative effect on the downstream ecosystem if peak flows occur within the normal period of seasonal high flows. Relatively high volume discharges are planned for release over approximately one month during early summer. Maximum capacity of the low-level outlets is 10,300 m^3/s; lower discharge amounts may be required to maintain the reservoir drawdown rate within safe limits to prevent landslide events along the reservoir slopes. The potential maximum volume is higher than normal flows over the early summer season and could adversely affect downstream ecological conditions.

High discharge during flushing is expected to create turbulent habitat conditions downstream of the dam though should be similar to conditions that prevail during natural high flow events. Close to the dam habitat conditions would be relatively poor with mobile biota likely displaced downstream during initial stages of water release. There is risk of high mortality of fish resulting from stranding when outlet discharge is reduced in order to fill the reservoir.

Mitigation: Flushing events should not occur earlier than the planned early summer period to prevent possible adverse effects outside the intended timing window especially during the winter low-flow period. Release flows during flushing should be within limits of historical flows for the season over which flows will be released (currently planned for mid-May to mid-June).

A ramp-down rate of 5-10cm/hr, measured at either Tailrace Outlet or Dasu Bridge, is recommended provisionally, and can be refined using recommended project-specific stranding/vulnerability studies (Section 5 of Vol. 4: Aquatic Ecology).

Upon completion of flushing during reservoir refill, relatively high release-flows should be adopted to reflect the naturally high minimum flows that occur at that time, if such flows are lower than flows to be released to meet dam safety protocols (to minimize reservoir landslide risks).

(7) Total Gas Pressure

Potential Effects: Total gas pressure values in the plunge pool and locations further downstream likely would be increased as oxygen and other gases are entrained in water that passes over the spillways and are forced under pressure into plunge-pool water. Spilled water will not enter the plunge pool directly; water will be deflected upwards by the spillway buckets and will enter the plunge-pool at an oblique angle. Entrained gases could reach supersaturation levels in the plunge-pool and for a distance downstream, creating risk of gas bubble disease and subsequent mortality in fish. The oblique angle of spill water entry to the plunge-pool and high turbulence in the plunge-pool likely will limit the amount of excess saturation passing downstream. For high dam hydropower projects, elevated levels of gas pressure occur up to 3 to 4 km downstream of the dam. Since these levels occur only during high flow season, when the fish in the Indus is low, no adverse impacts on the fish are expected.

Mitigation: Mitigation measures are not proposed. Environmental effects monitoring during DHP operations phase should include downstream dissolved oxygen measurements during key DHP activities, in particular spillway use, for which altered downstream oxygen levels are most likely.

7.5.4 Risk of Bird Collisions Electrocution

The Indus valley is a major fly-way for bird migration. Huge flocks of migrating birds follow the Indus valley fly-way twice a year in autumn and in spring passing the narrow Indus valley. Especially for birds with a large wingspan such as storks, cranes, herons and birds of prey there is a risk of bird collision with transmission cables. Fatal collisions occur mostly with cables hanging perpendicular to the flight direction.

Power line structures provide perching, roosting, and nesting substrates for some avian species especially for birds of prey. In open habitats where few natural perches exist, such as agricultural fields and pastures, raptors are attracted to power poles, which provide roosting and nesting sites as well as hunting perches. “Still hunting” from a perch is energy efficient for a bird, provided that good prey habitat is within view. Some structures are preferred by birds because they provide considerable elevation above the surrounding terrain, thereby offering a wide field of view.

The large wingspans of raptors enable them to simultaneously touch energized and/or grounded parts, potentially resulting in electrocution. Although raptors are most often considered when addressing electrocution risk, other birds such as crows, ravens, magpies, small flocking birds and wading birds can also be electrocuted. Closely-spaced exposed equipment, such as jumper wires on transformers, can pose an electrocution risk to small birds.

The electrical design factor most crucial to avian electrocutions is the physical separation between energized and/or grounded structures, conductors, hardware, or equipment that can be bridged by birds to complete a circuit. As a general rule, electrocution can occur on structures with the following:

- Phase conductors separated by less than the wrist-to-wrist or head-to-toe (flesh-to-flesh) distance of a bird. The wrist is the joint toward the middle of the leading edge of a bird’s wing. The skin covering the wrist is the outermost fleshy part on the wing.
- Distance between grounded hardware (e.g., grounded wires, metal braces) and any energized phase conductor that is less than the wrist-to-wrist or head-to-toe (flesh-to-flesh) distance of a bird.

Mitigation to prevent or reduce the number of bird fatalities is possible by maintaining a minimum distance of 1.5 meters between the energized parts of the transmission line and attaching visibility enhancement objects such as marker balls, bird deterrents, or diverters.

It is a general international practice, that in areas with known populations of raptors or other birds of concern, new lines should be designed with adequate separations for birds’ wingspan and height. In addition to the physical separation of the conductors, the exposed coverings and parts of the structure should be insulated.

7.6 POTENTIAL RISKS

7.6.1 Reservoir Induced Landslides

The reservoir area is prone to active geomorphological processes such as landslide, slope failure and surface erosion. Abundant distribution of rockslide materials and colluvial deposits along the existing KKH road indicates that the reservoir slopes are the sites of numerous rockslides and rock slope failures.

In addition, the impoundment and operation of a reservoir, especially rapid drawdown of reservoir water level would lead to largely reduced stability of potential landslides as a result of excess pore water pressure formation and toe erosion.

Therefore, reservoir slope instability or reservoir landslide is a critical geotechnical concern in this project. The main problems associated with landslide into the reservoir include:

- Direct damage to dam body and related facilities,
- Overtopping by landslide impulse waves with damage to dam body and its downstream,
- River channel blockage by landslide materials and subsequent landslide dam-break flooding,
- Reduction of reservoir capacity by landslide materials, and
- Adverse environmental impact and land loss by large-scale landslides and their regressive slope instabilities

Potential locations of landslides in the reservoir rim slopes are identified for their management. A detailed risk assessment was carried out on these landslides and the assessment is given in Annex 7.2.

Eighteen landslides with moderate risk level would cause a considerable damage to the project and were selected for further geotechnical investigations and probably structural stabilization, as listed in Table 7.26.

Table 7.26: Selected Landslides for Further Geotechnical Activity

No.	Landslide No.	Present Stability	Effect of Impoundment	Hazard Level	Severity of Landslide-related Consequence	Risk Level
1	R-05	II	l	B(II-l)	b	M(B-b)
2	R-06	II	l	B(II-l)	b	M(B-b)
3	R-07	III	l	B(II-l)	b	M(B-b)
4	R-08	III	l	B(II-l)	b	M(B-b)
5	R-09	II	l	B(II-l)	b	M(B-b)
6	R-10	II	l	B(II-l)	b	M(B-b)
7	L-03	II	l	B(II-l)	b	M(B-b)
8	L-04	II	m	B(II-m)	b	M(B-b)
9	L-06	II	m	B(II-m)	b	M(B-b)
10	L-08	II	m	B(II-m)	b	M(B-b)
11	L-17	II	m	B(II-m)	b	M(B-b)
12	L-23	II	m	B(II-m)	c	M(B-C)
13	L-24	II	m	B(II-m)	b	M(B-b)
14	L-25	II	m	B(II-m)	b	M(B-b)
15	L-26	II	l	B(II-l)	b	M(B-b)
16	L-29	II	m	B(II-m)	b	M(B-b)
17	L-33	II	m	B(II-m)	b	M(B-b)
18	L-34	II	m	B(II-m)	b	M(B-b)

Source: DHP Engineering Design 2012.

Mitigation Measures: A detailed geological and geotechnical study will be conducted on the basis of the above-listed data to develop a geotechnical recommendation on the management of these potential landslides, as listed below:

- Continuous monitoring of landslide movement, or
- Stabilization of landslides by structural measures such as removal of unstable area, and anchoring works, etc.
- Control of drawdown rate of reservoir water level during reservoir operation
- Surface water drainage management

- Vegetation development

It is recommended in engineering designs that the reservoir to be filled initially with a rate of 2 m/day and carefully monitor the slopes in in the landslide prone areas. During the sediment flushing, the fill rate of 4 m/day and emptying rate of 3 m/day is recommended to minimize the landslides. It is expected that after few cycles of reservoir filling and releasing the slopes will be stabilized.

7.6.2 Seismicity and Reservoir Induced Earth Quakes

According to the grouping of the Geological Survey of Pakistan, the Project area belongs to the 'Serious Seismic Danger Zone' (Seismic Zone 3 with peak horizontal ground acceleration of 0.24 to 0.32 g). In addition filling, drawdown, or the presence of the reservoir has caused earthquake(s) although there are a limited number of documented cases. According to the ICOLD (Bulletin 72, 2010 Revision), the largest recorded magnitude was 6.3.

Seismic hazard of the project is one of the main concerns of all stakeholders and was raised in all stakeholder consultation workshops. The seismic hazard assessment carried out by the Project is reproduced in Annex 7.3. The assessment estimated the key design parameters, 'Safety Evaluation of Earth Quake' and 'Maximum Credible Earth Quake'. Both the terms are explained below:

- Safety Evaluation Earthquake (SEE) is the maximum level of ground motion for which the dam should be designed or analyzed. For dams whose failure would present a great social hazard the SEE will normally be characterized by a level of motion equal to that expected at the dam site from the occurrence of a deterministically-evaluated maximum credible earthquake or of the probabilistically-evaluated earthquake ground motion with a very long return period, for example, 10,000 years. SEE was estimated to be in the order of 0.50 g.
- A Maximum Credible Earthquake (MCE) is the largest reasonably conceivable earthquake magnitude that is considered possible along a recognized fault or within a geographically defined tectonic province, under the presently known are presumed tectonic framework. The most severe ground motion affecting a dam site due to an MCE scenario is referred to as the MCE ground motion. Evaluation of the MCE ground motion is generally done using a deterministic approach, in which the MCE scenarios for each identified fault and tectonic province are taken into account. MCE is estimated as 0.54 g and is considered for the design of dam.

In addition to the design parameters above, it is noted that reservoir-triggered earthquake should be considered as one of seismic hazard assessment. It is sure that the filling, drawdown, or the presence of the reservoir has caused earthquake(s) although there are a limited number of documented cases. According to the ICOLD guideline (Bulletin 72, 2010 Revision), the largest recorded magnitude was 6.3.

The dam is designed in accordance with the international standards (ICOLD). A committee of international panel of experts was hired by WAPDA to review and approve the dam design in accordance with the World Bank Policy OP 4.37 Safety of Dams. A seismic monitoring program will established at the damsite for continuous seismic monitoring.

7.6.3 Dam Safety and Its Monitoring

Dam safety is given utmost importance in the Project design. The detail treatment of the subject is given in the design documents. A summary of safety parameters adopted in the project design and operation is given in Annex 7.4.

Monitoring is an important tool to ensure dam safety. A large number of instrumentation sensors will be installed in the body and foundation of Dasu Dam for the purpose of monitoring various important aspects of behaviour during construction, first filling and in operation. There will be a three tier monitoring of dam safety: (i) the first tier by the dam staff, (ii) second tier by Dam Safety Organization of WAPDA and (iii) third tier by an external team. Details of this monitoring are also given in Annex 7.4.

7.6.4 GLOFs and Flood Management

Most of the water resources of the Indus River are derived from glacial melt, and the DHP is designed to withstand probable maximum floods that may be caused by glacial lake outbursts. Nevertheless, continued monitoring of glaciers is crucial for the water security of the country, and useful for developing the knowledge base for the operation of the dam and for planning future hydropower investments in the Indus Basin. A glacier monitoring program was recommended by World Bank under Tarbela IV Project. This program would support the Glacier Monitoring and Research Center (GMRC) under the WAPDA General Manager Planning for monitoring and research on the UIB glaciers. This is intended to examine the characteristics and movements of these glaciers, and provide early warning for glacial lake outbursts. The proposed GMRC would have four sections: (a) a field investigations section responsible for establishing and managing field stations. The office is proposed to be established in the upper catchment of the Indus; (b) a remote sensing and modeling section located in Lahore to carry out remote sensing and modeling studies; (c) a forecasting section; and (d) a data management section to maintain and upgrade data management systems and carry out data analysis and research activities. It would also link up with the high altitude meteorological network, surface water hydrology, and the WAPDA hydro-meteorological network.

A telemetry system will be established in UIB to monitor the flood flows that will be connected to control room in Dasu and WAPDA's office in Lahore (Details are given in Section 6 of EIA).

Further specific to DHP, the gauging station located at Partab bridge (133 km upstream of Dasu dam) will be used as the key gauging station for DHP in view of daily inflow forecasting and transmitting of warning water level during GLOF. The lag time along Indus during occurrence of GLOF between Partab bridge and Dasu is 6.3 hours and is adequate for preparation of gate operation. Partab gauging station would not affect even after construction of Basha dam. The telecommunication system between the Dam Control Office at Dasu and Partab gauging station would be controlled by the public phone line and mobile phone.

When the rising of water level in Indus River at Partab site exceeds 2 m/hour (slope of the inflow hydrograph resulting from GLOF), the manager at Partab GS shall inform the warning level to the station manager at Dasu Control Office to undertake gate operation. The manager at Partab GS shall transmit the river water level at the Partab GS every half hour to Dasu Control Office. Dasu Control Office will be responsible for (i) Establishment of rating curve at Partab bridge through Dasu reservoir operation and (ii) Establishment of precise storage volume in Dasu reservoir through bathymetric survey including sediment concentration (annual survey).

Operation of gate facilities provided at the dam and flushing tunnels will be automatically controlled in Dasu Control Office to safely release the excess inflow discharge assuring the safety of dam and appurtenant facilities and control the reservoir water level in accordance with the operational guidelines.

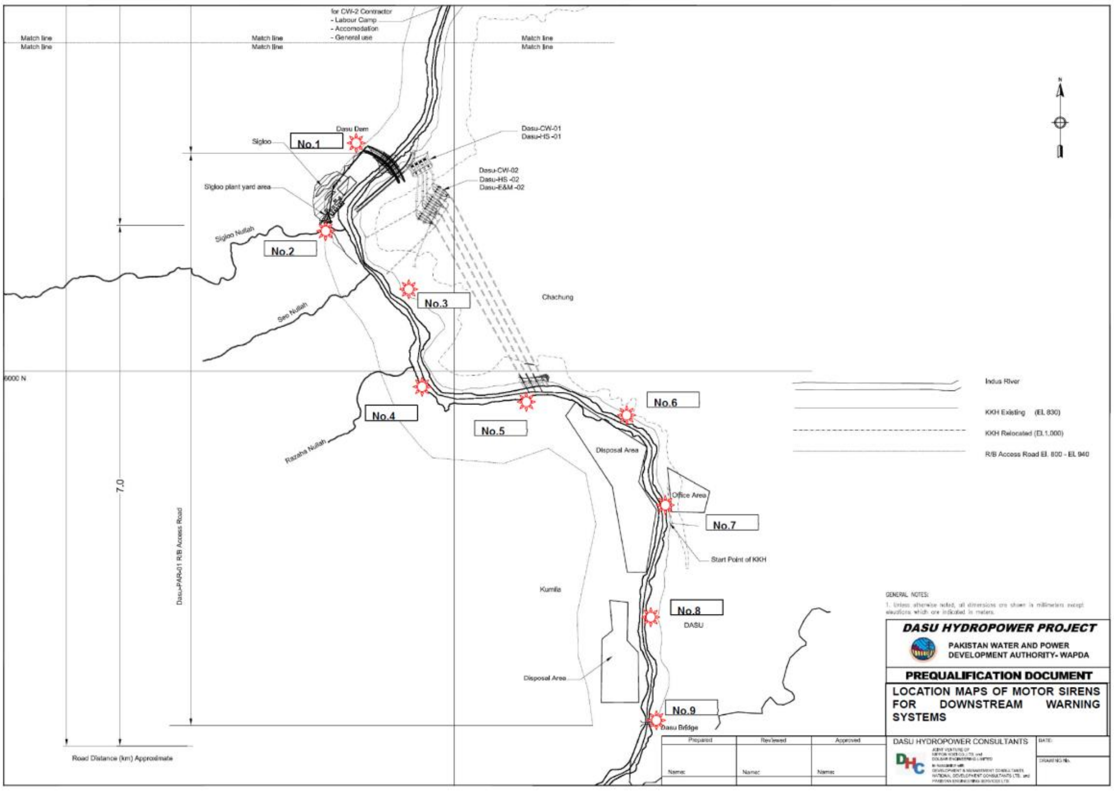
7.6.5 Downstream Warning System

The following events, during operation of the dam, when just started may trigger high surges:

- Spill-out after spillway gate opening during flood,

- Flushing operation through low level outlet and flushing tunnels, and
- The operation of power plant is started after interruption of all units

A warning system to warn local community will be established in the villages along downstream of Dasu dam up to the Dasu bridge. Nine (9) siren and loudspeaker warning stations will be installed along the downstream reach of the Dasu damsite over 9 km along both banks of Indus River. These warning systems will be organized and operated by Dam Control Office.



Source: DHP Engineering Design, 2012

Figure 7.8: Location Map for Motor Sirens for Downstream Warning System

Chapter 8
POTENTIAL SOCIAL IMPACTS AND THEIR MITIGATION

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8. POTENTIAL SOCIAL IMPACTS AND THEIR MITIGATION

8.1 LAND ACQUISITION AND RESETTLEMENT

The Project requires 4643 ha of land for siting of project facilities and inundation area of the reservoir. Reservoir area (including the buffer area around the reservoir) is the major component of the land requirement with 4006 ha (86% of total land acquisition). The land requirement for each component of the Project is as presented in Table 8.1.

Table 8.1: Distribution of Affected Land by Components

Component	Area of land to be affected (ha)
Reservoir (including buffer area around reservoir)	4006
Dam and Powerhouse Area	269
KKH realignment	42
Access roads	157
Colony, Office and Construction camp	102
Other uses(fish hatchery, Shatial rock carving site, etc.)	67
Total	**4,643**

Source: GIS Data, DHP 2012

The census and inventory conducted as part of the surveys have not been able to establish land tenure due to unavailability of cadastral land alienation data both at the Assistant Commissioner Revenue (ACR or DRO) and with the owners. The land inventory developed during the surveys will have to be completed after the land acquisition survey by the DRO for which the Project has provided additional resources.

8.1.1 Households to be affected

Based on the census surveys, the total households to be affected are 767and project affected people (‘PAP’ or ‘AP’) are estimated as 6,953 persons. About 98 percent of the AHs (753) are losing structures and 79% of AHs (600) are losing agriculture land. 13 affected households are *Soniwals* (gold explorers from river sand) who depend on the river. The types of losses of the affected households are given in Table 8.2.

Table 8.2: Type of Losses

Type of Loss	Number of Affected Households (AHs)
Households having Agriculture land	600
Structures (homestead, Commercial establishment and others)	753
Affected Soniwal households	13

Source: Resettlement Action Plan, DHP, 2012

Ownership of agricultural land to be affected is given in Table 8.3. About 302 of the affected households are from the left bank and the rest are from the right bank. About 69% of the land is cultivated by the owners and 24 % by the sharecroppers.

Table 8.3: Ownership of Agriculture Land to be affected

Sr. No.	Nature / Type	No. of Respondents			%
		Left Bank	Right Bank	Total	
1	Owner	229	183	412	68.67%
2	Owner cum Tenant	0	2	2	0.33%
3	Tenant	19	20	39	6.50%
4	Contractor	2	0	2	0.33%
5	Share Cropper	52	93	145	24.17%
Total		**302**	**298**	**600**	**100.00%**

Source: Resettlement Action Plan, DHP, 2012

8.1.2 Affected Structures

The Project is likely to affect 923 structures, which are mostly residential structures (83%), followed by 8.7% public and community structures and 8.2% commercial structures. Table 8.4 below presents usage wise details of the affected structures. The number of households and other establishments requiring relocation is higher on the right bank (54%).

Table 8.4: Details of Affected Structures

Location (River Bank)	Affected Structures							
	Residential Structures		Public and Community Structure		Commercial Enterprise		Total	
	No.	%	No.	%	No.	%	No.	%
Left	374	87.38	45	10.51	9	2.10	428	46
Right	393	91.82	35	8.18	67	15.65	495	54
Total	767	83.10	80	8.67	76	8.23	923	100

Source: Field Surveys, Detailed Design 2012, DHC

In addition to private structures requiring relocation, there are community owned structures including mosques and grave yards that will be affected due to inundation of the reservoir. A historical mosque at Seer Gayal that will be submerged in the reservoir will be relocated to a new resettlement site.

8.1.2.1 Construction Type of Affected Structures

Of the 923 affected structures, 51% are *Katcha (Katcha* means "in dry stone masonry" or in "masonry in mud mortar"), 36% are semi-Pucca ("Semi *pucca*" can mean construction in burnt bricks with mud plaster). Only 9 % of the total structures comprised of pucca ("Pucca" means in burnt bricks). While, wooden structures were less than 1%. Details are given in Table 8.5.

Table 8.5: Ground Area of Affected Structures

Structure Type by construction materials	*Katcha*		*Pucca*		Semi *Pucca*		Wooden Structure		Others	
	m2	%	m2	%	m2	%	m2	%	m2	%
Left	23,019	51	1174	14	11489	36.0	35	15	2143	72
Right	21,711	48	6970	86	20382	63.86	203	85	817	28
Access Road	293	1			45	0.14				
Total	45,023	51	8144	09	31916	36	238	<1	2960	3

Source: Resettlement Action Plan, DHP, 2012

8.1.3 Impact on Wage Earners

The Project is likely to affect 137 wage earners employed as laborers, helpers and masons. Most of the wage earners are employed as laborers and engaged in the construction works in the area and transportation of timber from logging area to KKH. A smaller number is employed as *Gujars* (*Gujars* belong to marginal caste as compared to the main local tribes, their main occupation is to rear livestock) looking after the livestock of *maliks* and in transportation of goods and groceries of villagers from KKH to higher elevation residences. Some are employed by small restaurants and shops on a daily paid basis. Details of wage earners are given in Table 8.6.

Table 8.6: Details of Affected Wage Earners

Category of wage earners	No. of Wage Earners Affected by Area		
	Left Bank	Right Bank	Total
Labour	38	33	71
Labour-Helpers	47	9	56
Mason	6	4	10
Total	**91**	**46**	**137**

Source: Resettlement Action Plan, DHP, 2012

8.1.4 Likely Impact on Vulnerable Groups

Certain groups of population by virtue of their socio-economic realities are considered socially vulnerable and thus in need of special consideration so that they can benefit from the development activities of the Project. These groups include: (a) Poor households; (b) Female-headed households and (c) Households headed by differently-abled persons.. In addition to these groups, *soniwals* who would lose their main income source as a result of the project impacts have also been included in the list of "vulnerable households". 68 households (9% of the total affected households) were identified as vulnerable groups. Details are given in Table 8.7.

Table 8.7: Details of Affected Vulnerable Groups

Village	Nature of Vulnerability	No of AHs
Gummo	Disabled	1
Sigloo	Female Headed	1
Cheir Shial (Gujjer)	Landless	6
Soniwal Group	Landless; no stable income	10*
Overall	Poor	50
	Total	**68**

**The actual number of soniwal* households*is 13, but three of them are engaged in government services.*
Source: Field Surveys, Detailed Design 2012, DHC

8.1.5 Loss of Business

Project will affect 76 commercial establishments including shops and restaurants. In addition, some fuel wood selling tolls along KKH needs to be relocated.

8.1.6 Loss of Agriculture and Grazing Land

Details of affected agricultural and grazing land are given in Table 8.8. The Project will acquire 143 ha of agriculture land and 280 ha of grazing land. The families that are presently involved in full and or part-time terrace agriculture will lose their cropping areas in the lower valleys along the banks of the Indus. In high altitudes, crops are grown only during the summer season. The combination of summer and valley crops is sufficient for family consumption requirements. Assessments based on livelihood survey, suggests that dependence on agriculture as livelihood is less than 15 % of their entire earnings from different sources like livestock, forest products. Some grazing land will also be affected by the reservoir but, the livestock production and rearing will not decrease due to moving and resettling of the APs on upper elevations.

Table 8.8: Affected Land by Types and by Ownership

Land Type	Over all land (ha)	Affected land (ha)	Ownership (%)	
			Individual	Communal
Agriculture Land	7,045	143	100	0
Barren Land	20,869	3126	78	22
Grazing Land	11,224	280	84	16

8.2 RESETTLEMENT ACTION PLAN

8.2.1 Resettlement Policy of the Project

The resettlement policy framework for the Project has been formulated to cover all affected persons irrespective of titles to land, compensation for lost assets, and restore or enhance the livelihoods of all categories of affected persons. The persons/ households affected by the project interventions will not only receive cash compensation for land and other assets at prevailing rates for full replacement cost but also will be given additional assistance for relocation and livelihood restoration. Thus, households to be displaced physically and affected economically will receive due compensation, relocation assistance, and allowances in accordance with the following guidelines and policy which are also part of Project Resettlement Framework.

(i) Affected persons will be paid negotiated value for acquired land and market rates for loss of standing crops and trees

(ii) Owners of residential/commercial units will be compensated at replacement costs. Renters/leaseholders affected by loss of living quarters or commercial premises will receive compensation and resettlement benefit due to loss of income; Eligibility for compensation will not be valid for new persons occupying/using the Project sites after the cut-off date, in accordance with this policy.

(iii) Compensation cost values will be negotiated based on the principle of replacement costs, as of the date that the replacement is to be provided or at the date of Project identification, whichever is higher. The market prices for cash crops will have to be determined based on the values as determined by valuation committee in consultation with the local *Jirga.*

(iv) Affected communal properties/structures or physical cultural resources will be re-built or replaced.

(v) Affected people will receive assistance to re-establish lost assets and livelihood.

(vi) The needs of women and vulnerable groups will be identified and provisions made for social and economic development support, employment, and means of subsistence to improve their status/livelihoods.

(vii) In compliance with community preference, community managed resettlement sites will be developed by the project with basic civic amenities, including access to higher elevation sites.

(viii) The Project will assist all PAPs directly and indirectly affected, in all aspects of relocation and resettlement including restoration of livelihoods. The head of safeguard/resettlement will facilitate the participation of PAPs in the decision-making process concerning relocation and resettlement.

(ix) The Project will guide, supervise, and monitor the land acquisition, compensation payment, and resettlement of the PAPs, including grievance redress and resolution of disputed claims for compensation/resettlement benefits.

(x) Grievance Redress Committees (GRCs) will be formed to ensure participation, and speedy and out of court settlement of as many disputes as possible.

(xi) Independent third party monitoring by an external monitor/agency will be contracted to monitor resettlement operations and outcomes evaluation.

8.2.2 Eligibility and Entitlement Matrix

Annex 8.1 provides an entitlement matrix for different types of losses and dislocation, based on the Inventory census. The matrix also includes provisions for any unanticipated impacts arising during project implementation. The mitigation measures in the matrix are consistent with World Bank safeguard requirements and Land Acquisition Act (LAA) 1894. They also reflect good practices and lessons learnt from earlier dam projects, replacement value for land, dislocation allowance, transfer grant, relocation at project-developed and PAP managed resettlement site, grievance redresses, income and livelihood restoration, third party independent monitoring etc. Compensation and other assistance will be paid to PAPs prior to dislocation and dispossession from acquired assets or three months prior to construction activities, whichever is earlier.

In some instances, the payment of compensation will be much later than the date of valuation due to phasing of construction activities and also the phased out nature of the resettlement program. If the payment is delayed more than two years from the date of valuation, the values will be indexed annually before payment.

8.2.3 Valuation of Assets

According to LAA 1894, the District Collector will consider the following in determining the amount of compensation to be awarded for land acquired under the Law:

(a) the negotiated/market value of the land at the date of publication of the notification;
(b) the damage sustained by the person by the loss of any standing crops or trees which may be on the land at the time of taking possession;
(c) the damage, if any, sustained by the person interested, at the time of taking possession of land, by reason of severing such land from his other land;
(d) the damage, if any, sustained by the person interested, at the time of taking possession of the land, by reason of the acquisition injuriously affecting his other property, movable or immovable, in any other manner, or his earnings;
(e) if in consequence of the acquisition of the land, the person interested is compelled to change his residence or place of business, the reasonable expenses, if any, incidental to such change; and
(f) the damage, if any, bona fide resulting from diminution of the profits of the land between the time of the publication of the declaration and the time of taking possession of the land.

The District Collector will receive assistance from the Communication and Works (C&W) Department and the Provincial Departments of Agriculture and Forestry to determine negotiated value for land and replacement value prices for assets as structures, and trees/crops. As there is the possibility for the assessed value to be lower than the replacement costs the rates to be used in the valuation of all assets will be reviewed and revised, if necessary, at a *jirga* where the local leading committee of the village committee (VC), the District Collector or his representative, and Project Resettlement Office (PRO) established under the Project Director (PD) of the Project Management Unit (PMU). The VCs were established by the Additional Assistant Commissioner (AAC) with recommendation of the village *malik* in every affected village, at the conclusion of and recommendation of the district level *jirga* conducted in April, 2012. Further, the valuation process will take into consideration the rates adopted by the Diamer-Basha Dam Project as the community made a request to base the compensation valuation on the values used in the said project.

The Project will pay the negotiated/replacement values to the PAPs through the District Collector and PAPs will be allowed to take away the materials salvaged from their dismantled houses and shops at no costs, despite the compensation paid. The cash payments will be made through crossed cheque in the name of the recipient PAP.

8.2.4 Resettlement Budget

The cost estimate in the budget is based on inventory of losses complied during May-September, 2012, and current compensation rate evaluation. The total estimated cost of implementation of RAP PKR 37,880 million (US$ 398 million) (Table 8.9). Detailed item wise cost estimates are given Annex 8.2.

Table 8.9: Summary Land Acquisition and Resettlement Budget

Sr. No.	Item	Amount (Million PKR)	Amount (Million USD)
1	Compensation & Allowances	17,122.17	180.23
2	Resettlement Site Development	1,210.47	12.74
3	Livelihood Support	1,500.00	15.79
4	Local Area Development	2,850.00	30.00
5	Institution & management	831.07	8.75
6	Planning & Design	484.50	5.10
7	Administrative Overheads	10.00	0.11
8	Monitoring & Evaluation	330.43	3.48
9	Training & Capacity Building	541.50	5.70
10	Contingencies	9,611.53	101.17
	Grand Total	**37,880.74**	**398.74**

8.3 DEVELOPMENT OF RESETTLEMENT VILLAGES

8.3.1 Resettlement Options

Given the past experience of resettlement in general and the Dasu project context in particular, the Project has adopted the following strategies and options for resettlement of the affected households and communities (**Error! Reference source not found.**). The community preferred site was well received and considered practical by the *jirgas* as well as at stakeholder workshops where INGOs and NGOs, Government Ministries and agencies were represented. Those who want to move on their own to Dasu/Kohistan and as far as Mansehra and Abbottabad districts mentioned about their kinship links in those places and/or availability of cheaper land for resettlement, including more job prospects in the cities.

Table 8.10: Resettlement Strategies and Options

Option	Strategies	%
Community-based Relocation to Sites in Upper Elevation	• Relocation to sites of their own choices in higher elevations • Community decision-making with regard to site lay out and civic amenities to be established • Site-specific Relocation Planning Committee consisting of the *malik*, representatives of affected families, and DHP Safeguard Unit • Site and services development at project costs • Subsidized plots to each affected families of the concerned community • Shifting and reconstruction grants as per the entitlement matrix	90%
Relocation to “Down country”	• Self-managed individual and/or families to identify destination and or site downstream and cities like Mansehra and Abbottabad districts • Project will pay all eligible compensation and benefits prior to relocation • Additional 15% of the total compensation for self-managed resettled households. • DHP Safeguard Unit to maintain the database for self-managed resettled households	10%

8.3.2 Affected Civic Amenities in the Project Area Villages

Two checklists were administered to (i) assess the existing civic amenities in the affected villages and (ii) feasibility of the proposed site on higher elevations. As evident in Table 8.11, the affected villages already have a range of civic amenities in their villages. Close to two-thirds of the villages have proper access roads and drinking water supply. A large majority of the villages have hydel power and irrigation systems. Nearly every village has a mosque. Only about one-third villages have schools. Two-thirds villages have latrines. There are two BHU in the project affected villages.

Table 8.11: Civic Amenities in the Existing Villages

Available Civic Amenities	Number of Villages	%
Access road from existing KKH	16	60
Internal road in the village	8	30
Drinking water supply	18	67
Irrigation water for terrace cultivation	21	78
Power supply (by local mini hydel)	21	78
Schools for boys and girls	11	41
Mosque	22	82
Playground	2	7
Latrine	20	74
Community graveyard	17	67
Basic Health Unit/Dispensary	2	11
Access to market	12	44
Community Centers	3	11

8.3.3 Resettlement Site, Layout Design and Development

Figure 8.1 presents the location of the existing villages and the potential sites selected by the affected village elders and *maliks.* The project will rebuild all existing civic amenities that are already there in the village. Additional amenities will be developed where needed so that people in their new relocated sites are better served and assisted with needed social infrastructures.

A sample layout plan for a resettlement site is presented in Figure 8.2. It includes all basic amenities, including plots for affected households. The layout plans and amenities and other facilities to be provided by the Project will be revealed to the affected households at disclosure consultations and their views and amendments will be incorporated in the final plans. The allocation of plots will be decided by the Village Committee (VC) and *malik/*s with the assistance of the DHP Safeguard Unit will mobilize the AHs to build their own houses on the plot allocated by the VC using compensation payments received.

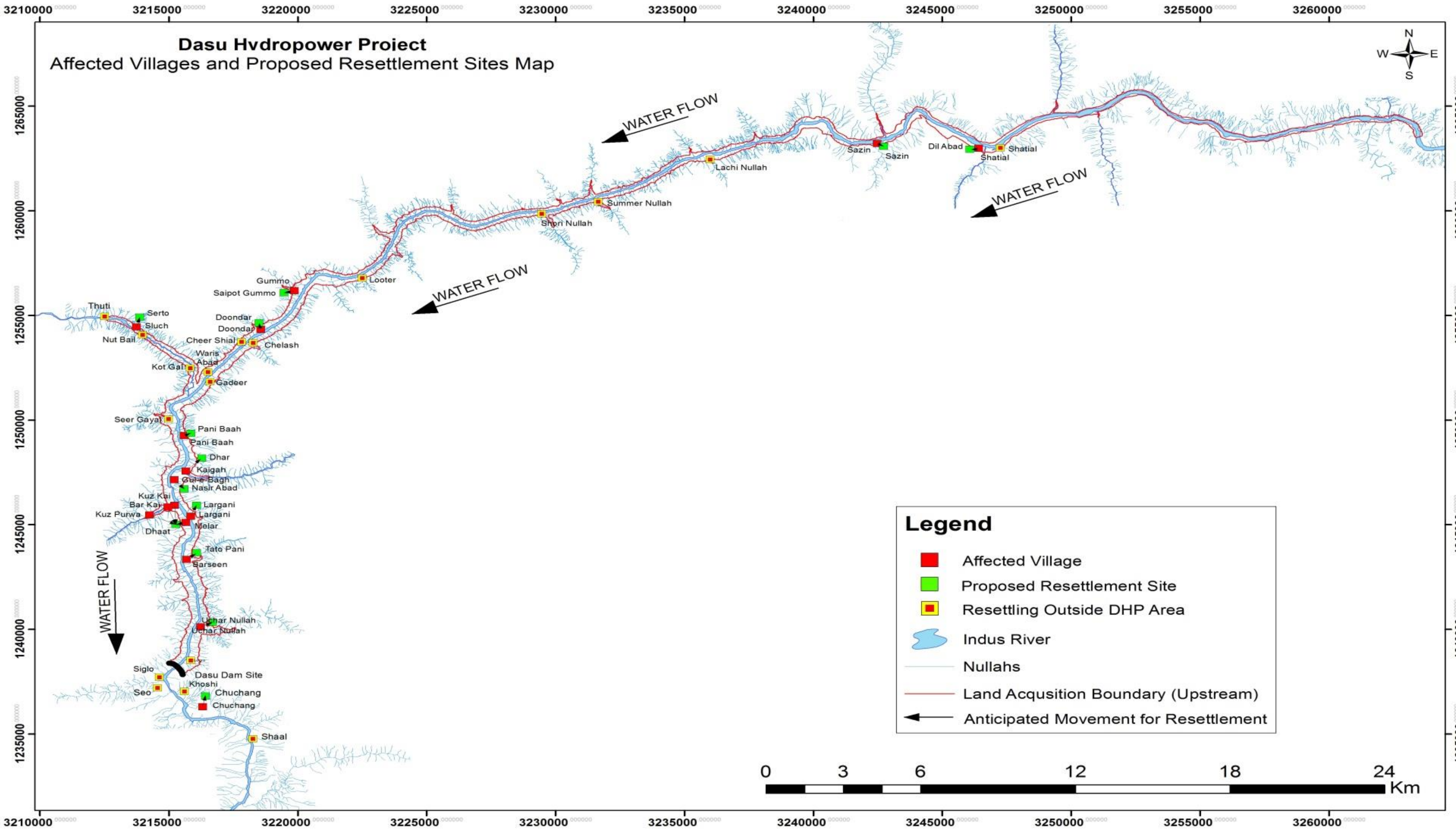

Figure 8.1: Affected Villages and Proposed Resettlement Villages

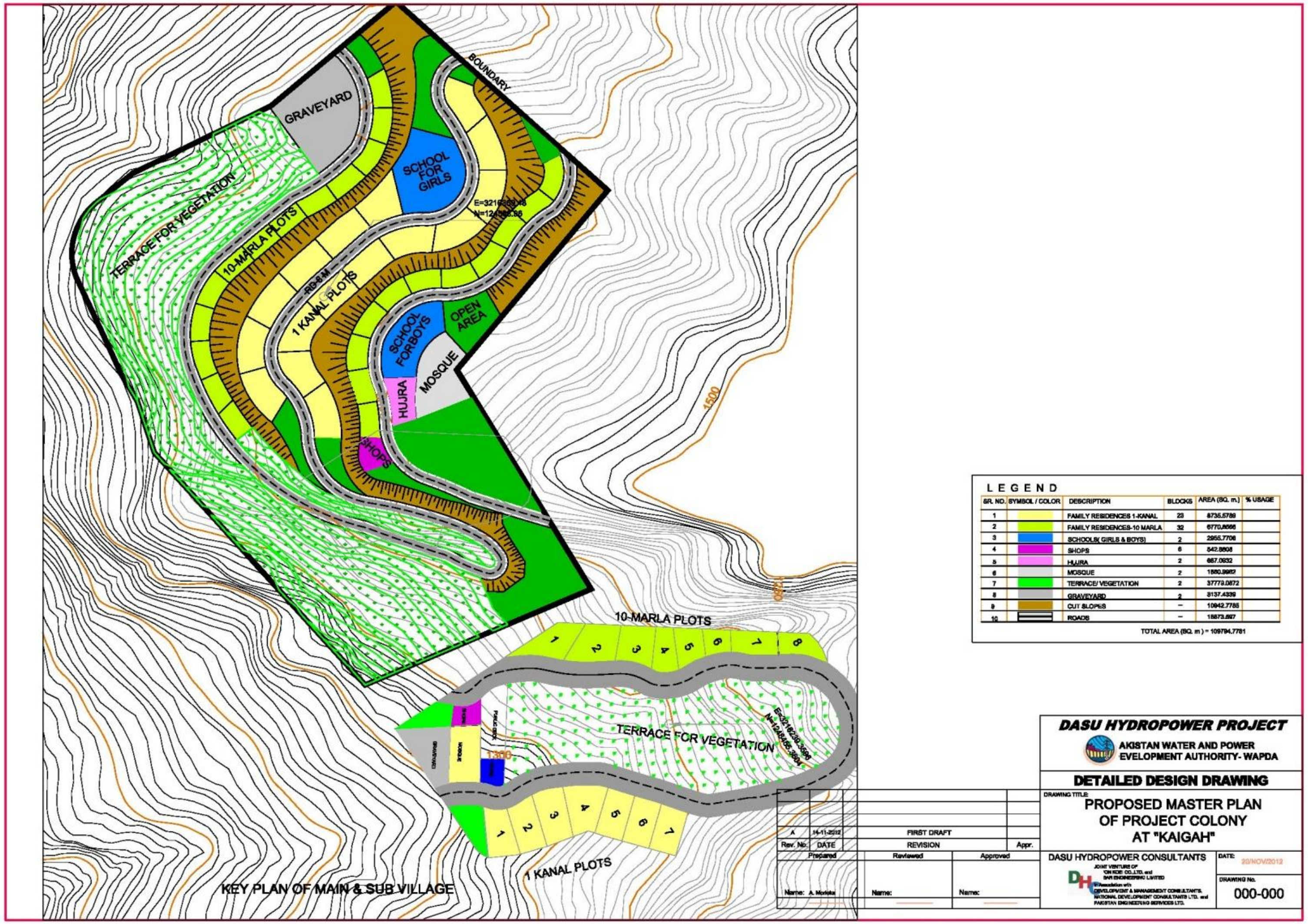

Figure 8.2: Sample Layout Plan of Resettlement Villages

8.4 IMPACT ON LIVELIHOOD

The livelihood resources of affected people of project area are land based activities as agriculture and animal feed collection and wages from timber transportation and labour. The income from selling produce from fruit and nut trees and a few home based small shops was a supplementation. A few APs in the downstream areas earn income from being involved in the transportation industry while some APs in the upstream villages were engaged in looking after the cultivation and livestock of local *maliks*. As per the findings of field Survey, the effects on livelihood sources of PAPs are mainly due to:

(i) Loss of agricultural/cultivation activities;
(ii) Loss of businesses including small shops, hotels and fuel wood selling spots;
(iii) Loss of range / grazing lands;
(iv) Loss of mature fruit / non-fruit trees;
(v) Loss of traditional fishing activities (though very limited);
(vi) Loss of access to sand gold mining on river bed by *soniwal* families;

8.4.1 Loss of Income Sources in Project Areas

The people are directly affected by the construction of DHP by the loss of their agriculture land, range land, natural fodder i.e. oak trees, wild olive and some other shade trees which are used as fodder for animals and; fruit/non-fruit trees and businesses including small shops, hotels and fuel wood tolls on main KKH. As explained in Section 4.0, the affected communities are transhumant agro pastoralists and have various sources of income at different elevations. The Project will affect their income sources from lower elevations, (800 to 1000masl). The affected communities have various sources of income at different elevations. Various sources of income of the affected communities from the lower elevations and impact on these sources due to the Project are given in Table 8.12. The impact sources are mainly land based activities in the land acquisition area, such as loss of agriculture and grazing land. The overall impact of the Project on the livelihood of the affected communities is estimated to be 5 percent.

Table 8.12: Losses of Income Sources at Lower Elevation (800-1000 masl)

Sr. #	Source of income	Ratio of Income from Livelihood Source (%)	Impact on Overall Income (%)
1	Agriculture	15.41	1.96
2	Livestock	5.45	0.00
3	Timber	25	0.00
4	Grazing land	2.5	0.75
5	Fruit trees	1.1	0.07
6	Medicinal plants	0.3	0.01
7	Mushroom	0.6	0.00
8	Fisheries	0.7	0.16
9	Business	10.36	0.00
10	Skilled labor	1.65	0.00
11	Unskilled labor	15.28	0.00
12	Government employment	11.26	0.00
13	Private Job	2.98	0.00
14	Commercial activities	5	1.00
15	*Soniwal*	2.69	1.07
16	Fire wood	1.14	0.00
Total		**100.00**	**5.01**

8.4.2 Livelihood Restoration

In the income and livelihood restoration, a two-phase approach has been adopted for the Project in line with the construction plan – for example, Phase I (2014-2019) for Short-term program (during construction of the dam and relocation phase). The first phase will be completed with the commissioning of the dam in 2019. Phase II (starting at 2020 - onward) will be a long-term development plan to be prepared and implemented by DHP (Table 8.13). Details of income and livelihood restoration plans are given in SRMP Vol. 5 RAP.

Table 8.13: Short and Long-Term Livelihood Programs

Construction Stage	ILRP Phase	Income and Livelihood Development Program
Stage 1 Phase I & II Construction of the Dam & 3 Turbines 2014-2019	Phase I Short Term	• Assistance to Support Lost Income • Assistance to Re-establish business/enterprises • Special Assistance to Vulnerable groups • Employment in Construction work • Reservation Area Plantation and Conservation
Stage 2 Phase III & IV (2022-on ward)	Phase II Long Term	• 10-Yr Project-sponsored Social Development Program through Social Development Fund (SDF) • Needs Assessment Survey • Target-Group Beneficiary Programs • Agriculture Development and Livestock Program
	Area Development Program	• Vocational Training and Skill Development • Fishery Development Program • Establishment of new health clinics • Improvements of existing social infrastructures

The short-term livelihood restoration program will be followed by a long term development plan. Prior to Phase II programs, DHP will undertake a needs assessment survey in the project area to select potential beneficiaries of the program and organize any necessary training and orientation. The detailed planning of livelihood activities will be carried out with participation of the local community. It will be developed on the basis of assessment of community needs, requests, skill and preferences as well as options and opportunities available in local areas.

8.5 OTHER PROJECT IMPACTS

8.5.1 Loss of KKH and Access Roads

Around 46 km of the Karakorum Highway (KKH) will be submerged by the reservoir. This part of the road lies between dam site and Shatial. A new KKH with 62 km length will be constructed from upstream of dam site at a higher level on the left bank of the Indus.

There are five river valleys along right bank of River Indus in Dasu area. Population around these valleys accesses the Karakorum Highway on left bank of the Indus River through five suspension bridges namely Larghani, Kandia, Tangir, Shatial and Dhundishal. The bridge at Dhundishal was washed away during August 2010 flood; however the other bridges are functional at present. Reservoir elevation resulting from Dasu Dam will be 957masl at the dam axis.

According to studies conducted during detailed design, the existing suspension bridges at Larghani and Kandia will get submerged into reservoir of the Dasu Dam and shall be dismantled. However, the existing suspension bridge at Tangir and Shatial are above the reservoir elevation at their respective places and as such will remain intact. The Diamer Basha Dam Authorities have planned to construct a bridge very near to Dudishal, therefore no additional bridge is required at the location.

Construction of a new suspension bridge at Larghani is no longer required because the Doga valley will be connected to the dam with a metaled road for access to KKH through Komila. However, a suspension bridge at Kandia will be constructed at a level above the dam reservoir. Furthermore, Kandia will be connected to Larghani by extending the asphalt road to Kandia.

8.5.2 Loss of *Dolleys*/Cable Cars

Due to construction of the project, 14 *dolleys*[1] will be submerged in the reservoir. People on the right banks use these dolleys to cross the river and go to local market in Komila or down to the country through KKH. To compensate the loss of access to KKH, a 37 km access road will be built from Komila to proposed relocation of Kandia Bridge.

8.5.3 Traffic Safety

The construction activities can potentially impact the residents of Dasu-Komilla and along KKH, particularly the movement and safety of school children. In addition, due to increased use of trucks and other vehicles on the narrow roads in the project area and the access roads elderly people, women and children will be more exposed to dangerous situations, which may lead to traffic accidents. A Traffic Management Plan will be implemented that will aim at ensuring access to residential areas, preventing unsafe situation, especially near schools, housing areas, construction areas, camps and offices. Similarly, construction activities such as blasting and excavation particularly at the borrow areas may pose safety risk to the nearby population. Appropriate procedures including cordoning off the area and prior information to nearby population will be followed for such activities, and liaison with the community will be maintained. There will be appropriate medical services and a facility with the capacity to treat emergency cases and trauma patients.

8.5.4 Influx of In-Migrants and Related Social Issues

The influx of construction workers to the project site may place considerable pressure on the traditional Kohistani socio-cultural systems as well as resources. Although the volume and number of in-migrants is difficult to accurately determine at this time, a possible scenario suggests that for every job created by the project, at least additional 3-5 jobs will be created as a snow-ball impact to support and sustain the growing population and businesses in the project area. Table 8.14 presents a conservative estimate of the number of in-migrants and their followers, including traders and entrepreneurs.

Table 8.14: Estimates of In-Migrants at Different Stage of Project Construction

Stage	Types of in-migrant	Number (Direct)	Number (Indirect)	Total
Pre-construction	All types of planning, design, survey, investigations, and construction-related temporary migrants, family/followers	500	2000	2500
Construction	Construction workers, consultants, and management staff, traders/entrepreneurs, family/followers	3000	9000	12000
Post-construction	O&M/technical advisory staff, family, support staff	1375	2000	3375

[1] A "dolley" is local cable car, which may be manually operated or motorized, to cross the Indus or tributary.

As evident from the table, there will be 3 to 5 times more indirect in-migrants (family, followers, service providers etc.) than direct in-migrants as construction workers/staff for project construction. In addition to the in-migrants, there will be foreign workers (skilled and semi-skilled) employed in the project site. At the construction stage, Dasu will have over six-times more people than the current number of residents, putting considerable pressure on existing resources – for example, housing/shelter, land, water, power, food supplies, jobs, transport/infrastructure etc. – on households and communities, threatening their general well-being and welfare.

The stakeholder consultations revealed that some locals already fear of conflicts, ethnic tensions between the locals and in-migrants, increased crime and violence and perhaps a general breakdown of law and order, social unrest and disruption undermining the project work. Further, many foresee this coming unless pro-active measures are taken to address the issues and to build local capacity to bridge the inter-cultural gaps and enhance understanding between the in-migrants and locals for mutual benefits. Otherwise, any reactive outcomes will likely need intervention of security forces at the project gate for law and order, risking further reputational risks for the project.

A set of strategies will be undertaken for management of in-migrants in the project area. These are detailed in the ‘Management Plan for Construction-related Impacts’ (SRMP – Volume 8). The migration management plan of the Dasu Project comprises of the following programs to manage the impacts of the project-induced migration and population influx.

- Formation of migration management team in DHP
- *Awareness building about in-migration*: will undertake an effort to raise awareness about, advocate for, and develop and share the case for in-migrants to meet the shortfall in the local labour market. This would be done taking into consideration the local cultural context, sensitivities and attitudes to “outsiders” to ensure a wider sense of ownership of the migration management plan by the local communities.
- *In-migration relocation planning and distribution*: will undertake community level consultations to preparing local communities and businesses in relocation planning and distribution of the in-migrants over the project construction period.
- *Access to Housing/Shelter, Food Sources and Market*: The Committee for in-migrants relocation and distribution will encourage local business groups and market committees in Dasu and Komila bazaars.
- *Improvements in local social infrastructure*: Presently, the conditions of the local roads in Dasu and Komila bazaars/markets are in poor state. DHP will work with C&W Department to draw up plan for improvements and maintenance of the roads and other social infrastructure at project costs.
- *Employment and business opportunities for all*: DHP will ensure that local labourers as well as in-migrants have access to work opportunities created by the project. Local people will get training from different vocational training institutes. They will be adjusted in the workforce of contractor on preference basis. People willing to work cannot be discriminated based on race, religion, caste, residence or place of birth. However, people from the affected families with relevant qualifications would get preferences for employments in the project.
- *Inter-Cultural Understanding and Cohesion*: DHP will undertake initiatives to enhance better understanding between locals and in-migrant groups for mutual benefits and the need to share project benefits by all stakeholders.
- *Management of Security Issues*: DHP will work with various stakeholders to avoid and or reduce or contain such situation through establishing district and

inter-district law and order committees to deal with any emerging law and order *problems.*

- *Codes of Conduct for Construction Workers:* Keeping in view the local customs, traditions and considerations, a set of "rules" have been identified through stakeholders meetings that provide guidelines for "code of conduct" for the workers – both local and outsiders. These codes of conduct must be respected by the workers, contractors, WAPDA staff and consultants engaged for project construction (see Table 8.15). The 18-point codes of conduct will be enforced to help facilitate a "positive" environment in the project area and thus build a "community" of mutual trust and respect for project construction.

Table 8.15: Codes of Conduct for Construction Workers and In-Migrants

Sr. No	Codes of Conduct
1.	Local religious beliefs, moral and ethical codes must be respected.
2.	Full respect to local norms, customs, and values of the society
3.	Local populations are legally recognized as landowners and therefore, must be respected all times
4.	DC, District Collector (Revenue and Estate), village committee members and affected community *maliks*are the civil authorities recognized by the local District Government and must be acknowledged and honored as such
5.	All workers are strictly forbidden to establish any kind of relationship with local women bring any un-related women to the project site.
6.	All workers are forbidden to possess or consume alcohol. The use of drugs or medicines must be prescribed by the physician on site
7.	All workers are forbidden to carry guns or any other types of weapon.
8.	All workers are forbidden to casually stay or visit any local community or village located along the route to or from the project while the construction is in development
9.	All workers must not leave the camps or work sites unless a written authorization is issued by the respective supervisor
10.	If a local inhabitant approaches any worker on a construction site or camp, the worker shall refer him respectfully to the Supervisor at site.
11.	All workers are forbidden to collect, purchase forestry products from the surrounding area of the corridor, other camps or work sites.
12.	The contractors will advise and prohibit the local population and its authorities or representatives not to enter the project operation areas (camp sites, colonies, etc.) in order to minimize the potential risk of incidents related to the operations.
13.	All workers are forbidden to purchase goods from any indigenous community. If any local purchase is required, it will only be done through a representative appointed by the Company or its contractors
14.	In the event of any payment being made to a local community for the purchase of any goods or services by its contractor, such payments shall be fully documented
15.	All workers are forbidden to hunt, purchase or possess wild animals; or interfere in one or the other way in their normal life
16.	All workers will be prohibited to fishing or disturb the aquatic flora and fauna.
17.	All workers must dispose of or remove adequately all residuals/waste produces at site, whether temporary or permanent.
18.	On their days off, the workers of the project may visit or stay around Dasu/Komila Bazaars by wearing local dresses like shalwar and kamiz and a cap on their head.

8.5.5 Public Health

8.5.5.1 Health and Hygiene at Construction Sites

SRMP Volume 7 Public Health Action Plan (PHHP) covers the public health issues along with proposed action plans in the Project area. Construction sites are likely to have health impacts on the construction workers. There will be a potential for diseases to be transmitted, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading sexually transmitted diseases such as HIV/AIDS. Mitigation measures include:

(i) provision of adequate health care facilities within construction sites;
(ii) training of all construction workers in basic sanitation and health care issues (e.g., how to avoid transmission of sexually transmitted diseases such as HIV/AIDS);
(iii) clean drinking water and safe sanitation for all workers;
(iv) adequate drainage throughout the work sites to ensure that disease vectors such as stagnant water bodies and puddles do not form; and
(v) Septic tank and garbage box will be set up in construction site, which will be periodically cleared by the contractors to prevent outbreak of diseases. Where feasible the contractor will arrange the temporary integration of waste collection from work sites into existing waste collection systems and disposal facilities of nearby communities.

8.5.5.2 Health and Hygiene at Construction Camps

Camp sites for construction workers are the important locations that have significant impacts such as health and safety hazards on construction workers and nearby communities. The potential implications associated with housing of immigrant workforce include generation of solid waste, adverse water quality impacts arising from discharge of partially treated sewage and refuse, public health impacts through the possible introduction of diseases not prevalent in the surrounding areas and promotion of disease vector habitats within the temporary housing areas.

The camps will have adequate housing for all workers, safe and reliable water supply, fuel supply, waste disposal facilities, hygienic sanitary facilities and sewerage system, treatment facilities for sewerage of toilet and domestic wastes, storm water drainage facilities, adequate health care facilities, and in-house community/common entertainment facilities.

The Contractor shall conduct ongoing training programs to all construction workers on basic sanitation and health care issues and HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication.

The contractor will prepare and implement EHS Plan, in accordance with relevant standards and guidelines including IFC's EHS Guidelines.

8.5.5.3 Health Impacts of Reservoir

Some stakeholders raised the issue of sandfly, a parasite said to be endemic in the project area and the Kala Azar disease caused by it. Even though, no data could be traced, Leishmaniasis and Kala Azar appear to be endemic. Passive case detection followed by treatment and case reporting constitutes the basis of the majority of control programmes in endemic countries. The difficulty for public health programmes is a direct result of the complexity and diversity of the parasite, i.e. finding and identifying vectors; developing feasible vector control methods; establishing barriers between humans and vectors; identifying and reducing reservoir animal populations; adequate chemotherapy and access to treatment services. A good public health strategy includes prevention combined with effective treatment of infected individuals; better diagnostic techniques; strategies targeted at the health care delivery system of the very poor; education of the population and strengthening the reporting of Leishmania cases. Dasu reservoir is not expected to be an ideal place for breeding of mosquitoes or sand fly because of high surface water velocities in the reservoir.

Vector and reservoir host control measures are expensive, requiring good infrastructure and maintenance, often giving short-lived results. Spraying with residual insecticides can be effective where transmission occurs in and around the home. Evaluations of the effect of "blanket spraying" on sand fly populations are crucial for cost effective targeting of household spraying. Maintaining barriers between human populations and vectors is an important aspect of a control programme, such as insect repellent or insecticide and bed netting where sand flies are most active when people are asleep. However fly screens typically have openings of 1.3-1.5 mm, but against sand-flies these openings can be a maximum of 0.9mm. Education of the lifecycle, signs, symptoms and prevention strategies of Leishmaniasis is one of the most important elements of a public health programme. Treatment for infected individuals is vitally important, not only for the well-being of the patient, but also to prevent the further spread of leishmaniasis. Early recognition and treatment of cases must be included in the control program.

Given the complexity of the control programme, as well as of diagnoses and treatment, the PHAP foresees that district specific evidences will be included in the initial studies of the health care support project to the public sectors, which will be the base for a realistic public health programme and also design a feasible referral system for suspected cases.

8.5.6 Employment Opportunities

The project offers good opportunities for local residents to apply for employment as unskilled and skilled construction worker. Within the construction contracts the contractor(s) would have to attract certain quota of local workers and technician on basis of quota. Construction works could offer at least for a period of 10 years many opportunities for unskilled workers and technicians. Also there will be employment opportunities for office staff, administrative and logistic functions and in transportation. Important for sustainable livelihood restoration is that sufficient vocational training and skill development is provided. A pro-active program to this end is already started by WAPDA: local youths are receiving a six-month vocational training in various lines of work to prepare them for guaranteed jobs in the project construction work. The graduates may also obtain jobs elsewhere, if they choose to. Establishment of vocational training centers for men and women will be part and parcel of the project resettlement plans. After the construction phase there will be other opportunities for more permanent functions within the project operation and maintenance. All these new opportunities for work for local residents could boost employment and improve the social and economic position of the population. This will be a major and significant positive impact of the project.

After completion of the construction works, employment opportunities will suddenly seize and unemployment for local residents may increase. However, with the experience gained from Dasu project, the local people will have potential opportunities in future hydropower projects in Kohistan and GB, and also abroad. WAPDA could develop a preferential system for local workers with good qualifications and experience at the end of construction of stage-1. Construction workers could also qualify for positions in operation and maintenance activities.

Chapter 9

ENVIRONMENTAL MANAGEMENT PLAN

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9. ENVIRONMENTAL MANAGEMENT PLAN

9.1 GUIDING PRINCIPLES OF EMP

Environmental Management Plan (EMP) is prepared for all the identified environmental impacts during all stages of Project implementation in accordance with international best practices and World Bank guidelines. The methodology followed for preparing the EMP is given in Figure 9.1 and consists of the following steps:

- Deriving mitigation measures for each identified impact and risk,
- Developing a mechanism for monitoring the proposed mitigation measures,
- Estimating budget requirements for implementation mitigation and monitoring measures,
- Identifying responsibilities of various agencies involved in the Project for implementation and monitoring of mitigation measures,
- Auditing of the implementation activities to ensure that mitigation measures are implemented appropriately,
- Corrective actions if there are any non-compliances in the implementation of the mitigation measures, and
- Reporting mechanism.

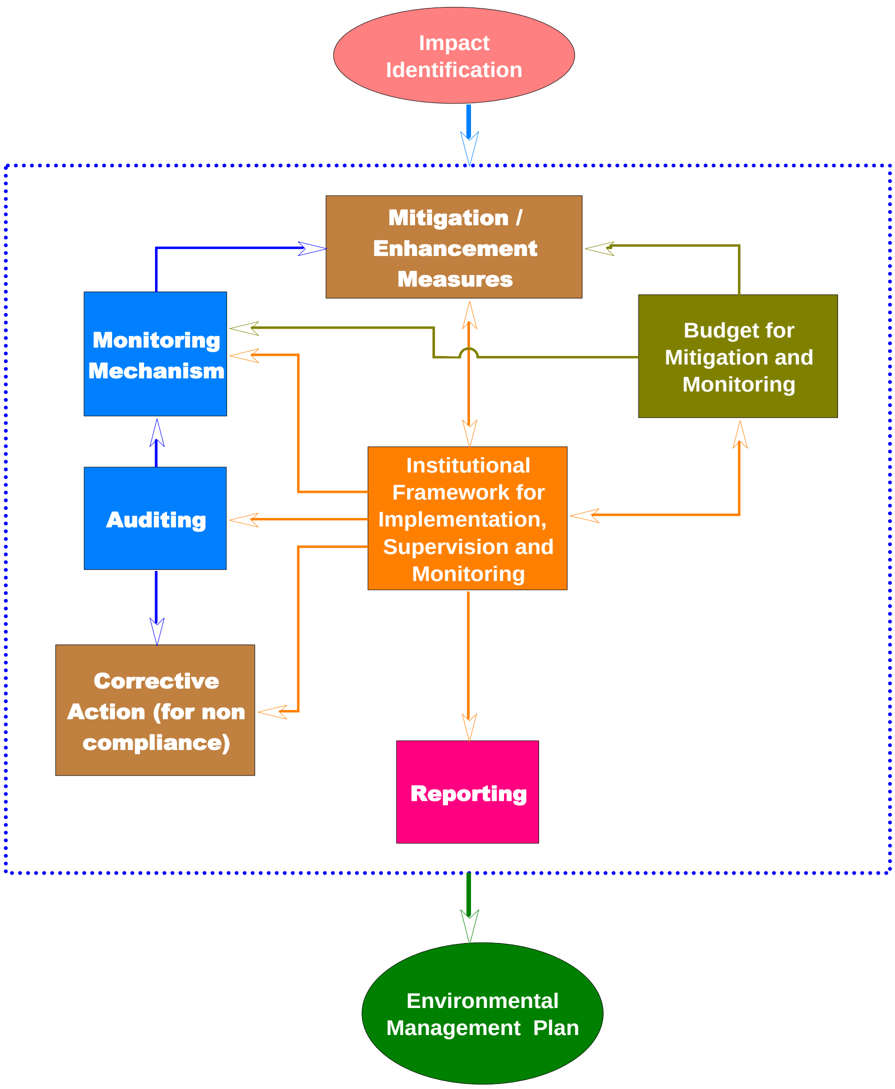


Figure 9.1: Framework for Preparation of EMP of DHP

Various environmental management sub-plans prepared in accordance with the above framework are given in Section 9.2. Each of the components in the framework is discussed in the following sections. The strict implementation of the EMP and project management's strict enforcement of the adequate construction practices and standards will greatly reduce the negative impacts of the Project.

9.1.1 Mitigation Measures

A wide range of mitigation/protection measures are used to address significant environmental impacts (Chapters 7 and 8). These mitigation measures are derived after evaluation of six possible categories: three categories (viz. avoidance, modification and control/mitigation) that can be incorporated in project activity and three categories (viz. protection, relocation/compensation, and enhancement) to address receptor or environmental component. The most effective combination of all these strategies (in terms of its applicability and cost-effectiveness) are found and then incorporated in the EMP. A brief description of each of these possibilities is given below.

- Project Activities
  - Avoidance/Prevention: Avoidance/prevention means essentially keeping away from environmentally sensitive areas by locating (siting) or reducing the size of project activity
  - Modification: In some cases modification of a project activity or its implementation under special conditions (e.g., timing of activities, buffers around nesting areas) will greatly reduce the adverse impacts
  - Control/Mitigation: It is not possible or even practical to avoid all impacts. Following proper control/mitigation measures will reduce (i.e., control) the extent of impact on the environment. The best construction practices also helps in reducing the extent of impact
- Environmental Component
  - Protection: Protection/insulation of receptors from impacts will reduce the impacts that remain after control measures have been used
  - Relocation/Compensation: Compensation refers to the provision of "equivalent" environmental features
  - Enhancement: Enhancement refers to the provision of features that are an improvement over previous environmental conditions

9.1.2 Institutional Framework for Implementation of EMP

Institutions responsible for executing and monitoring the environmental aspects of this Project are:

- DHP and its Project Management Unit (PMU) will be responsible for overall implementation of the Project and hiring of contractors and consultants
- A 'Safeguard Unit' will be established in PMU, which will be responsible for all required administrative and financial decisions and actions for effective and timely implementation of the safeguards. The Safeguard Unit will consists of an Environmental Unit and a 'Social and Resettlement Unit'
- The Environmental Unit in DHP (EU-DHP) will be responsible to undertake responsibility for routine and random monitoring of implementation of EMP
- As several contractors will be working simultaneously for timely and speedy implementation of the project, it is important that Construction Supervision Consultant (CSC) has an environmental unit to effectively supervise and monitor the environmental activities being implemented in the field. Environmental Unit in CSC (EU-CSC) is responsible for supervision of implementation of EMP.

- Contractors will be responsible for implementation of EMP during construction and first year of operation of the project. They also have dedicated staff for EMP implementation.
- In some cases consultants and specialist organizations will be hired to implement specific plans in EMP such as conservation areas development, fish monitoring, etc.
- Internal auditing on implementation of EMP will be taken up EU-DHP and WAPDA's Environmental Cell (WEC)
- External auditing will be taken up by an independent agency
- A Grievance Redress Committee (GRC) will be established (to deal with the complaints related to environmental and social issues (as a part of the DHP overall GRC framework – SRMP Volume 9: Grievance Redress Plan)

Organization chart of PMU of DHP and institutional framework for implementation of social and environmental safeguards is shown in Figure 9.2. An extract of the organization which demonstrates the organizational structure and how it relates to the implementation of the EMP is shown in Figure 9.3 .

Roles and responsibilities relating to environmental management for the key positions in the Project team are given below.

9.1.2.1 Project Director of DHP (PD)

The PD/GM-CEO of DHP is the executive head of the entire Dasu Hydropower Project operations. He is responsible for necessary policy, administrative and financial decisions and actions for effective and timely implementation of the project as per the approved framework and implementation schedules. The Deputy Project Director-Safeguards will assist the PD in the execution of EMAP

9.1.2.2 Environmental Unit of DHP (EU-DHP)

A 'Safeguard Unit' will be established in PMU, which will be headed by a Deputy Project Director. The safeguard unit will consist of two units – one 'Environmental Unit' and one 'Social and Resettlement Unit'.

Environmental Unit in DHP will consist of three sub-units (Environment, Ecology, Occupational Health and Safety) with the following Staff

- Director - Environment
- Deputy Director - Environment
- Assistant Director - Environment (with two site engineers)
- Assistant Director - Ecology (with two support specialists - Fish expert 1, plantation expert 1)
- Assistant Director - Occupational Health and Safety (with one support specialist)

Deputy Project Director of Safeguard Unit will be responsible for overall implementation of SRMP and EMP and guiding the social and environmental units. He may delegate his/her power through the Director –Environment Unit. He will be responsible for ensuring the EMP, ECPs and bills of quantities are included in the contract documents, and approval of contractors 'environmental management action plan'.

Responsibilities of staff of Environmental Unit are briefly described below. These positions are field based and they have to reside in Dasu. Terms of reference (TOR) is prepared for all these positions and given in Annex 9.1.

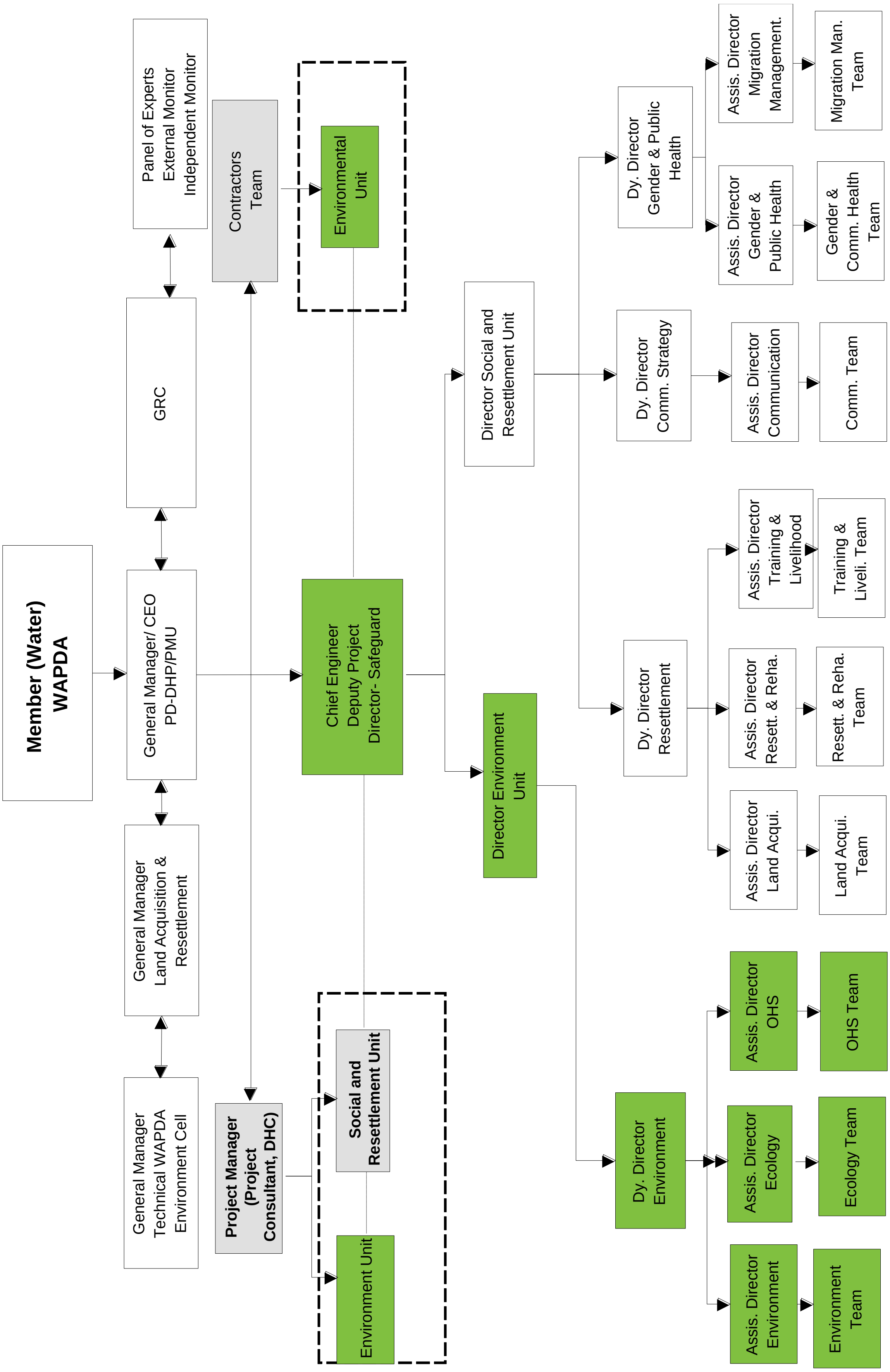
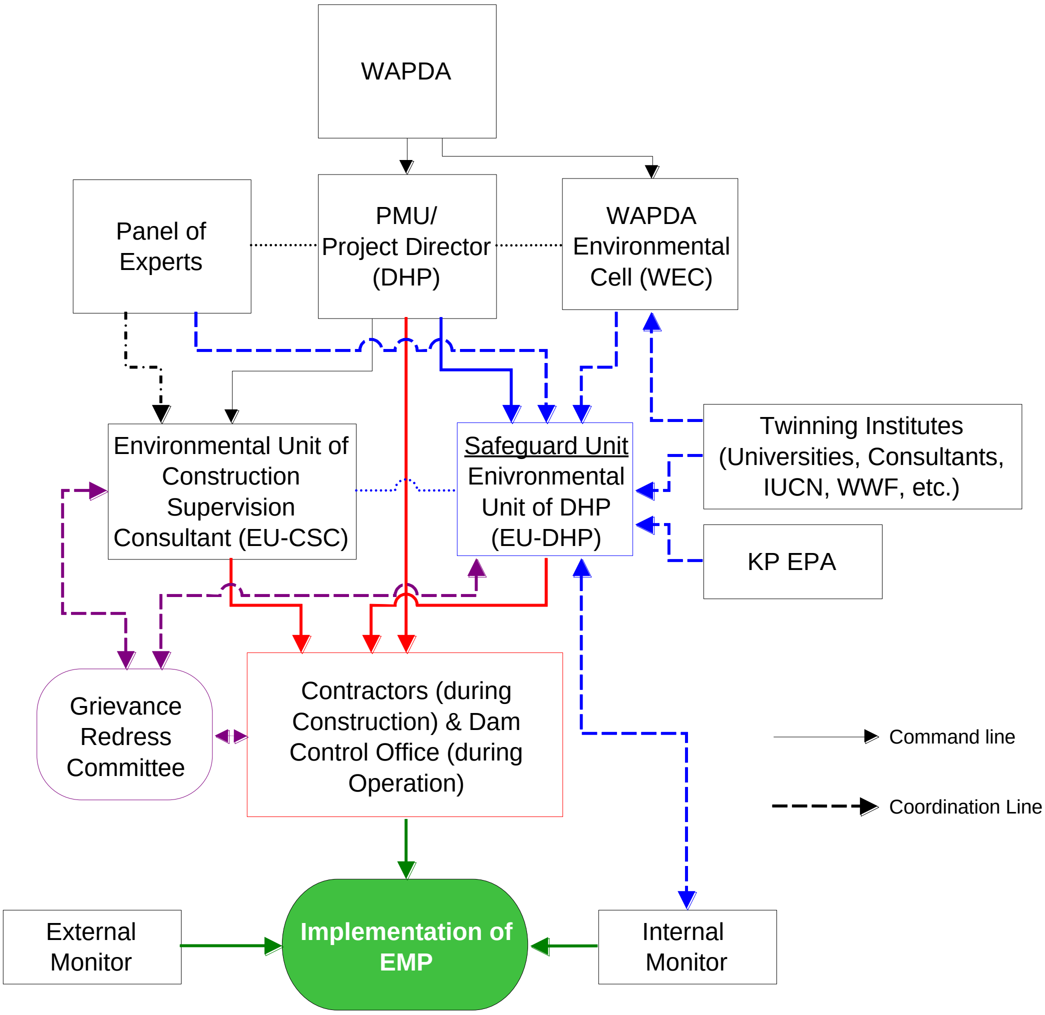


Figure 9.2: DHP Organization Chart



Note: Each box in the above figure represents an organization contributing to the 'Implementation of EMP'. Description of responsibility of each organization is given in Section 9.1.2.

Figure 9.3: Organizational Framework for Implementation of EMP

The EU-DHP Director will endorse and support the implementation of the EMP and associated policies and documentation. The Director shall be responsible to ensure appropriate resources are made available to implement the EMP and to support established systems, procedures and environmental objectives. Some specific responsibilities include:

- Overall planning, management and monitoring of EMP implementation
- Liaising with the EU-CSC, and ensuring that they perform their responsibilities effectively and adequately
- Assist in resolving disputes which may arise in respect to environmental management (if required).
- Liaising with government agencies and relevant stakeholders regarding environmental matters; overseeing the implementation of EMP;
- Coordinating appropriate responses to environmental related complaints, ensuring complaints are investigated for effective resolution;
- Coordinating the involvement of environmental specialists (from the broader project team) as the need arises throughout the construction phase.
- Liaise with the Social and Resettlement Unit and other relevant Project entities
- Liaising with WEC to update them on the EMP implementation, and seeking any technical backup

- Carryout additional studies, such as aquatic and terrestrial ecology, recommended in EMAP. Prepare necessary TORs for hiring of consultants and contractors
- Prepare monthly and quarterly reports on the status of implementation of the Project
- Conduct monthly meetings with the environmental staff of consultants and contractors on the progress of EMP implementation, issues associated with implementation, non-compliance issues, and recommended course of action. Document the minutes of the meetings and present them in the monthly reports
- Review of EMP, every six months, and if update if required in coordination with the EU-CSC

The Deputy Director of Environmental Unit will work under the overall guidance and supervision of the Director, Environmental Unit and will be directly responsible for overseeing the execution of all tasks related to EMP with teams of environmental, ecology and OHS, which will be led by respective Assistant Directors.

The Assistant Director – Environment of EU-DHP will be mainly responsible for overseeing of implementation of EMP and prepare weekly compliance reports.

The Assistant Director – Ecologist is responsible for coordinating with district forest and agriculture departments for development of nurseries for plantation in the project area, supervision of aquatic ecology studies and monitoring, developing landscaping plans for the quarry and spoil disposal areas, identifying needs for environmental enhancement measures in Kaigha CCA, conducting additional studies recommended in the terrestrial and aquatic ecology reports.

The Assistant Director – OHS is responsible for overseeing of occupational health and safety issues at the work areas.

9.1.2.3 Environmental Unit of Construction Supervision Consultant (EU-CSC)

Environmental Unit of CSC (EU-CSC) will consist of the following personnel

- Team Leader (international environmental specialist)
- Environmental Specialists (two national specialists)
- Ecologist (one international and one national)
- Occupational Health and Safety Specialist (one international and one national)
- Environmental Surveyors (two national)

The EU-CSC shall be responsible for the supervision of implementation of the EMP. It will liaise heavily with the construction team to ensure all environmental commitments are incorporated into the construction activities and work processes. Specific responsibilities include:

- Review and approve the contractors management plans
- Supervision of implementation of EMP
- Review of EMP every six months and update the EMP if required
- Supervising and supporting contractors in achieving their responsibilities as outlined in the EMP;
- Providing input and advice on activity specific work plans relating to EMP;
- Regularly reviewing and assessing environmental risks throughout the construction phase;
- Identifying and preparing environmental induction and training materials;
- Responding to environmental incidents as required;
- Managing compliance reporting as it relates to the Project.
- Liaise with DHP’s EU for effective environmental management at site
- Liaise with the Resettlement Office and other relevant Project entities

- Prepare terms of references for the consultants to be hired by EU-DHP for conducting additional studies recommended in EIA.

9.1.2.4 Contractors

Each contractor will be required to have suitably qualified and experienced persons acceptably fluent in the English language, to function as environmental specialists and occupational health and safety Specialists, who will be working in close liaison with the environmental staff of PMU and CSC. Appropriate numbers of the following personnel are required in the contractor's environmental team.

- Environmental Specialists
- Occupational Health and Safety Specialists
- Environmental Technicians (both for lab and field investigations)

The contractor will be responsible for implementation of measures to avoid or minimize adverse environmental impacts during construction. Contractors are required to prepare 'Construction Environmental Action Plan' (CEAP) demonstrating the manner in which they will comply with the requirements of EMP before mobilization and obtain approval from the EU-DHP and EU-CSU (see Section 9.2.3 for further details).

9.1.2.5 Dam Control Office

Dam Control Office of DHP will be responsible for implementation of EMP during O&M stage, such as release of environmental flows during winter, sediment flushing, flood management, etc.

9.1.2.6 WAPDA Environmental Cell (WEC)

WAPDA Environmental Cell (WEC) is responsible for overseeing environmental issues associated with WAPDA's hydropower projects in the country. The unit is headed by a Director General with specialists in environment, ecology, geology, soil, economy, social and gender specialists. The WEC will also conduct periodic monitoring of EMP implementation activities and advise the EU-DHP on any action necessary to comply with the implementation requirements.

9.1.2.7 External Environmental Auditors

External Auditors or External Monitoring Agency will be engaged to conduct the external and independent monitoring of the implementation of the EMP. This external monitoring agency is to carry conduct six-monthly, annual and final evaluation of the EMP implementation and recommend changes if and when necessary to the EU-DHP.

9.1.2.8 Panel of Experts

WAPDA will engage an independent panel of environment and social experts to advise DHP Safeguard Unit and other project entities on all environmental and social matters including effective implementation of EMAP and SRMP, particularly on unanticipated situations, impacts, and their mitigation. The Panel will review on a regular basis the various reports and documents produced by Safeguard Unit, Supervision Consultants and contractors; periodically visit the site to have firsthand information on the environmental and social impacts and EMP/SRMP implementation; and provide report to WAPDA on the overall environmental and social performance of the project.

9.1.2.9 Grievance Redress Committee

Several environmental issues may arise during implementation stages of the Project. Following are some of the environmental issues that could be subjected to grievances from the affected people, concerned public, construction workers and civil society members.

- Soil, water, dust, noise and air pollution from construction related activities
- Traffic movement and congestion
- Waste disposal
- Lack of adequate safety at the construction areas and approach roads
- Lack of water and sanitation facilities at the construction sites/camps
- conflicts among construction workers and with local community
- Disturbances to flora and fauna
- Failure to comply with standards or contractual obligations

In order to provide an accessible mechanism to all the affected persons to raise their issues and grievances related to environmental issues, a four tier grievance redress committees (GRCs) will be established. Details of the GRCs are given in SRMP Vol.10: Grievance Redress Plan. Environmental staff of PMU, CSC and contractors will be part of GRC team when dealing with environmental issues related to the project. Mechanism of filing complaints will include sending text messages from the cell phones, establishment of complaint boxes at the convenient locations for the community, etc. Details of the receiving and addressing grievances are given in detail in SRMP Vol.10.

The responsibilities of GRC include:

- review the merit of the complaints/case received for consideration;
- review the case in the light of related project activity and within the context of applicable laws/guidelines in Pakistan and/or international practices and standards;
- undertake field level investigations, if necessary for review of the case at hand; and
- review and resolve the case and recommend necessary measures or mitigation, if required.

9.1.3 Monitoring Mechanism

Monitoring of environmental components and mitigation measures during construction and operation stages is a key component of the EMP to safeguard the protection of environment. The objectives of the monitoring are to (i) ensure that the mitigation measures included in the EMP are effectively and regularly implemented (compliance monitoring); and (ii) monitor changes in the environment during various stages of the project life cycle with respect to baseline conditions (effects monitoring);. A monitoring mechanism is developed for each identified impact and it includes:

- Location of the monitoring (near the Project activity, sensitive receptors or within the Project influence area)
- Means of monitoring, i.e. parameters of monitoring and methods of monitoring (visual inspection, consultations, interviews, surveys, field measurements, or sampling and analysis)
- Frequency of monitoring (daily, weekly, monthly, seasonally, annually or during implementation of a particular activity)

The monitoring program will also include regular monitoring of construction activities for their compliance with the environmental requirements as per relevant standards, specifications and EMP; The purpose of such monitoring is to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance as appropriate during construction.

The environmental parameters that may be qualitatively and quantitatively measured and compared are selected as ‘performance indicators’ and recommended for monitoring during project implementation and operation and maintenance (O&M) stages. These monitoring indicators will be continuously monitored to ensure compliance with the national or other applicable standards and comparison with the baseline conditions established during design stage.

The environmental monitoring requirements for the Project are detailed under each environmental aspect within the EMP and its sub-plans.

It is recommended that the contractor establishes an environmental quality laboratory at the site with all necessary equipment to measure water, air, and noise and vibration quality. All environmental monitoring equipment, such as noise meters and water quality meters should be maintained and calibrated according to manufacturer's specifications. All monitoring equipment details, status, calibration dates and maintenance should be documented and recorded.

9.1.3.1 Compliance Monitoring

The compliance monitoring of the project activities is principally a tool to ensure that the environmental and social control measures identified are strictly adhered to during the project execution. Various aspects of the EMP compliance monitoring will be to:

- Systematically observe the activities undertaken by the contractors or any other persons associated with the project.
- Verify that the activities are undertaken in compliance with the EMP.
- Document and communicate the observations to the concerned person(s) of the contractors, EU-DHP and EU-CSC, so that any corrective measures, if required, can be taken in a timely fashion.
- Maintain a record of all incidents of environmental and social significance and related actions and corrective measures.
- Maintain contact with the communities, solicit their views and concerns, and discuss them during the monthly meetings.
- Prepare periodic reports of the environmental and social performance of project.

9.1.3.2 Monitoring Predicted Effects (Effects Monitoring)

The EIA predicts the impacts of the proposed project on the basis of information available at the time of conducting the assessment and the natural processes that link various environmental and social parameters. Based on this prediction, mitigation measures are introduced such that the predicted residual effects do not exceed acceptable levels. However, there can be an element of uncertainty in such predictions, for example, due to an insufficient grasp of the processes, limitations in prediction techniques, or inadequate data on the environment. This is true for the physical, biological, as well as socioeconomic environment. Consequently, it is possible that even if the mitigation measures are implemented fully, the negative impacts of the Project could exceed predicted levels or acceptable limits.

In order to address the above concerns, effects monitoring will be undertaken during the Project activities, with the overall objective of proper management of environmental and social risks and uncertainties. Broadly, effects monitoring has the following objectives:

- To verify that the impacts of the proposed project are within acceptable limits, thus establishing credibility (public assurance);
- To immediately warn the PMU of unanticipated adverse impact or sudden changes in impact trends so that corrective actions can be undertaken, which may include modifications in the proposed activities, or the inclusion of modified or additional mitigation measures;
- To provide information to plan and control the timing, location, and level of certain project activities so that the effects are minimized; and

- To facilitate research and development by documenting the effects of the proposed project that can be used to validate impact-prediction techniques and provide a basis for more accurate predictions of future projects.

The contractor is responsible for monitoring and assessing how environmental management at each site, and for the entire project, is performing. He will monitor environmental controls employed at each site, and environmental aspects of the construction activities in general. The contractor is required to carry out routine monitoring of construction sites and construction activities in order to ensure that requirements and measures specified in the CEAP are implemented and impacts are minimized or mitigated. This will be on a site by site basis, and shall be continual frequent. This includes physical monitoring such as water quality sampling, air quality monitoring, waste tracking etc. Environmental staff of contractor is responsible for this monitoring.

9.1.4 Auditing

Internal and external environmental audits will be undertaken throughout the construction process to ensure that the Project environmental requirements and the EMP are implemented appropriately.

The auditing process should be designed to identify any non-conformances, providing an opportunity to apply corrective and / or preventative action where appropriate. The auditing schedule will be

- Internal auditing every three months on implementation of the EMP
- Internal auditing every six months on adequacy of EMP
- External (third party or independent) auditing on the project environmental performance every six months.

Internal auditing will be carried out by the EU-DHP quarterly and by WEC six months. External auditing will be conducted by the external monitoring and evaluation consultants for auditing of existing practices against the requirements of EMP. The following aspects will be covered under the external audit:

- the EMP is being adequately implemented,
- mitigation measures are being implemented and their effectiveness,
- the compliance and effects monitoring are being conducted,
- environmental and social trainings are being conducted, and
- complete documentation is being maintained.

These audits would be used to re-examine the continued appropriateness of the EMP and to provide advice on any up-dates required. Attention would be given to lessons learnt in the light of experience. In particular, consideration would be given to the monitoring programs in place to determine whether their purpose has been served and they can therefore be terminated or reduced in frequency.

WAPDA Management would review the results of internal and external audits and provide commitment and resources to tackling outstanding issues. WAPDA Management would support the proposed EMU in mechanisms to manage financial payments to contractors based on performance against the items identified in the EMP.

9.1.5 Corrective Action (Non-Compliance Notice)

Any no-compliances identified on the Project during monitoring and auditing will be immediately reported to the contractor through a corrective action request. For serious non-compliance issues such as pollution, erosion, reckless treatment of nature, hazardous working conditions, etc., the Deputy Project Director – Safeguards have authority to give stop-orders to the contractor and address .those issues immediately.

For other issues, a request will be sent within one working day of any of the following:

- A major departure from agreed or approved procedure, approval conditions or Project environmental management objectives;
- A minor non-compliance with the EMP performance criteria; and/or
- Any perceived breaches of the contractual requirements.

The corrective action report from contractor in response to non-compliance notice should include details of the environmental effect, action taken to correct the problem and proposed measures to prevent the occurrence of a similar incident. The identification, reporting and rectification of environmental deficiencies by the construction workers should be encouraged at Project inductions and in toolbox talks (Section 9.4.1.2).

Regular and continuous site inspections should be undertaken by the EU-CSU in conjunction with the contractor's environment manager and EU-DHP to identify those day-to-day tasks such as the maintenance of environmental controls, the adjustment of existing environmental controls or minor modifications to practices that need to occur. A list of observations will be made during these site inspections and actions recommended to rectify issues.

Where recommended actions are suggested, priorities shall be set against these actions for site implementation. The list of actions shall be distributed to the responsible personnel, typically the Foremen or responsible Site Engineer for action.

9.1.6 Reporting and Feedback Mechanism

The following reports to be prepared by various parties during implementation of EMP:

- Daily reports by the Contractor to the EU-CSC and EU-DHP
- Weekly reports by EU-CSC to the EU-DHP
- Monthly reports by Contractor to the EU-CSC and EU-DHP
- Monthly reports by EU-DHP for internal circulation
- Quarterly reports by EU-DHP to the World Bank and KP-EPA
- Six-monthly reports by External Auditors

Daily reports by the contractor shall include compliance issues related to the daily construction activities. Before starting of construction works, the contractor will prepare a checklist and pro-forma for preparing daily reports which will be approved by EU-CSC. The daily monitoring reports will include following compliances, but not limited to:

- Excavation, re-use and disposal quantities of earth materials
- Dust suppression
- Noise and vibration control
- Sewage and waste water releases
- Spoils and Solid waste
- Soil erosion and landslides
- Oil or hazardous waste spills
- Training
- OHS

EU-CSC will prepare weekly reports on the status of EMP implementation and environmental performance of the contractor. These reports shall be based on the contractor's reports and their supervision. EU-CSC shall assess how accurate is the factual information provided in the contractor's reports, fill any gaps identified in them, and evaluate adequacy of mitigation measures applied by contractor. CSC must highlight any cases of non-compliance with EMPs, inform on any acute issues brought up by contractor or revealed by supervisor himself, and propose corrective actions.

Contractors will prepare monthly reports on implementation of EMP against the approved programs; any difficulties encountered in the implementation of EMP and recommendations for remedying them for the future; the number and type of non-compliances and proposed corrective action; reports from sub-contractors on implementation of EMP; details of air, noise and water quality monitoring; and minutes of monthly meeting held with EU-DHP and EU-CSC.

EU-DHP will prepare brief monthly reports for internal circulation with information on the main types of activities carried out within the reporting period,

- status of any clearances/permits/licenses which are required for carrying out such activities,
- mitigation measures applied, and any environmental issues emerged in relations with suppliers, local authorities, affected communities, etc.
- findings of the monitoring programs, with emphasis on any breaches of the control standards, action levels or standards of general site management
- any emerging issues where information or data collected is substantially different from the baseline data reports in the EIA
- outstanding non-compliance issues

EU-DHP shall report quarterly to the World Bank and KP-EPA on the status of environmental compliance of construction works. The quarterly reports will include environmental mitigation measures and monitoring activities undertaken, details of monitoring data collected, analysis of monitoring results, recommended mitigation measures, environmental training conducted, and environmental regulatory violations. EU-DHP shall inform the World Bank on any major environmental issues at any time, independently from the schedule of regular reporting.

9.2 EMP SUB PLANS

The EMP is prepared as a series of sub-plans which as a whole will direct environmental management procedures and the implementation of prescribed mitigation measures during the construction and operational phases of the Project. The following sub-plans have been developed and presented in Sections 9.2.4 to 9.2.18:

- EMP Sub-Plan 1: Construction Management
- EMP Sub-Plan 2: Operational Management
- EMP Sub-Plan 3: Physiography and Geology
- EMP Sub-Plan 4: Hydrology & Surface Water Management
- EMP Sub-Plan 5: Air Quality Management
- EMP Sub-Plan 6: GHG Emission Reductions and Climate Change Monitoring
- EMP Sub-Plan 7: Noise and Vibration Management
- EMP Sub-Plan 8: Waste Management
- EMP Sub-Plan 9: Hazardous Substances Management
- EMP Sub-Plan 10: Terrestrial Ecology (Flora and Fauna) Management
- EMP Sub-Plan 11: Aquatic Ecology Management
- EMP Sub-Plan 12: Traffic Management
- EMP Sub-Plan 13: Physical Cultural Resources Management
- EMP Sub-Plan 14: Occupational Health and Safety
- EMP Sub-Plan 15: Summary 'Social and Resettlement Management Plan'

It is the accumulation of these sub-plans that constitutes the Project EMP. There might be some overlap between sub-plans as often several different environmental impacts can be mitigated for by a single action. The first two sub-plans on construction and operations contain directions to appropriate sub-plans. The discipline-specific sub-plans contain direction that is relevant to all phases of the Project and as such they are applicable throughout the entire Project life-cycle.

EMP related to construction impacts and mitigation measures are presented in the form of Environmental Code of Practices and explained in the following section.

9.2.1 Environmental Code of Practices (ECP)

The objective of the Environmental Code of Practices (ECPs) is to address all potential and general construction related impacts during implementation of the DHP. The ECPs will provide guidelines for best operating practices and environmental management guidelines to be followed by the contractors for sustainable management of all environmental issues. These ECPs shall be annexed to the general conditions of all the contracts, including subcontracts, carried out under the Project.

The list of ECPs prepared for the DHP is given below and ECPs are presented in Annex 9.3:

- 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 & 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: Construction Camp Management
- ECP 17: Cultural and Religious Issues
- ECP 18: Workers Health and Safety

The ECPs will form the part of the contract documents and will be used as monitoring tool for compliance. It is mandatory for the main contractors procured directly by the project to include these ECPs in their subcontracts. The contractor shall also comply with the guidelines given in World Bank Group Environmental, Health and Safety Guidelines, 2007[1].. Contractors and subcontractors are requested to refer the EMP sub-plans given in the EIA report of the Project for further information on corrective actions, performance indicators, monitoring and auditing protocols.

9.2.2 Adaptation of EMP during Implementation

Though the EMP and its sub plans covers all the possible impacts arising from various project activities – for a project as big as DHP, some adaptation/changes are possible during implementation. These changes may not be known at this stage. In such instances, modifications in the EMP will be carried out by the EU-CSC.

The EU-CSU will review the EMP, its operation and effective implementation at least every six months. Between the scheduled reviews, a register of issues will be maintained to ensure that issues raised by internal or external personnel associated with the Project is recorded.

[1] http://www1.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES

The purpose of the review is to ensure that the EMP is meeting the requirements of the standards, policies and objectives and if not to amend the EMP to address any short comings. The review will consider:

- Site personnel comments;
- Audit findings;
- Environmental monitoring records;
- Community complaints;
- Details of corrective and preventative actions taken;
- Incident reports;
- Changes in organization structures and responsibilities;
- The extent of compliance with objectives and targets; and
- The effect of changes made to environmental standards and/or legislation.

Acting on the findings of the review, the EU-CSU will review the various policies and objectives and submit PD and World Bank for approval.

9.2.3 Inclusion of EMP in Contract Documents

In order to make contractors fully aware and responsible of the implications of the EMP and to ensure its compliance, it will be ensured that environmental measures are treated appropriately and separately in the tender documentation and that payment milestones are linked to environmental performance, measured by execution of the prescribed environmental mitigation measures. Such a procedure would help ensure adequate assessments of project impacts are carried out during Project construction and operation phases, where a consistent approach will be expected on behalf of contractors that warrant data and information collected from monitoring programs are compared to baseline conditions.

The contractor would be made accountable through contract documents and/or other agreements of the obligations and importance of the environmental and social components of the Project. They would be prepared to co-operate with the executing agency, project management unit, supervising consultants and local population for the mitigation of adverse impacts. After the EMP's addition in the contract documents, the contractor will become bound to implement the EMP and to hire trained environmental management staff for implementation and effectiveness of the mitigation measures.

The contractor is to bid for executing the EMP, including the hiring of recommended staff, recommended mitigation measures and monitoring programs, as part of their Bill of Quantities.

9.2.3.1 Contractors Environmental Action Plan (CEAP)

The Contractors shall be required to prepare a 'Construction Environmental Action Plan' (CEAP) demonstrating the manner in which they will comply with the requirements of EMP Sub-Plans, ECPs and the World Bank Group EHS guidelines. before mobilization and obtain approval from the EU-DHP and EU-CSU. The Plans will include a series of management plans:

- Site specific sediment and erosion control plan for each construction site and quarry;
- Site specific camps management plan for each camp;
- Spoil management and disposal plan for each site;
- Waste management plan for each construction site and quarry;
- Site specific pollution control (water, air, noise) plan for each construction site and quarry;
- Site specific traffic management plan for each construction site and quarry;
- Site specific decommissioning and landscaping plans for quarry sites, spoil disposal sites, temporary roads and other disturbed areas;

- Occupational health and safety plan and training programs;
- Emergency Response Plan and Early Warning System ;
- HIV-AIDS Preventive Management Plan and training programs;
- Complaints logging system and response plan;
- Standard Operating Procedures for blasting operations;
- Standard Operating Procedures for pollution spills, and management of fuels and hazardous goods; and
- Demobilisation plan after completion of works

9.2.3.2 Contractor's Management Plans as BOQs

Preparation and implementation of above mentioned management plans in CEAP will be included as a line item in BOQ with a lump sum provision. Thus the contractor has a contractual obligation to prepare and implement CEAP. The contractor shall submit a draft CEAP six months before commencement of the work for approval of PMU and CSC and final version two months before the commencement.

The CEAP will form the part of the contract documents and will be used as monitoring tool for compliance. Violation of the compliance requirements will be treated as non-compliance leading to the corrections or otherwise imposing penalty on the contractors.

Payment to the contractor for all his works should be linked to the environmental performance and compliance with the EMP.

The Project Director should be entitled to stop the entire payment to the consultant if non-compliance issues are not addressed. For serious non-compliance issues such as pollution, erosion, reckless treatment of nature, hazardous working conditions, etc., the Deputy Project Director – Safeguards have authority to give stop-orders to the contractor and address .those issues immediately.

9.2.4 EMP Sub-Plan 1: Construction Management

<table>
<tr><th colspan="6">EMP Sub-Plan 1. Construction Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ To manage construction worksites to prevent environmental harm.
▪ To develop a culture of good environmental management practices among all construction personnel.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ Worksites prepared in accordance with designs providing for the management and mitigation of construction impacts.
▪ Waste water discharges, air and noise quality shall comply with NEQS, EHS and other international standards
▪ Water quality in the project area should not exceed the baseline data of 2012.
▪ Construction works are managed to avoid, or mitigate and manage impacts on the amenity and environmental conditions prevailing in the vicinity of the worksites.</td></tr>
<tr><td>Targets</td><td colspan="5">▪ Zero pollution incidents.
▪ Zero impact on human and wildlife.
▪ 100% of site personnel are trained in the environmental induction.</td></tr>
<tr><th>Impact/Issue</th><th>Mitigation Measures/ Actions</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><th colspan="6">Construction Environmental Management Plans</th></tr>
<tr><td>▪ Contractors not familiar with environmental safeguards</td><td>▪ Prequalification criteria of main contractors (dam, tunnel) shall consist of criteria to evaluate the environmental performance of the contractors. A suggested approach include their compliance with ISO 14001, 2004 Environmental Management System (EMS), OHSAH 18000 (2007) related Occupational Health and Safety (OHS) and SA 8000 (Social Accountability); and experience in working with World Bank or other donor projects for a minimum 500 million USD project.</td><td>PD</td><td>CSC</td><td>During pre-qualification of contractor</td><td></td></tr>
<tr><td>▪ Contractors' environmental staff communication skills</td><td>▪ Contractors should employ suitably qualified and experienced persons acceptably fluent in the English language, to function as Environmental Specialist and Occupational Health and Safety Specialist. Their CVs to be included in the proposal.</td><td>PD</td><td>CSC</td><td>During evaluation of contractors proposals</td><td></td></tr>
<tr><td>▪ Construction Environmental Action Plan (CEAP)
▪ Strategies/plans that require development pre- construction</td><td>○ A 'Construction Environmental Action Plan' (CEAP) needs to be prepared demonstrating the manner in which the Contractor will comply with the requirements of ECPs and the management plans proposed in Environmental Management Action Plan (EMAP).
○ The following management plans will be developed</td><td>Contractor</td><td>EU-CSU/ EU-DHP</td><td>Prior to the commence-ment of construction</td><td>Details of strategies to be formalised and documented; details of implementation of strategy to be included in monthly updates by EU-CSU</td></tr>
</table>

EMP Sub-Plan 1. Construction Management					
	prior to the commencement of Project construction: ○ Site specific sediment and erosion control plan for each construction site and quarry; ○ Site specific camps management plan for each camp; ○ Spoil management and disposal plan for each site ○ Waste management plan for each construction site and quarry; ○ Site specific pollution control (water, air, noise) plan for each construction site and quarry; ○ Site specific traffic management plan for each construction site and quarry; ○ Site specific decommissioning and landscaping plans for quarry sites, spoil disposal sites, temporary roads and other disturbed areas; ○ Occupational health and safety plan and training programs; ○ Emergency Response Plan and Early Warning System ; ○ HIV-AIDS Preventive Management Plan and training programs; ○ Complaints logging system and response plan; ○ Standard Operating Procedures for blasting operations ○ Standard Operating Procedures for pollution spills ○ Demobilisation plan after completion of works				
▪ Subcontractors procured by main contractor are not aware of EMP	▪ Main Contractors are responsible for environmental compliances of their sub-contractors. ▪ Environmental Code of Practices (ECP) should be part of contract documents of all subcontractors hired by the main contractor.	Contractor	EU-CSU/ EU-DHP	Pre-construction / Construction	Details of subcontractors are to be included in the contractors monthly report

EMP Sub-Plan 1. Construction Management					
Monitoring					
▪ Monitoring programmes that require development pre-construction	▪ The following monitoring schedules will be developed prior to the commencement of Project construction: ○ Air, noise and water quality monitoring at each construction site/quarry site and sensitive receptor; and at the baseline monitoring stations of the EIA ○ Sediment/erosion monitoring at each construction site/quarry site; ▪ A complete laboratory at the site will be established with all necessary equipment to measure air, noise and water quality for all key parameters mentioned in NEQS ▪ Review and compilation of baseline data on fauna, including ○ Establishment of monitoring criteria (e.g. indicating species, critical areas) ○ Establishment of monitoring technology (sampling system, frequency, etc.) ○ Establishment of critical thresholds	Contractor Consultant	EU-CSU/ EU-DHP	Prior to the commencement of construction	Details of strategies to be formalised and documented; monitoring results to be included in monthly updates by EU-CSU
Training Programmes					
▪ Training programmes that require development pre-construction	▪ The following training programmes will be developed prior to the commencement of Project operations (refer Section 9.4): ○ Code of conduct for all Project personnel; ○ Tool box talks; ○ OHS issues ○ Health education programme for Project personnel and local residents; ○ Environmental and wildlife awareness programme for all Project personnel.	EU-CSU	EU-DHP	Prior to the commencement of construction	Details of educational programmes to be formalised and documented; details of implementation of educational programmes to be included in monthly updates by EU-CSU
Construction Phase Impacts					
▪ Construction activities will create a wide range of environmental impacts on physical, ecological, social and cultural resources	▪ Implement mitigation measures proposed in ECPs 1 to 18. ▪ Implement mitigation measures and protocols proposed in EMP sub-plans 3 to 12	Contractor	EU-CSU/ EU-DHP		Weekly monitoring by the EU-CSU along with Contractor's Environmental Manager.

EMP Sub-Plan 1. Construction Management					
▪ Personnel who are unsure of sensitive environments, potentially polluting substances, ECPs undertake works in a way that results in environmental harm.	▪ Implement a site based induction program to communicate EMP requirements of the Project to the construction personnel.	Contractor	EU-CSU	For all new personnel on first day of work	Details of inductions to be included in monthly updates to PD
▪ Local community is not kept informed about the Project related disturbances (e.g. traffic and blasting) and timeframes.	▪ Notify the local and broader community, including potentially affected businesses, residents and local government about the Project related disturbances.	Contractor	GRC	Monthly	Details of notifications to be included in monthly updates
Auditing	▪ Review the EMP every six months. ▪ Audit (internally) the implementation of the EMP every three months. ▪ Audit (externally) the Project environmental performance annually.				
Relevant Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007 ▪ Relevant policies mentioned in the sub-plans 3 to 12				

Potential Concern (Non Compliances)	Corrective Action	Responsibility
▪ Personnel are not being trained in the appropriate environmental constraints and environmental management measures	▪ Review the environmental induction to provide clearer instructions. ▪ Increase the frequency of environmental toolbox talks.	EU-CSU
▪ Local communities complain about the Project and its activities	▪ Develop a strategy for the public to raise grievances and complaints register, which will include – Time and date of complaint. – Personal details of the complainant, if no details are provided a note to that effect. – Details of the pollution event that led to the complaint including time, date, duration and any other information provided. – Details of the actions taken in response to the complaint. – Details of the reason the chosen actions were taken.	GRC-Environment

EMP Sub-Plan 1. Construction Management		
	– Communication back to complainant as to the actions undertaken to address the complaint.	
▪ Environmental incidents are occurring.	▪ Review the environmental mitigation and management measures and environmental controls being applied to each work activity affected. ▪ Increase the frequency of environmental site inspections.	EU-CSU
Reporting	▪ Contractor to report daily and monthly status reports on EMP implementation and related issues with photographs ▪ EU-CSU to report weekly and monthly with respect to environmental management performance. ▪ EU-DHP to report monthly and quarterly reports on EMP implementation ▪ Community complaints register should be filed for each complaint. ▪ Quarterly reports on the water quality, air quality, noise and vibration quality at the construction sites	

9.2.5 EMP Sub-Plan 2: Operations Management

<table>
<tr><th colspan="6">EMP Sub-Plan 2. Operational Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ To manage operations of the Project to prevent environmental harm.
▪ To develop a culture of good environmental management practices among all Project employees.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ Operations are managed to avoid, or mitigate and manage impacts on the amenity and environmental conditions prevailing in the vicinity of the dams, reservoirs and supporting infrastructure.
▪ Waste water discharges, air and noise quality shall comply with NEQS 2000
▪ Water quality in the project area should not exceed the baseline data of 2012.</td></tr>
<tr><td>Targets</td><td colspan="5">▪ Zero pollution incidents.
▪ 100% of operational personnel trained in the environmental induction.
▪ Zero impacts to wildlife as a result of Project operations.
▪ Successful implementation and maintenance of all restoration area resulting from Project implementation.
▪ Increase in the numbers of wildlife utilising the reservoirs and surrounding Protected Areas.
▪ Minimise the environmental footprint of the Project.</td></tr>
<tr><th>Impact/Issue</th><th>Mitigation Measures/ Actions</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><th colspan="6">Strategies/Plans</th></tr>
<tr><td>▪ Strategies that require development pre-operations.</td><td>▪ An ‘Operation Environmental Action Plan’ (OEAP) needs to be prepared demonstrating the manner in which the Contractor/Operator will comply with the requirements of management plans proposed in EMAP.
▪ The following strategies and procedures will be developed prior to the commencement of Project operations:
○ Dam specific security and public access control strategy;
○ Dam specific GHG abatement strategy;
○ Dam specific waste management strategy;
○ Dam specific air and noise control strategy;
○ Dam specific traffic control strategy;
○ Reservoir specific sediment and erosion, and landslides control strategy;
○ Recycling strategy;
○ Environmental releases strategy;</td><td>Dam Control Office</td><td>EU-DHP</td><td>Prior to the commencement of operations</td><td>Details of strategies to be formalised and document details of implementation of strategy to be included in monthly updates by EU-CSU</td></tr>
</table>

EMP Sub-Plan 2. Operational Management					
Monitoring					
▪ Monitoring programmes that require development pre-operations.	▪ The following monitoring programmes will be developed prior to the commencement of Project operations ○ Sediment movement and reservoir accumulation monitoring; ○ Environmental releases monitoring; ○ Seismic activity monitoring; ○ Landslide monitoring; ○ Fish monitoring; ○ Water quality monitoring ○ Watershed, glacier and flood telemetry monitoring	Dam Control Office/ EU-CSC	EU-DHP	Prior to the commencement of operations	Details of monitoring programmes to be formalised and documented, monitoring results to be included in monthly updates by EU-CSU
Training/Educational Programmes					
▪ Training/ educational programmes that require development pre-operations.	▪ The following educational programmes will be developed prior to the commencement of Project operations (ref. Section 9.4): ○ Employee induction programme on environmental awareness; ○ Employee code of conduct; ○ Wildlife education program for employees and local residents; ○ Health and Safety training programme	EU-CSC	EU-DHP	Prior to the commencement of operations	Details of educational programmes to be formalised and documented; details of implementation of programmes to be included in monthly updates by EU-CSU
Operations Phase Issues (*to be applied in addition to all relevant sections of sub-plans 3-12*)					
▪ Operational activities will have impacts on water quality, GHG emissions, waste etc.	▪ Implement mitigation measures included EMP sub-plans 2 to 14	Dam Control Office	EU-DHP	Throughout operational life cycle of Project	Monthly monitoring
▪ Personnel who are unaware of operational measures that may result in environmental harm	▪ Implement an operational induction program to communicate environmental management requirements of the Project to all new operational personnel.	EU-DHP	WEC	For all new personnel on first day of work	Include details of inductions in monthly updates by EU-CSU to management

<table>
<tr><th colspan="6">EMP Sub-Plan 2. Operational Management</th></tr>
<tr><td>▪ Loss of active dam storage due to sediment deposition in the reservoirs</td><td>▪ Develop and implement a detailed monitoring programme of sediment movements in the reservoir systems, use data to optimise power generation whilst minimising environmental harm</td><td>Dam Control Office</td><td>PD</td><td>Throughout operational life cycle of Project</td><td>Include details of sediment monitoring programme in monthly operations reports</td></tr>
<tr><td>▪ Landslides in reservoir during operational phase</td><td>▪ Monitor stability of landslide prone areas during operational phases (see sub-plan 5).
▪ First filling of reservoir should be done at a slow pace of 1 m/day</td><td>EU-DHP</td><td>WEC</td><td>Throughout operational life cycle of Project</td><td>Include details of landslide stability monitoring programme in monthly reports</td></tr>
<tr><td>▪ Impacts on fish movement and its habitat</td><td>▪ Implement EMP sub-plan on Aquatic Ecology
▪ Start a reservoir fishery management program and monitor reservoir fishery production</td><td>Consultant</td><td>EU-DHP</td><td>Throughout operational life cycle of Project</td><td>Include details of fish monitoring program in monthly operations reports</td></tr>
<tr><td>Auditing</td><td colspan="5">▪ Review the OEAP every six months.
▪ Audit (internally) the implementation of the OEAP every three months.
▪ Audit (externally) the Project environmental performance annually.</td></tr>
<tr><td>Relevant Guidelines, Standards and Legislation</td><td colspan="5">▪ United Nations framework on Climate Change, 1992;
▪ Pakistan Environmental Protection Act, 1997
▪ National Environmental Quality Standards, 2000 and 2010
▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007
▪ Relevant policies mentioned in the sub-plans 3 to 12</td></tr>
</table>

Potential Concern (Non Compliances)	Corrective Action	Responsibility
▪ Personnel are not being trained in the appropriate environmental constraints and environmental management measures	▪ Review the environmental induction to provide clearer instructions. ▪ Increase the frequency of environmental updates.	EU-DHP
▪ Local communities complain about the Project operations.	▪ Develop a strategy to clearly communicate with the community about the Project.	GRC - Environment
▪ Environmental incidents are occurring.	▪ Review the environmental mitigation and management measures and environmental controls being applied to each work activity affected. ▪ Increase the frequency of environmental site inspections.	EU-DHP

Reporting	▪ Contractors to report monthly status reports on EMP implementation, monitoring outcome and related issues with photographic record ▪ Operations EU-CSU to report monthly with respect to Project environmental management performance. ▪ Document all activities which are haltered due to environmental incidents. ▪ Community complaints register should be filed for each complaint.

9.2.6 EMP Sub-Plan 3: Physiography and Geology

EMP Sub-Plan 3. Physiography and Geology Management					
Objective	▪ Reduce the potential for impacts resulting from topographical changes (soil erosion, landslides) and soil contamination during construction. ▪ Manage and minimise impacts of construction works on the environmental values of the Indus River. ▪ Seek to increase the recovery of construction spoil for re-use in the project works.				
Performance criteria	▪ Identify the potential for and then avoid or reduce, monitor and manage the potential impacts of erosion, landslides Manage and mitigate the impacts of spoil removal, haulage, soil disturbance, stockpiling and placement at spoil placement sites. ▪ Conduct induction and training for construction staff on procedures for recognising, remediation and management of spills and leaks of hazardous materials.				
Targets	▪ 50 percent of excavated rock (spoils) to be reused as aggregates and road fill ▪ Landscaping of all disturbed areas				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Changes in natural topography, due to excavation, will impair the natural landscape and induce a series of impacts such as soil erosion, landslides and changes in drainage pattern	▪ The topography of the final surface of the leveled lands shall be conductive to enhance the natural draining of rainwater and floodwater. ▪ Restoration of cleared areas, quarries which are no longer in use, spoil areas, and any areas temporarily occupied during construction of works shall be undertaken using landscaping, provision of adequate drainage and revegetation ▪ spoil heaps and excavated slopes shall be compacted and protected to prevent erosion	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Landslides during excavation of weak slopes	▪ Considering of Land sliding issues in the project design by including retaining walls, cross drainage, toe protection, rock anchoring and other similar structures/measures.	Design Engineer	DHP	Pre-Construction	
	▪ During construction, any blasting activities near the potential landslide areas will be controlled and contained within defined limits. Special attention will be paid to the blasting areas, where rock mass conditions are poor due to presence of shear zones. ▪ During excavations the concerned slopes will be	Contractor	EU-CSU/ EU-DHP	Construction	Monthly displacement monitoring and visual inspection of slopes/landslides during construction

EMP Sub-Plan 3. Physiography and Geology Management					
	stabilized and excavation started exacted from the top then gradually working down the slope. After blasting a riser, it will be stabilized by pre-designed support systems such as shotcrete, mesh and rock bolts prior to drilling the next riser for excavation. ▪ Installation of drainage systems will to prevent water entering in to these areas with adequate maintenance and monitoring. ▪ The contractor will develop Emergency Preparedness Plan and Early Warning System to set out response actions in the event of a landslide. ▪ Monitor stability of landslide prone areas at 18 identified locations along reservoir and 30 locations along relocated KKH during construction and operational phases				
▪ Reservoir induced landslides	▪ Initial filling of reservoir shall be slow at the rate of 2m/day. During the sediment flushing, the fill rate of 4 m/day and emptying rate of 3 m/day is recommended to minimize the landslides ▪ Monitor stability of landslide prone areas at 18 identified locations along reservoir ▪ Stabilization of landslides by structural measures such as removal of unstable area, and anchoring works, etc. ▪ Control of drawdown rate of reservoir water level during reservoir operation ▪ Surface water drainage management ▪ Vegetation development	Contractor	EU-CSU/ EU-DHP	Construction/ Operation	Monthly displacement monitoring and visual inspection of slopes/landslides
▪ Soil erosion from construction activities, spoil disposal sites and quarry sites	▪ Implement ECPs 6, and 7 on Erosion and Sediment Control and Top Soil Management ▪ Erosion control measures and landscaping of spoil disposal areas, quarry sites and construction areas	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection

EMP Sub-Plan 3. Physiography and Geology Management					
▪ Excessive Groundwater dewatering can lead to significant delays in construction of tunnels	▪ Groundwater control methods are included in the technical designs to construction process to effectively reduce the dewatering requirement to a minimum	Contractor	EU-CSU/ EU-DHP	Construction	Daily monitoring of groundwater discharges
▪ Generation of about 20 million cubic meters of spoils	▪ Minimize generation of spoils by recycling the excavated rock to the maximum extent by using them as aggregate material for concrete and road fill ▪ Carry out the necessary tests immediately after excavation, as and where required, to assess the suitability of excavated material for aggregates manufacturing. All suitable material will be transported to the crushing site at Kaigah for further processing. Contractors will carefully plan both excavation and quarrying activities to maximize the use of excavated rock as aggregates. ▪ Disposal at the approved locations, filling behind retaining walls and filling of low level areas along KKH ▪ Protection of spoils from erosion through landscaping	Contractor	EU-CSU/ EU-DHP	Construction/ Operation	Daily monitoring of soil generation and reuse
▪ Loss of active dam storage due to sediment deposition in the reservoirs.	▪ Integrated watershed management of UIB is critical for control of sedimentation in to the Indus. Detailed studies are recommended for planning, design and implementation of integrated watershed management for control of erosion and sedimentation in the UIB.	EU-DHP	WEC	Operational Phase	Monthly inspection of sedimentation records
▪ Dam safety due to earth quakes	▪ Monitoring of seismicity in the project area ▪ Installation of dams safety monitoring equipment	DHP	Dam Safety Unit of WAPDA	Operational Phase	Daily record of seismicity and safety monitoring equipment
Auditing	▪ Audit sediment and erosion controls and review the management measures monthly ▪ Carry out formal inspections of stockpiles, work areas and adjacent areas to verify spoil and stockpile management weekly. ▪ Carry out formal inspections of hazardous substances storage and usage areas weekly.				
Relevant Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000, 2009 and 2010				

EMP Sub-Plan 3. Physiography and Geology Management		
	▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007	
Potential Concern	**Corrective Action**	**Responsibility**
▪ New deformation due to landslide movement	▪ Implement structural measures such as (i) Partial removal of the rockslide materials from the upper slope, and (ii) Concrete retaining wall to support the toe part of the rockslide.	Contractor
▪ Land is contaminated by Project activities.	▪ Use spill containment and clean up measures to prevent spread of contamination. ▪ Manage contaminated land in accordance with specialist advice. ▪ Review the containment and control measures in place to prevent pollution.	Contractor
▪ Sediment is generated and released from the Project area.	▪ Review the sediment and erosion control plans. ▪ Reinstate damaged sediment and erosion controls as soon as practical following rainfall events.	Contractor
▪ Land is lost around the Project site through river erosion or land slide processes exacerbated by the Project.	▪ Apply the mechanism for compensation to land holders in the event that the Project causes loss of land.	PD
Reporting	▪ Daily records on soil generation, re-use and their disposal ▪ Monthly reports with details of landslide stability monitoring, sedimentation incidents, and quarry related environmental impacts ▪ Report all spills and incidents that pollute terrestrial and aquatic environments. ▪ Report on soil condition observations (such as the adequacy of sediment and erosion controls) in a monthly report.	

9.2.7 EMP Sub-Plan 4: Hydrology & Surface Water Management

<table>
<tr><th colspan="6">EMP Sub-Plan 4. Surface Water Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ To reduce potential impacts of construction on the water quality of Indus and its tributaries
▪ To reduce potential impacts on hydrology from the operation of the project with no net increase of the downstream flooding potential resulting from the Project.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ Waste water quality shall comply with NEQS 2000
▪ Water quality in the project area should not exceed the baseline data of 2012.
▪ Sediment generation from the works is controlled and mobilisation of sediment into surface water systems is reduced.</td></tr>
<tr><td>Targets</td><td colspan="5">▪ No sustained or significant increase in pollutant levels in local waterways due to the Project.
▪ No environmental harm caused by hydrocarbon or chemical spills.
▪ No significant impacts to downstream ecosystems as a result of the Project.</td></tr>
<tr><th>Impact/Issue</th><th>Mitigation Measures/ Actions</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><td>▪ Discharges from the construction yards and sites (alkaline water from batching plants and high turbidity water from tunnel construction and quarry area)</td><td>▪ Design drainage for the quarry areas, batching plant area to direct runoff into a sump/basin for inspection for pollutants prior to discharge
▪ Design settling basins for the discharges from tunnel construction areas
▪ Establish a laboratory at Dasu with all necessary facilities for chemical analysis of water for key parameters (DO, TOC, turbidity, TSS, TDS, petroleum products); along with potable conductivity, pH and turbidity meters to assess pollution from construction activities.</td><td>Contractor</td><td>EU-CSC/
EU-DHP</td><td>Pre-Construction</td><td>Details of plans to be formalised and documented</td></tr>
<tr><td>▪ Water pollution from construction activities with in the river (coffer dams, main dam), seepage water from tunnels, and discharges from all construction sites, fuel and material storage sites, soil erosion, workers camps, etc.</td><td>▪ Implement mitigation measures proposed in the following ECPs
○ ECP 2: Fuels and Hazardous Goods Management
○ ECP 3: Water Resources Management
○ ECP 4: Drainage Management
○ ECP 6: Erosion and Sediment Control
▪ Silt fences, sediment barriers or other devices will be provided to prevent migration of silt during construction within streams and river
▪ Discharge of sediment-laden construction water</td><td>Contractor</td><td>EU-CSC/
EU-DHP</td><td>Construction</td><td>Quarterly monitoring of Water Quality at downstream of various construction sites; Spot measurements for turbidity and pH at all construction sites</td></tr>
</table>

EMP Sub-Plan 4. Surface Water Management					
	directly into surface watercourses will be forbidden. Sediment laden construction water will be discharged into settling lagoons or tanks prior to final discharge. Settling basins will be periodically cleared so as to ensure adequate water storage. Regular waste water streams are to be passed through settling basins.				
▪ Caustic / alkaline runoff from the concrete batching area may affect receiving aquatic and / or terrestrial ecosystems	▪ Contain and treat water runoff from the batching plant area prior to discharge into any natural system. ▪ Undertake pH monitoring of site runoff to ensure alkaline runoff is not leaving the site.	Contractor	EU-CSC/ EU-DHP	Construction	Weekly monitoring of pH at the concrete batching plant areas
▪ Washing out of excess concrete, concrete laden tools and equipment may mobilise concrete slurry to aquatic environments resulting in reduced water quality	▪ Construct a designated, signposted concrete wash down bay that is fully contained and bunded for all excess concrete and concrete wash down, e.g. plastic lined. ▪ Regularly maintain the concrete washout bay, treating any water prior to release to natural systems.	Contractor	EU-CSC/ EU-DHP	Construction	Weekly visual inspection on hazardous waste spills
▪ Changes in Natural river flows of the downstream (lows flow between dam and tailrace during low flow season; and downstream of tailrace during peaking operation)	▪ Operate the dam as a true run of river by allowing the whatever flow received will be returned in the Stage 1 (pre-Basha) ▪ Maintain a minimum environmental flow of 20 m^3/s from dam and 222.5 m^3/s from tailrace during low flow season ▪ Always run one turbine during Stage 2 (post-Basha) if the dam is operated as peaking plant.	Dam Control Office	EU-DHP/ WEC	Operation	Monthly measurement of water flows during low season on downstream near Dasu
▪ Degradation of downstream erosion and ecosystems	▪ Implement a sediment monitoring and management programme in the reservoir systems to minimise sedimentation.	Consultants	EU-DHP/ WEC	Operations	Six monthly

<table>
<tr><th colspan="6">EMP Sub-Plan 4. Surface Water Management</th></tr>
<tr><td>▪ Changes in downstream water quality due to thermal stratification and changes in sediment load and dissolved oxygen in the reservoir</td><td>▪ Vertical monitoring of DO and temperature in the reservoir
▪ Operational protocol to release simultaneous release of waters from LLOs and spillways for mixing of surface and deep waters in the reservoir</td><td>Dam Control Office</td><td>WEC</td><td>Operation</td><td>Monthly DO and temperature monitoring of tail race water and upstream water at Basha</td></tr>
<tr><td>▪ Surges from tailrace flows due to peaking operations</td><td>▪ Develop an operational protocol to soften the rapid water level and flow variations due to peaking
▪ This will include: (i) each turbine goes from zero to full level in two or three equal steps separated in time by a few minutes. When a second turbine is started, the same procedure will be followed for each turbine in order. The same procedure will be followed when reducing the load. The start and stop procedure can be further adjusted with the monitoring results.
▪ The start and stop procedures will be proceeded by warning signs</td><td>Dam Control Office</td><td>WEC</td><td>Operation</td><td>Monitoring of river water levels from the tailrace discharge point to the downstream</td></tr>
<tr><td>Auditing</td><td colspan="5">▪ Undertake monthly pH audits of site runoff to ensure alkaline runoff is not leaving the casting yards.
▪ Monitor physical river water quality quarterly with observations of visual assessment of oils, grease, floating scum and quantity of litter.
▪ Following extended wet weather or storm events monitor the sediment and erosion controls.</td></tr>
<tr><td>Guidelines, Standards and Legislation</td><td colspan="5">▪ Pakistan Environmental Protection Act, 1997
▪ National Environmental Quality Standards, 2000 and 2010
▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007</td></tr>
<tr><th>Potential Concern</th><th colspan="4">Corrective Action</th><th>Responsibility</th></tr>
<tr><td rowspan="2">▪ Pollutants are observed entering surface water systems.</td><td colspan="4">▪ Identify the source of pollutants and immediately implement strategies to contain and treat the discharge stream.</td><td>All site personnel.</td></tr>
<tr><td colspan="4">▪ Provide hydrocarbon spill kits at locations where pollutant sources are used and provide training to personnel on use of spill kits.
▪ Modify activity specific work practices with the aim to contain and treat any pollutants.</td><td>Contractor</td></tr>
<tr><td>▪ Significant soil erosion has occurred as a result of disturbance linked to Project activities.</td><td colspan="4">▪ Identify source of sediment and stabilise subject land.
▪ Review erosion and sediment controls.</td><td>Contractor</td></tr>
</table>

EMP Sub-Plan 4. Surface Water Management		
▪ Drainage is not effectively conveying storm flows, leading to waterlogging in Project adjacent areas.	▪ Review the drainage design and rectify any ineffective designs. ▪ Maintain the drainage system, clearing debris after rain events.	Contractor
Reporting	▪ Report site discharge / drainage pH monitoring results in a monthly report. ▪ Report all spills and incidents that pollute aquatic environments. ▪ Report all near miss pollution incidents that have the potential to pollute aquatic environments.	

9.2.8 EMP Sub-Plan 5: Air Quality Management

<table>
<tr><th colspan="6">EMP Sub-Plan 5. Air Quality Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ Ambient air quality is maintained at properties adjacent to worksites, quarry sites, stockpile locations and along KKH throughout the construction phase.
▪ Community concerns and complaints about air quality are addressed quickly and effectively.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ Avoid, mitigate and/or manage potential air quality impacts including dust, odour and vehicle emissions from construction, spoil haulage and spoil stockpiling.
▪ Air quality shall comply with NEQS 2000
▪ Take measures to manage the potential for diminished air quality (dust, odour, plant and vehicle emissions) near construction work sites.
▪ Take corrective action in response to complaints about diminished air quality at properties adjacent to construction sites as a consequence of construction works or operation of construction vehicles.</td></tr>
<tr><td>Targets</td><td colspan="5">▪ Zero community complaints regarding diminished air quality.</td></tr>
<tr><th>Impact/Issue</th><th>Mitigation Measures/Actions</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><td>▪ Ambient Air quality will be affected by construction traffic along KKH, access roads; and construction equipment and activities at the construction sites and quarry areas</td><td>▪ All access roads in the construction area that will be used by the project will be paved
▪ The construction and road machinery used during the construction process shall comply with NEQS requirements with respect to emission and noise pollution.
▪ Maintaining the construction equipment and vehicles as per manufacturer's recommendation will reduce the emissions from the equipment and vehicles
▪ Material such as pozzolan and cement will be covered with tarpaulin during transportation. covering of stock piles to minimize the amount of airborne dust generated from the site.
▪ Implement mitigation measures in ECP 10: Air Quality Management</td><td>Contractor</td><td>EU-CSU/EU-DHP</td><td>Construction</td><td>Quarterly monitoring of air quality by contractor. Weekly visual inspection for dust</td></tr>
<tr><td>▪ Dust and air pollution from the construction activities and quarry areas</td><td>▪ All dust raising locations shall be kept wet with water sprinkling. Fugitive dust emissions will be minimized by appropriate methods such as spraying water on material where required and appropriate.
▪ Development of water supply system for controlling</td><td>Contractor</td><td>EU-CSU/EU-DHP</td><td>Construction</td><td>Monthly air quality monitoring at nearby sensitive receptors</td></tr>
</table>

EMP Sub-Plan 5. Air Quality Management					
	dust from the quarry area; ▪ Continuous air monitoring will be carried out near the sensitive receptors to ensure they do not exceed ambient levels and NEQS. ▪ Implement mitigation measures in ECP 10: Air Quality Management				
▪ Dam and surrounding areas will become hotspots of air pollution hotspot due usage of about 1100 trucks per day for transport of material from quarry sites to batching plant; and from excavation areas to spoil disposal site	▪ Use of belt conveyor system for transport of material (13 km from quarry/crushing plant to batching plan; 4 km for spoil disposal) ▪ Dust controlling system will be extended to the conveyor belt system. A belt conveyor system	Contractor	EU-CSU/EU-DHP	Construction	Monthly air quality monitoring at nearby sensitive receptors
▪ Decrease of oxygen levels and increase of carbon dioxide levels in the tunnels during construction	▪ Air quality in the tunnels should be maintained in accordance with technical specifications ▪ The quantity of fresh air pumping from outside to inside the tunnel must be boosted such that a wind velocity of 1 m/s is maintained as the minimum.	Contractor	EU-CSU/EU-DHP	Construction	Quarterly monitoring of air quality by contractor. Monthly spot measurements
▪ Removal of waste facilities and sanitation facilities may result in the production of odours that affect local people.	▪ Sanitation facilities should be decommissioned and sealed, e.g. landfills, sewage treatment, etc.	Contractor	EU-CSU/EU-DHP	Post construction	Monthly during decommissioning
▪ Demobilisation of the field camp and construction footprint may leave disturbed areas of land which generate dust that affects local people and/or crops.	▪ Stabilisation, e.g. re-vegetation/compaction of disturbed areas, should be undertaken as soon as possible following works.	Contractor	EU-CSU/EU-DHP	Post-construction	Monthly during decommissioning
Auditing	▪ Audit community complaints and responses with regards to the incidence of dust deposition, odours and construction vehicle emissions in relation to ambient air quality. ▪ Visual Site audits in the instance a complaint relevant to nuisance dust are received.				

<table>
<tr><th colspan="3">EMP Sub-Plan 5. Air Quality Management</th></tr>
<tr><td>Relevant Guidelines, Standards and Legislation</td><td colspan="2">▪ Pakistan Environmental Protection Act, 1997
▪ National Environmental Quality Standards, 2000 and 2010
▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007</td></tr>
<tr><th>Potential Concern</th><th>Corrective Action</th><th>Responsibility</th></tr>
<tr><td>▪ Community complaints received in relation to Project air emissions.</td><td>▪ Conduct a review of construction activities / methods in the area, propose or adopt methods to reduce dust generation or site emissions in the event of goals being exceeded.
▪ Modify the site environmental management practices as required.
▪ Follow the status of all registered air quality complaints.</td><td>GRC - Environment</td></tr>
<tr><td>▪ Environmental recommendations, environmental constraints or environmental requirements in relation to air quality are not adequately reflected and/ or incorporated into construction activities.</td><td>▪ Commit to regular construction planning meetings to review all relevant construction activities and agree on suitable control/management measures that can be adopted to achieve nominated goals.
▪ Conduct regular site inspections of the construction site activities against relevant environmental performance criteria.</td><td>Contractor</td></tr>
<tr><td>Reporting</td><td colspan="2">▪ Report on construction air quality observations in a monthly report.
▪ Documentation of all logged activities which were haltered due to adverse weather (wind) conditions.
▪ Report all air quality complaints to the EU-DHU immediately.
▪ Summarise the outcome of any complaint investigations in monthly reports.
▪ All air quality complaints received shall be recorded in a register.</td></tr>
</table>

9.2.9 EMP Sub-Plan 6: GHG Emission Reductions and Climate Change Monitoring

EMP Sub-Plan 6. GHG Emission Reductions and Climate Change Monitoring					
Objective	▪ To minimise the release of GHG's from the Project during the construction phase and operation phase ▪ Monitoring of climate change and design any adaptation measures if required.				
Performance criteria	▪ Avoid, mitigate and/or manage the release of GHG's as a result of construction activities. ▪ Implement measures to reduce the release of GHG's from the Project during the operational phase ▪ Project withstands to extreme climate change events.				
Targets	▪ Measurable reductions in GHG's emissions from the Project during both construction and operational phases as a result of the implementation of proactive reduction measures. ▪ Better understanding of climate change and its impacts on DHP				
Impact/Issue	**Mitigation Measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Extreme events such as floods caused by climate change	▪ A flood telemetry network is recommended in the catchment of DHP for early warning system and better management floods ▪ Glacier monitoring program for monitoring and research on the Upper Indus Basin glaciers.	Snow and Hydrology Department of WAPDA	PD	Through out Project life cycle	Online continuous data
▪ Uncertainties in climate change impacts on land slides, river erosion, etc.	▪ A follow-up monitoring and adaptive management mechanism is required to monitor and understand the climate and its impacts on the project and design any adaptation measures if required ▪ Monitoring of temperature and rainfall in the DHP catchment area with the telemetry network ▪ Establishment of a complete weather monitoring station at DHP (rainfall, snow fall, temperature, wind speed, wind direction, evaporation, etc.)	Snow and Hydrology Department of WAPDA	PD	Through out Project life cycle	Annual review of the data
▪ Emissions from construction vehicle and equipment may contribute to greenhouse gas concentrations	▪ Implement vehicle exhaust emission controls including the following: ○ Regular maintenance of vehicles, plant and machinery in accordance with manufacturer's specifications. ○ Monthly visual inspections on vehicle and plant exhausts to identify excessive emissions of smoke, and maintenance undertaken where required. ○ Approved pollution control devices to be fitted to equipment and machinery. ○ Transport vehicles shall not be overloaded.	Contractor	EU-CSU/EU-DHP	Construction/ Operation	Monthly visual inspections

<table>
<tr><th colspan="6">EMP Sub-Plan 6. GHG Emission Reductions and Climate Change Monitoring</th></tr>
<tr><td></td><td>○ Switch off / throttle down all site vehicles and machinery when not in use.
○ Avoid unnecessary idling of equipment.
▪ Develop planation sites wherever feasible in the buffer areas of the reservoir, along KKH, and near permanent facilities of the project, WAPDA colony, resettlement villages, etc.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>▪ Emissions of CO_2 and CH_4 from reservoir</td><td>▪ Remove all trees from reservoir area prior to inundation. This will allow the reservoir less organic matter available for decomposition
▪ Reduce the biomass and debris quantity in the reservoir which generates GHG emissions. Ensure proper operation of trash racks at the power intake and flaps at spillway gates that are installed to collect and dispose the biomass such as logs and vegetation</td><td>Contractor</td><td>EU-DHP</td><td>Operations</td><td>Monthly monitoring of approximate biomass volumes collected</td></tr>
<tr><td>Auditing</td><td colspan="5">▪ Audit all vehicles, plant and machinery used during the construction phase of the Project to ensure it is running to manufacturer's specifications and not emitting excessive GHG's due to poor maintenance.
▪ Record amount of arboreal vegetation removed from reservoir sites prior to inundation and calculate the reduction in GHG emissions resulting from this removal.</td></tr>
<tr><td>Relevant Guidelines, Standards and Legislation</td><td colspan="5">▪ Pakistan Environmental Protection Act, 1997
▪ National Environmental Quality Standards, 2000 and 2010
▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007
▪ United Nations framework on Climate Change, 1992</td></tr>
</table>

Potential Concern	Corrective Action	Responsibility
▪ Excessive GHG emissions are observed.	▪ Stand Down relevant plant / equipment / vehicles that are producing excessive emissions. ▪ Plant / equipment / vehicles identified as generating excessive air emissions shall be repaired and more regular maintenance scheduling shall be implemented.	Contractor
Reporting	▪ Report monthly on compliance of GHG emissions abatement measures throughout construction and operational phases of Project. ▪ Report on compliance of GHG emissions reduction measures (e.g. vegetation removal) prior to inundation of reservoirs.	

9.2.10 EMP Sub-Plan 7: Noise and Vibration Management

<table>
<tr><th colspan="6">EMP Sub-Plan 7. Noise and Vibration Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ Maintain a reasonable acoustic environment for living, in particular for sleeping, and use of properties adjacent of the area of construction influence during construction works.
▪ Residential and other structures are protected from the effects of construction vibration.
▪ Consultation with concerned property owners and occupants in the area of construction influence is effective and responsive.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ Compliance with NEQS and international standards on air and ground vibration
▪ Achieve a 'reasonable' noise and vibration environment within the area of construction influence.</td></tr>
<tr><td>Targets</td><td colspan="5">▪ Zero complaints from local population relating to noise or vibration disturbance
▪ No damage to infrastructure from Project related vibrations.</td></tr>
<tr><th>Impact/Issue</th><th>Mitigation Measures/ Actions</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><td>▪ Noise and Vibration from blasting could affect the people and wildlife</td><td>▪ Perform test blasting with various charges and monitor resultant noise and vibration levels at various distances and chose optimum blast size to avoid any impacts on the nearby receptors
▪ Prior to commencement of the blasting programme (which shall be prepared in consultation with local government) the surrounding community should be notified of the timing and frequency of blasts.
▪ install and operate a siren of sufficient volume to be easily heard above the general site noise from all points within a radius of 1 km of surface blasts
▪ Blasting should only be carried out during day time.</td><td>Contractor</td><td>EU-CSC</td><td>Pre-Construction</td><td>Before, during and after blasting</td></tr>
<tr><td>▪ Traffic and construction activities may produce noise that could affect people (e.g. sleep disturbance).</td><td>▪ Implement noise control measures given in ECP 11: Noise and Vibration Management
▪ If noise standards are exceeded at sensitive receivers, adopt appropriate noise attenuation measures to reduce the noise generation from construction activities. The noise attenuation measures will include, (i) fitting of high efficiency mufflers to the noise generating equipment; and (ii) keeping acoustic enclosures around drilling equipment.
▪ Stop the construction activities, near the settlements, during night times if high noise values are observed.</td><td>Contractor</td><td>EU-CSC</td><td>Construction</td><td>quarterly noise and vibration monitoring at sensitive receptors</td></tr>
</table>

<table>
<tr><th colspan="6">EMP Sub-Plan 7. Noise and Vibration Management</th></tr>
<tr><td></td><td>▪ All vehicle used in the construction activities will comply with NEQS exhaust and noise standards (85 dBA at 7.5m from the source).</td><td></td><td></td><td></td><td></td></tr>
<tr><td>▪ Noise levels from quarry and crushing activities will affect nearby villages and community conservation area near Kaigah</td><td>In addition to above
▪ Excavation at Kaigah quarry shall be started from southern end and shall be progressed towards north, thus always maintaining a natural berm on northern and eastern side to act as acoustic shields and to avoid impacts on Kaigah village and CCA.
▪ Excavation at Gini site shall be started from the eastern side and will proceed to the western side; excavation will be carried out in a way that there will be a narrow strip of area along KKH and Gini village are maintained to act as natural berm to reduce noise and dust.
▪ Material stockpiles will also be used as acoustic shields around high noise generating equipment and crushing plants, and also along the boundaries of quarry area.</td><td>Contractor</td><td>EU-CSC</td><td>Construction</td><td>Monthly noise and vibration monitoring at sensitive receptors</td></tr>
<tr><td>Auditing</td><td colspan="5">▪ Noise monitoring schedule should be reviewed on a complaints basis at the nearest sensitive receivers.</td></tr>
<tr><td>Guidelines, Standards and Legislation</td><td colspan="5">▪ Pakistan Environmental Protection Act, 1997
▪ National Environmental Quality Standards, 2000 and 2010
▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007
▪ Air and Ground Vibration Standards (US Department of Interior Office of Surface Mines and The Australian and New Zeeland Environment Conservation Council)</td></tr>
<tr><th>Potential Concern</th><th colspan="3">Corrective Action</th><th colspan="2">Responsibility</th></tr>
<tr><td>▪ Community complaints received in relation to Project air emissions.</td><td colspan="3">▪ Conduct a review of construction activities / methods in the area, propose or adopt methods to reduce noise and vibrations in the event of standards being exceeded.
▪ Modify the site environmental management practices as required.
▪ Follow the status of all registered air quality complaints.</td><td colspan="2">GRC</td></tr>
</table>

EMP Sub-Plan 7. Noise and Vibration Management		
▪ Environmental recommendations on noise quality are not adequately reflected and/ or incorporated into construction activities.	▪ Commit to regular construction planning meetings to review all relevant construction activities and agree on suitable control/management measures that can be adopted to achieve nominated goals. ▪ Conduct regular site inspections of the construction site activities against relevant environmental performance criteria.	Contractor
Reporting	▪ Report on construction noise and vibration observations in a monthly report. ▪ Report all noise quality complaints to the EU-DHU immediately. ▪ Summarise the outcome of any complaint investigations in monthly reports. ▪ All noise and vibration related complaints received shall be recorded in a register.	

9.2.11 EMP Sub-Plan 8: Waste Management

<table>
<tr><th colspan="6">EMP Sub-Plan 8. Spoil and Waste Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ To reduce the amount of waste generated by the Project through implementing the waste management hierarchy (avoidance, reuse, recycling, and waste disposal).
▪ To reduce impacts of waste on receiving environments.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ Waste generated from the Project is to be reused or recycled where practicable on site.
▪ Any waste products leaving the site will be by safe transport methods to an approved waste management facility.
▪ Project methods and design will aim to reduce waste generation.</td></tr>
<tr><td>Targets</td><td colspan="5">▪ 50 percent reuse of excavated material (spoils) as aggregates for concrete and road fill
▪ No environments nearby the site are impacted by Project waste.</td></tr>
<tr><th>Impact/Issue</th><th>Mitigation Measures/Actions</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><td>▪ Huge quantities (about 20 MCM)of excess rock material will be generated from excavation at dam site, levelling of the grounds, tunnelling and relocation of KKH</td><td>▪ Minimize the generation of spoils by reusing the excavated rock to maximum extent as aggregates for concrete and fill material for roads
▪ Carry out necessary tests immediately after excavation, as and when required, to assess the suitability of excavated material for aggregate manufacturing
▪ Carefully plan both excavation and quarrying activities to maximize the use of spoils
▪ Prepare and implement spoil disposal plan
▪ Dispose excess rock material in the designated disposal site in an orderly manner (different spots to different size rocks)
▪ Disposal site shall be fenced towards the river side to arrest washing into the river
▪ Landscaping and erosion control plan for spoil hills
▪ New sites for spoil disposal, if required, to be approved by EU-DHP.</td><td>Contractor</td><td>EU-CSU/
EU-DHP</td><td>Construction</td><td>Monthly visual inspection</td></tr>
<tr><td>▪ Sites or facilities of waste disposal</td><td>▪ Appropriate hazardous, industrial and domestic waste disposal or recycling facilities must be identified or to be established</td><td>Contractor</td><td>EU-CSU/
EU-DHP</td><td>Pre-construction</td><td>Locations are identified and designs are approved</td></tr>
</table>

EMP Sub-Plan 8. Spoil and Waste Management					
▪ Waste generation may result in pollution of surrounding environments.	▪ Implement mitigation measures proposed in ECP1: Waste Management ▪ Regular maintenance of waste management facilities should be undertaken.	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Excess waste, chemicals or hazardous materials are left on site and pollute the surrounding environment.	▪ Remove all hazardous materials when the site is decommissioned. ▪ The contaminated areas at the construction yards, hazardous and fuel storage sites are to be rehabilitated to original condition.	Contractor	EU-CSU	Post-construction	Monthly visual inspection and chemical analysis if soil or water pollution found
▪ Demobilisation may leave litter and disturbed land which pollutes receiving environments.	▪ Field camps should be rehabilitated to pre-mobilisation condition, unless otherwise agreed in leasing conditions.	Contractor	EU-CSU	Post construction	Monthly visual inspection
Auditing	▪ Visually inspect waste storage areas during the weekly environment inspections. Observations should include: ○ detecting any leaks, spills or uncontrolled discharges; ○ excessive generation of waste; ○ visible evidence that wastes are not disposed of or collected efficiently; and ○ Visible evidence that wastes are not separated and stored in designated receptacles. ▪ At six-monthly intervals audit for presence and relevance of all MSDS's				
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007				

Potential Concern	Corrective Action	Responsibility
▪ Large unpredicted volumes of waste are generated during the construction phase, with recycling and reuse objective not being met.	▪ Undertake waste inspections to identify areas for improvement.	EU-CSU
▪ Litter is being observed around the Project site.	▪ Provide accessible and clearly labelled bins for site personnel waste. ▪ Undertake additional staff training on waste management policy.	Contractor
▪ Poor segregation of waste is observed.	▪ Provide clearly labelled bins for general waste, recyclable metal, plastic, glass and paper while providing staff training.	Contractor
▪ Complaints from the community	▪ Correction action	GRC - Environment

Reporting	▪ Summaries of waste information should be reported in the monthly report and should include:
	  ○ Details of spoil generated, suitability for reuse, transported to crushing plants, and disposed at the disposal site.
	  ○ Details of waste disposal and recycling;
	  ○ Details of any poor waste management practices observed / remedied; and
	▪ The implementation of any new initiatives to reduce waste on-site.
	▪ Include details of the decommissioning and rehabilitation in the project completion report

9.2.12 EMP Sub-Plan 9: Hazardous Substances Management

<table>
<tr><th colspan="6">EMP Sub-Plan 9. Hazardous Substances Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ To manage and mitigate any potential impacts of hazardous substances on soils, waterways and other components of the environment.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ To prevent any adverse impacts to the local environmental conditions from any spillage or leakage of fuels and chemicals.
▪ To ensure the correct transport, storage, handling and use of chemicals and fuels during the construction phase of the Project.</td></tr>
<tr><td>Targets</td><td colspan="5">▪ No environmental incidents from the release of hazardous substances, e.g. pollution of waterways from a spill.
▪ Training in environmental incident and spill response provided to all relevant site based Project personnel.
▪ Prevention of reoccurrences of incidents by appropriately implementing corrective and preventative actions and planning.</td></tr>
<tr><th>Impact/Issue</th><th>Mitigation Measures/ Actions</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><td>▪ Spill Controls</td><td>▪ Develop controls and standard operating procedures for the use of fuels to prevent spills
▪ Train and designate personnel for various spill control procedures
▪ Establish fire fighting system and fire safety (fire extinguishers) at the construction sites where fire is an hazard</td><td>Contractor</td><td>EU-CSU/
EU-DHP</td><td>Pre-
Construction</td><td></td></tr>
<tr><td>▪ Potential spills from transport, storage and use hazardous and fuel sites will contaminate the surrounding environment</td><td>▪ Implement mitigation measures in ECP 2: Fuels and Hazardous Goods Management
▪ Spill kits and trained personnel are to be made available at the workshops. Drainage from the workshops is be collected and passes through oil water separators.
▪ Contain all fuel tanks in a fully bunded area with a storage capacity of at least 110% of the potential storage volume.
▪ Use auto shut down valves for fuel transfer pipes
▪ Transport of hazardous goods and fuel to be done in closed containers and ISO certified tanks</td><td>Contractor</td><td>EU-CSU/
EU-DHP</td><td>Construction</td><td>Monthly visual inspection</td></tr>
<tr><td>Auditing</td><td colspan="5">▪ Check for leaking or damaged containers/drums weekly.
▪ Assess the walls and floor of storage bund for cracking monthly.
▪ Check bunded areas for visible pollution weekly.
▪ Check that all fuel and oil spills are cleaned up immediately using the available spill kits and in accordance with the instructions on the relevant material safety data sheet (MSDS).
▪ Check spill kits are well maintained and complete monthly.</td></tr>
</table>

EMP Sub-Plan 9. Hazardous Substances Management		
	▪ Visual inspections shall be undertaken after rainfall events, to assess the contamination risk of overland storm waters migrating through the chemical storage areas.	
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007	
Potential Concern	**Corrective Action**	**Responsibility**
▪ Spillage of hydrocarbons, oils, dangerous chemicals or other hazardous substances	▪ Clean-up, contain and dispose of spills in accordance with product specific MSDS requirements.	Contractor
	▪ Corrective Actions following a fuel or chemical spill should involve at a minimum, some of the following: ○ Conduct inspection and rectification depending on risk level. ○ Modify work practices or conduct repairs. ○ Conduct training and induction, issue memos. ○ Update procedures and documentation. ○	
Reporting	▪ Monthly reports should describe any incidents along with control measures in place to manage hazardous substances on site. Any other information considered relevant should also be included, such as: ○ Monitoring results / observations. ○ Details of quantities and type of spills. ○ Summaries of water quality checks, and any remedial actions undertaken.	

9.2.13 EMP Sub-Plan 10: Terrestrial Ecology (Flora and Fauna) Management

EMP Sub-Plan 10. Terrestrial Ecology Management					
Objective	▪ Impacts to the wildlife, habitat and ecological values of the River Indus and surrounds are minimised. ▪ Potential construction impacts on native flora and fauna are reduced and disturbed areas are rehabilitated. ▪ Impact on fauna minimized				
Performance criteria	▪ Implement measures to maintain the ecological and habitat character of the River Indus and surrounds during construction. ▪ Reasonable and practicable measures are taken to reduce the potential for native fauna to be harmed. ▪ Rehabilitate and landscape work sites upon completion of construction.				
Targets	▪ No permanent vegetation loss for temporary works; ▪ No reduction in suitable habitat for key species such markhor, musk deer, etc. ▪ Development of two community managed wildlife conservation areas in the project area				
Impacts/Issues	**Mitigation Measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Some data gaps in the presence and wildlife and its habitat in the project surrounding areas	▪ Carry out detailed studies to establish baseline data on terrestrial ecology and forests in Upper Indus Basin ▪ Establish vantage stations to monitor the presence and movement of Tragopan and migratory birds, breeding birds, small mammals, ungulates and otters. ▪ Revise, if required, this EMPs sub-plan or mitigation measures proposed in ECP 12 on Protection of Flora and ECP 13 on Protection of Fauna.	Wildlife Monitoring Consultants (like WWF, IUCN)	EU-CSU/ EU-DHP	Pre-Construction/ Construction	Monthly Monitoring using the methods described in the Terrestrial Ecology Report of EMAP
▪ 21,000 trees to be cut from the construction sites and reservoir inundation area	▪ A nursery will be established with the native species with a capacity to produce about 300,000 saplings with an objective to develop 100,000 trees (3 saplings for each proposed tree).	District Forest & Agriculture Departments	EU-CSU/ EU-DHP	Construction	Monthly monitoring of the saplings raised and delivered
	▪ Plantation to be developed in the buffer areas (at suitable sites) of the reservoir on the right bank, in DHPs office and colony, and at the resettlement with a target to develop about 5 trees for each tree cut.	District Forest & Agriculture Departments with the support of local community	EU-CSU/ EU-DHP	Construction/ Operation	Monthly monitoring of the trees planted and survived

EMP Sub-Plan 10. Terrestrial Ecology Management					
	▪ Maintain each sapling for a period of minimum 2 years with the support of local community. Community will be paid for watering and raising the plantation.				
▪ Construction activities will have wide range of impacts on flora (vegetation clearance, loss of animal shelter, soil erosion)	▪ Implement mitigation measures proposed in ECP 12: Protection of Flora ▪ A public education programme should be designed and implemented to discourage cutting of trees by the construction workers	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Construction activities will have wide range of impacts on fauna (loss of habitat and habitat quality, active nests, night lighting, poaching, dust, noise and vibration, etc.)	▪ Implement mitigation measures proposed in ECP 13: Protection of Fauna ▪ Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff ▪ conducting wildlife awareness programs to the construction workers on protection of wildlife ▪ Noise attenuation and dust control measures ▪ Decommission redundant roads after completion of construction	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Increased pressure on forest products such fuel wood for increasing demand for cooking and heating from in-migrants	▪ Support the local government to establish market for supply of non-timber fuels such as LPG for cooking and heating to reduce the pressure on firewood. ▪ Strengthening management practices of community forestry activities ▪ Afforestation programs and forest regeneration	DHP and local government	EU-CSU/ EU-DHP	Pre-Construction/ Construction	Monthly visual inspection
	▪ provide non timber fuels such as LPG to the construction staff for cooking and heating purposes	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Impact on Kaigah	▪ Carry out trail blasts with various charge amounts and	Contractor	EU-CSU/	Construction	Monthly visual

EMP Sub-Plan 10. Terrestrial Ecology Management					
community conservation area from blasting and construction activities at Kaigah quarry and crushing plant	record vibrations levels at the closest boundary of the CCA and finally chose the optimum amount of blasting per event to comply with international standards (e.g. Australia). ▪ Monitor noise levels at CCA and if it exceeds the standards, acoustic enclosures for noise attenuation are recommended for crushing plant. ▪ Realigned KKH construction at Kaigah tributary shall also comply with relevant standards..		EU-DHP		inspection
	▪ Strengthening of management measures for Kaigha CCA ▪ Promote and support two community conservation areas in the project area	EU-DHP	EU-CSU/ EU-DHP	Construction	Visual inspection
▪ Improvement and protection of local wildlife habitat and its quality	▪ Develop community based protected areas and trophy hunting (similar to existing one in Kaigah) in Kandia or Laachi valley for protection of Markhor, Musk deer, and Western-horned Tragopan ▪ Kaigah trophy hunting model and such other programmes continuing in Northern Pakistan should be propagated in the area	WWF with support of local community	EU-CSU/ EU-DHP	Construction/ Operation	Monthly noise and vibration measurements
▪ Impacts of transmission lines on migratory birds	▪ Avian risk assessment studies ▪ Maintaining 1.5 meter spacing between energized components and grounded hardware; covering energized parts and hardware; ▪ Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters ▪ Monitor the migratory birds migration to the reservoir	Consultants (e.g. WWF)	EU-CSU	Operation	Monthly inspection
Auditing	▪ Inspect work sites weekly and assess compliance with mitigation measure requirements for flora and fauna. ▪ Inspect and monitor the Project area on a monthly basis for the presence of pests and weeds.				

<table>
<tr><th colspan="3">EMP Sub-Plan 10. Terrestrial Ecology Management</th></tr>
<tr><td>Guidelines, Standards and Legislation</td><td colspan="2">▪ Forest Act of 1927 and Later Amendments
▪ KP Wildlife (Protection Preservation Conservation and Management) Act (1975) and Rules (1976)
▪ Pakistan Environmental Protection Act, 1997
▪ National Environmental Quality Standards, 2000 and 2010
▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007
▪ Interim Guidelines for Potential Effects on Bird (California Department of Transportation, 2007)</td></tr>
<tr><th>Potential Concern</th><th>Corrective Action</th><th>Responsibility</th></tr>
<tr><td>▪ Unauthorised clearing / damage to vegetation occurs.</td><td>▪ Review of current internal controls (pre-construction approvals process; survey set out; activity specific risk assessments; tool box talks) to assess where the system breakdown occurred.
▪ Develop and Implement additional or alternative controls methods if deemed necessary.
▪ Reiterate to staff the importance of environmental standards and the potential penalties associated with non-conformance.</td><td>EU-CSU</td></tr>
<tr><td>▪ Disturbed areas not reinstated / re-vegetated (rehabilitated) within nominated timeframes after the completion of construction.</td><td>▪ Review program / resources to identify timeframe constraints leading to the delay of rehabilitation.
▪ Implement temporary controls (i.e. seeding unconsolidated surfaces; compacting cut batters to ‘hard’; installation and ongoing maintenance of drainage erosion and sediment control measures) where risk is evident / within close proximity to sensitive receivers.</td><td>Contractor</td></tr>
<tr><td>▪ Fauna becomes trapped or injured by Project activities or traffic</td><td>▪ Rescue and trapped fauna where possible and release to nearby habitat.
▪ Protect worksites from future instances of fauna trapping.
▪ Where fauna is injured by Project activities, seek specialist advice and pass to a local wildlife departments.
▪ Install wildlife warning signs and impose speed limits on all Project access roads and realigned KKH</td><td>Contractor</td></tr>
<tr><td>▪ Sapling mortality and lack of growth in plantation</td><td>▪ Sapling mortality will be checked and replanting for gap filling</td><td>District Forestry Dept.</td></tr>
<tr><td>Reporting</td><td colspan="2">Monthly environmental reporting relevant to flora and fauna should include:
▪ Summary of fauna encounters.
▪ Details of any vegetation cleared and vegetation planted
▪ Any fauna injuries or deaths as a result of construction activities.
▪ Any remedial actions undertaken to protect flora and/or fauna.</td></tr>
</table>

9.2.14 EMP Sub-Plan 11: Aquatic Ecology Management

EMP Sub-Plan 11. Aquatic Ecology Management					
Objective	▪ Impacts to the aquatic habitat and ecological values of the River Indus and its tributaries are minimised. ▪ Potential construction impacts on fish are reduced and disturbed areas are rehabilitated.				
Performance criteria	▪ Implement measures to maintain the ecological and habitat values of the River Indus and its tributaries during construction. ▪ Reasonable and practicable measures are taken to reduce the potential for fish to be harmed due to construction related water pollution				
Targets	▪ No pollution of the River Indus and its tributaries ▪ No reduction in suitable habitat for native fish species ▪ Develop successful hatchery development for snow carps				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Gaps in the biological knowledge of key fish species in Indus (snow carps)	▪ Long term field studies are to be conducted to obtain biology, movement patterns and seasonal habitat use of snow carp and other native cold water species in Indus and its tributaries	Consultant or University	EU-CSU/ EU-DHP	Pre-Construction	Quarterly
▪ Adverse effect on aquatic biota by release of high concentrations of sediment, fuels/oils and other toxic compounds, and solid waste	▪ Implement mitigation measures proposed in ECPs 1 to 4, 6, 14 on water quality, waste management, and sedimentation control ▪ avoidance of coffer dam placement during the start and middle of low flow winter season when fish may be using pool areas as refuges and sediment levels are seasonally low ▪ Avoiding initial activation of diversion tunnels in winter/low flow season ▪ No dumping of excavation waste in the river	Contractor	EU-CSU/ EU-DHP	Construction	Quarterly water quality monitoring
▪ Fish entrainment and mortality when fish attempting to pass through tunnels and spillways	▪ Fish exclusion screens or fish deterrent devices on both side of the tunnels, spillways, LLOs (if justified by recommended studies on aquatic ecology)	Contractor	EU-CSU/ EU-DHP	Construction	Quarterly water quality monitoring
Changes in the upstream fish habitat (in Indus and tributaries) due to reservoir formation	▪ Developing of fish hatchery with native snow carps for stocking fish in the affected tributaries and reservoir. Experience from the snow carp hatcheries established in Uttaranchal, India (Garhwal Himalaya) and Nepal (Kali Gandaki A, Plkhra, Trishuli and Godavari) are to be considered ▪ A single facility could be used to produce juveniles for stocking streams for which spawning populations have been affected by the project, and	EU-DHP	EU-CSU/ EU-DHP	Construction/ Operation	

EMP Sub-Plan 11. Aquatic Ecology Management					
	additional fish for reservoir-stocking or to supply local grow-out facilities. The facility would require a research and development component to improve local methods and capacity for snow trout hatchery production. ▪ Maintaining spawning areas through placement of gravels/boulders and creating ripples				
▪ Impact on river habitat due to no/reduced flows between dam and tailrace during low flow season	▪ Further studies are recommended to determine the environmental flows (. Until results of those studies are available, a release of 20 m3/s from dam and 222.5 m3/s from tailrace is recommended tentatively and can be adjusted when results of further studies are available	Dam Control Office	WEC	Operation	During Flushing
▪ Impact on downstream fish due to changes in water flows and quality (temperature, DO, sediment load)	▪ Monitoring water quality and flow changes and their impact on the fish habitat; and devise additional offset measures if required ▪ Stocking of native species, through hatchery development, in the affected area	Dam Control Office	WEC	Operation	During Operation
▪ Impact on river habitat on downstream of tailrace due to reduced flows during peaking operation	▪ Operate at least one turbine and use additional water for peaking operation. This will ensure release of 222.5 m^3/s from tailrace ▪ If the high release flows are moderated by improved ramp-up protocols then stranding can be addressed through improvement of ramp-down procedures ▪ Flushing during high flow season (not in low flow/winter)	Dam Control Office	WEC	Operation	During Flushing

▪ Potential for reservoir fish development	▪ Native fish species (snow carp) are recommended for reservoir fisheries development. However further following studies are required to assess the potential for reservoir fisheries development:
	  ▪ A small R&D hatchery is recommended to undertake applied research on snow carp focussing on need to increase biological knowledge related to wild fish and fish habitat management and culture.
	  ▪ Fish, fish habitat and fisheries in Tarbela Reservoir;
		Consultants/ KP Fisheries	EU-CSU/ EU-DHP	Prior to first reservoir filling	Monthly fish catch data

Auditing	▪ Limnological conditions in reservoir: Temperature-depth profiles; DO-depth profiles; turbidity and suspended solids; other water quality parameters ▪ Fish production in tributary habitat and contribution to reservoir fish populations: ▪ Fish abundance and composition in reservoir ▪ Amount of fish entrainment through outlet portals (powerhouse intakes; spillways; lower level outlets) and associated mortalities and loss from reservoir fish				

EMP Sub-Plan 11. Aquatic Ecology Management		
	populations and/or effectiveness of measures to mitigate entrainment ▪ Effectiveness of reservoir fishery enhancement measures	
Guidelines, Standards and Legislation	▪ Fisheries Ordinance 1961 ▪ KP Fisheries Rule 1976 ▪ Pakistan National Conservation Strategy 1992. ▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007	
Potential Concern	**Corrective Action**	**Responsibility**
▪ Water pollution from construction activities	▪ Identify the source of pollutants and immediately implement strategies to contain and treat the discharge stream. ▪ Review the drainage design and rectify any ineffective designs.	Contractor
Reporting	▪ Monthly environmental reports with details of water related pollution ▪ Bi annual reports on fish and downstream habitat monitoring ▪ Annual reports on fisheries development in the reservoir	

9.2.15 EMP Sub-Plan 12: Traffic Management

<table>
<tr><th colspan="6">EMP Sub-Plan 12. Traffic Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ Project related traffic does not cause impacts to local population or environment
▪ Drivers and other Project personnel operate vehicles in a safe manner
▪ No impact on KKH traffic</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ Injuries due to traffic accidents are minimised
▪ Impacts to environment and wildlife are minimised
▪ Smooth traffic flow on KKH</td></tr>
<tr><td>Targets</td><td colspan="5">▪ Zero injuries due to Project related traffic accidents
▪ Zero traffic jams due to project related construction vehicles
▪ Minimal loss of wildlife due to traffic related encounters
▪ All Project related traffic travels within designated speed limits at all time
▪ Minimal disruption to local populous as a result of project related traffic</td></tr>
<tr><th>Impact/ Issue</th><th>Mitigation Measures/ Action</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><td>▪ About 200 -300 construction vehicles will use existing KKH, which causes traffic congestion and safety hazard</td><td>▪ Establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along KKH, contractor). Hold a one day workshop with the stakeholders to devise a plan for traffic management along KKH during construction period.
▪ A traffic unit at Dasu is proposed to control the construction related traffic inflow and outflow with sub offices along KKH at Hassanabdal, Haripur, Abbotabad, Chatter plain, Thakot, Besham, Pattan, Komela, dam site, quarry site Kaigah. These offices will be connected with telephone, fax, mobile phone and internet.
▪ The movement of traffic carrying cement or steel to be register at Hassan Abdal (junction of KKH and GT road). These will travel in small lots of 10 trucks. Hassan Abdal will inform the next stations by phone, Fax or internet.
▪ The weather conditions must be known before the start of the journey from Met office and drivers must be briefed before the start of the journey so that cargo may be protected from rain damage and driver may plan the journey accordingly.
▪ The receiving stores must be notified, who must prepare for offloading the goods. This preparation includes the location of offloading, labour for offloading together with crane or low lift fork lifters.</td><td>Contractor</td><td>EU-CSC/ EU-DHP</td><td>Pre-Constriction</td><td>Monthly inspection process</td></tr>
</table>

EMP Sub-Plan 12. Traffic Management					
	▪ Traffic facilities, such as speed limits and signal lights, are to be strengthened from Hassan Abdal to Dasu ▪ Support to be provided to the local traffic authorities to engage traffic police at the busy junctions	Traffic Police Authorities	PD	Pre-Construction	Monthly inspection
	▪ Implement the mitigation measures proposed in ECP 15: Road Transport and Road Traffic Management	Contractor	EU-CSC	Construction	Monthly
▪ No rest or lay-over areas on KKH	▪ Layover spaces to be provided between Besham and Dasu (where there no layby areas) so that the drivers can stop the vehicles whenever they feel sleepy.	Project Resettlement Office	PD	Pre-Construction	Monthly inspection of vehicles
▪ Accidents as a result of poor driving practices	▪ Upgrade all Project related roads to appropriate standards for safety ▪ Signpost hazards in high risk areas ▪ Educate all nearby villages on road safety ▪ All vehicles must be maintained to manufacturer's standards including regular maintenance of tires, breaks and lights. ▪ Capacity building of drivers on defensive driving	Contractor	EU-CSU	Pre-construction/ Construction	Monthly traffic related accidents
▪ Weak carrying capacity of KKH	▪ Repair of the road as well as that of bridges including routine repair. Up-grading of the KKH has already been initiated to provide the means of transportation for the construction requirements of the Basha Dam project, which was previously planned to be constructed prior to the DHP. ▪ FWO shall increase the number of road gangs and machinery stationed for immediate removal of landslides and clearance of the road. ▪ The jurisdictions of the gangs and machinery be reviewed and made shorter for better control and tacking of the problem.	NHA	PD	Pre-construction/ Construction	Quarterly
Auditing	▪ Audit condition of all Project vehicles on a regular basis; ▪ Audit adherence to speed limits, issue fines to drivers who repeatedly speed; ▪ Investigate all deaths and injuries to humans and wildlife resulting from collisions with Project related vehicles ▪ Compliant register				
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007				

EMP Sub-Plan 12. Traffic Management		
Potential Concern	**Corrective Action**	**Responsibility**
▪ Complaints related to traffic congestion and safety from community	▪ Investigations of complaints	GRC - Environment
▪ Speeding in Project related vehicles resulting in injury or death	▪ Implement disciplinary measures for repeat offenders	EU-DHP
▪ Accidents due to poorly maintained vehicles	▪ Ensure all Project vehicles undergo a monthly safety inspection, do not use any vehicle that fails this inspection	EU-CSU
▪ Accidents due to poorly maintained roads	▪ Ensure all Project related roads are well maintained	Contractor
Reporting	▪ Monthly environmental reports should include: ○ Details of any traffic related incidents ○ Details of corrective action implemented ○ Details of any disciplinary measures taken against Project personnel deemed at fault ○ Details of potential traffic hazards identified by Project personnel	

9.2.16 EMP Sub-Plan 13: Physical Cultural Resources Management

<table>
<tr><th colspan="6">EMP Sub-Plan 13. Physical Cultural and Social Resources Management</th></tr>
<tr><td>Objective</td><td colspan="5">▪ Protection and preservation of cultural heritage
▪ Physical cultural resources in the area protected and respected.</td></tr>
<tr><td>Performance criteria</td><td colspan="5">▪ No historical, archaeological and cultural sites are affected by the project activities
▪ All graveyards that will be submerged are properly protected through stone/mud pitching.
▪ No community conflicts due to project related activities
▪ No stress on existing community resources due to influx of large number of construction workers</td></tr>
<tr><td>Targets</td><td colspan="5">▪ Rock carving sites are protected and fenced
▪ Minimal disruption to local populous as a result of project activities</td></tr>
<tr><th>Issue</th><th>Action</th><th>Responsibility for implementation</th><th>Responsibility for Supervision</th><th>Timing</th><th>Monitoring</th></tr>
<tr><td>▪ An historical old mosque with wooden structure will be submerged under reservoir</td><td>▪ The mosque at Seer Gayal will be disassembled and reassembled at a new location
▪ Additional facilities such drinking water, sanitation and termite protection measures will also be provided to the mosque</td><td>Contractor</td><td>EU-CSC/ EU-DHP</td><td>Prior to first reservoir filling</td><td>Monthly</td></tr>
<tr><td>▪ Submergence of 17 grave yards in the reservoir</td><td>▪ The graves must be protected by stone-pitching so that no floating and washing away of the bodies or skeletal remains occur.</td><td>EU-CSC</td><td>EU-DHP</td><td>Prior to first reservoir filling</td><td>Monthly</td></tr>
<tr><td rowspan="2">▪ Rock carvings at Shatihal are currently located in a private land and not protected and are subjected to vandalism. They have potential for further vandalism by construction workers</td><td>▪ DHP will support KP archeological department to (i) procure 25 acres of land for acquisition of land, in which rock carvings are located , (ii) fence the area, (iii) provide fiberglass sheds; (iv) develop tourist facilities and (v) documenting the importance of rock carvings and their translations</td><td>KP Archaeological Department</td><td>EU-DHC/ EU-DHP</td><td>Pre-Construction / Construction</td><td>Monthly</td></tr>
<tr><td>▪ No construction facilities or spoil disposal facilities are to be established near Shatial rock carvings
▪ No construction areas and construction activities will be carried out near the rock carvings site</td><td>Contractor</td><td>EU-DHC/ EU-DHP</td><td>Construction</td><td>Monthly</td></tr>
<tr><td>▪ Enhancement measures for a 400 year old historical mosque at Seo that is widely revered in the project area</td><td>▪ Construction of toilet facilities in the mosque
▪ Provision of firefighting equipment to the mosque</td><td>Community</td><td>EU-DHC/ EU-DHP</td><td>Construction</td><td>Monthly</td></tr>
<tr><td>▪ Chance finds during construction</td><td>chance-find procedures, described in Section 5 of Antiquity Act of 1975, are:
▪ Sub-section (1): Whoever discovers, or finds accidentally, any</td><td>Contractor</td><td>EU-DHC/ EU-DHP</td><td>Construction</td><td>Whenever reported</td></tr>
</table>

<table>
<tr><th colspan="6">EMP Sub-Plan 13. Physical Cultural and Social Resources Management</th></tr>
<tr><td></td><td>movable antiquity shall inform the Director General within seven days of its being discovered or found and preserve it for the period specified in sub-section (2).
▪ Sub-section (2): If, within seven days of his being informed under sub-section (1) of the discovery of moveable antiquity or of a moveable antiquity having been found the Director General decides to take over the antiquity for purposes of custody preservation and protection the person discovering or finding its shall hand over to the Director General or a person authorized by him in writing.
▪ Sub-section (3): Where the Director General decides to take over an antiquity he may pay to the person by whom it is handed over to him such cash reward as the Advisory Committee may deem fit.
▪ Sub-section (4): If any person who discovers or finds any movable antiquity contravenes the provisions of sub-section (1) or sub-section (2), he shall be punishable with imprisonment for a term which may extend to three years, or with fine or with both or\and the court convicting such person shall direct that the antiquity in respect of which such contravention has taken place shall stand forfeited to the Federal Government.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>▪ Auditing</td><td colspan="5">▪ Audit the development of Shatihal rock carvings.
▪ Audit the facilities at the construction work sites and workers camp sites
▪ Complaints register</td></tr>
<tr><td>Guidelines, Standards and Legislation</td><td colspan="5">▪ Pakistan Environmental Protection Act, 1997
▪ National Environmental Quality Standards, 2000 and 2010
▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007
▪ Pakistan Antiquity Act, 1975</td></tr>
<tr><th colspan="2">Potential Concern</th><th colspan="3">Corrective Action</th><th>Responsibility</th></tr>
<tr><td colspan="2">▪ Complaints from the community about the construction activities and construction workers</td><td colspan="3">▪ Investigate and address the necessary problems</td><td>GRC</td></tr>
<tr><td colspan="2">▪ Lack of basic infrastructure facilities at the camp sites or Complaints from the construction workers for lack of standard facilities at the construction sites and campsites</td><td colspan="3">▪ Investigate and address the necessary problems</td><td>GRC</td></tr>
<tr><td>Reporting</td><td colspan="5">Monthly reports shall include information on the shifting of mosque, protection of graveyards, details of migrant construction workers and complaints on social and cultural issues</td></tr>
</table>

9.2.17 EMP Sub-Plan 14: Occupational Health and Safety Plan

EMP Sub-Plan 14. Occupational Health and Safety Plan					
Objective	▪ Promote health and safety of construction workers in accordance with best international standards ▪ Comply with national employment and labour laws ▪ To anticipate and avoid adverse impacts on the health and safety of the construction workers and the community				
Performance criteria	▪ IFS performance standards on labour and working conditions				
Targets	▪ Zero accidents				
Issue/impact	**Mitigation measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Rough terrain and difficult work conditions at the construction areas will create a number of occupational risks and hazards ▪ The construction activities will involve blasting, large scale excavation, underground works, operations of heavy construction machinery and vehicular traffic. These activities may pose health and safety hazards to the workers at site during the use of explosives, use of hazardous substances, lifting and handling of heavy equipment, operating machinery and electrical equipment, working near water or at height and more. ▪ Accidental fall in to the Indus will be a major risk for the construction workers because of steep slopes	▪ Each contractor will establish a comprehensive OHS Plan aimed at preventing accidents, injuries and work-related diseases. This plan will be submitted to PMU and supervision consultant for review and approval before construction. Each contractor will also prepare an Emergency Response Plan defining procedures to be followed during any emergency. This plan will be submitted to PMU and supervision consultant for review and approval.	Contractor	EU-DHP/EU-CSC	Pre-Construction	
	▪ All workers must be provided with and use appropriate personal protective equipment (PPE) such as safety boots, helmets, gloves, protective clothing, goggles, and ear protection. First aid must be provided and there would be procedures in place to access appropriate emergency facilities; ▪ Contractors will be responsible for developing procedures to address the OHS hazards. Signage related to hazards and risks must be in place at the work sites. ▪ Management procedures to address temperature stress, for instance in relation to extreme heat will be required; ▪ Health screening of employees would be a Contractor obligation prior to laborers working on site and living in the temporary accommodation facilities. The health screening would entail normal review of physical fitness and also include a review of appropriate vaccinations. Workers would be given vaccinations where required; ▪ All employees need to carry out induction health and safety training prior to commencement of work. OHS issues would be part of the employee training plan. Training would include the provision of appropriate written or visual materials to reinforce learning. Where illiteracy levels are high,	Contractor	EU-DHP/EU-CSC	Construction	Monthly

EMP Sub-Plan 14. Occupational Health and Safety Plan					
	OHS issues need to be covered more frequently than normal in toolbox talks; ▪ An emergency response team and plan must be identified. Training and drills based on the accident and emergency preparedness and response plan must be carried out quarterly. Training requirements, including for emergency preparedness, will need to be updated annually; ▪ It is essential that all personnel likely to be involved in the Project at the construction site undergo a basic training program prior to performing assigned work. ▪ Standard operation procedures for handling accidents related to electrocution, movement of plant equipment; falls from height, falling objects, working in confined spaces and dealing with hazardous materials				
▪ Increased OHS risks during construction of tunnels	In addition to above ▪ OHS protocols for tunnel construction in accordance with industry standards ▪ Maintenance of safe working conditions in the tunnels including adequate lighting, ventilation, oxygen supply ▪ Record of personnel entering and exiting the construction areas	Contractor	EU-DHP/EU-CSC	Construction	Monthly
▪ Campsites for construction workers are the important locations that have significant impacts such as health and safety hazards	▪ Implement mitigation measures in ECP 16: Construction Camp Management	Contractor	EU-DHC/ EU-DHP	Construction	Monthly
▪ Health Issues for workers and local population	▪ Ensure that periodic awareness campaign for HIV/AIDS is under taken for the project staff and workers. ▪ To accompany the resettlement process with adequate public health safeguarding for both relocated and residents population. ▪ To set and operationalize adequate and appropriate measures to minimize adverse effects on health risks of population. ▪ To keep the construction workers safe from the occupational hazards	CSC with the help of EDO,Dasu	DHP	Construction	Monthly
Auditing	Review of OHS of Protocols and implementation				
Guidelines, Standards and Legislation	▪ IFC Performance Standards World Bank Group EHS Guidelines				

EMP Sub-Plan 14. Occupational Health and Safety Plan		
Potential Concern	**Corrective Action**	**Responsibility**
▪ Unsafe working conditions and practices	Training of construction workers	Contractor
▪ Accidents	Thorough investigation on the cause of accidents and develop procedures to mitigate further accidents	Contractor
▪ Grievances from the construction workers	Investigate and address the necessary problems	GRC
Reporting	▪ Data on the OHS related incidents in the contractors monthly reports	

9.2.18 EMP Sub-Plan 15: Summary of Social and Resettlement Management Plan

EMP Sub-Plan 15. Summary of Social and Resettlement Management Plan					
Objective	▪ No adverse impacts on the community and their livelihoods ▪ Social and cultural aspects of the local community and the in-migrant construction workers are not affected.				
Performance criteria	▪ Affected people living condition to be improved or restored at the pre-project level ▪ Compensation in accordance with approved entitlement matrix given in RAP				
Targets	▪ Zero grievances				
Issue/impact	**Mitigation measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Acquisition of 4643 ha of land for project interventions	▪ Compensation amount for land acquisition will be disbursed in an equitable and transparent manner. The compensation will be paid to land owner before the land is acquired. Compensation will be paid on Agreed Values which are based on prevailing market rates and rates adopted in Diamer Basha Project. For detail see RAP(reservoir and Dam)	District Revenue Officer (DRO)	DHP	Pre-Construction	Monthly
▪ Loss of property and trees of 767 households	▪ Compensation for on Replacement Values as given in RAP	DRO	DHP	Pre-construction	Monthly
▪ Loss of Income from displaced commercial premises	▪ . All the business operators will be entitled for grant against loss of business and relocation to the Resettlement Sites and new market area to be established under Management Plan for ▪ In migration and construction workers (volume 10 of social and Resettlement Management Plan).	DHP.	WAPDA	Construction	Monthly
▪ Resettlement of Affectees	▪ Residential plots will be provided o affectees in self managed resettlement sites where land and basic amenities will be developed by WAPDA. For detail see RAP (reservoir and Dam)	Project Resettlement Office	WAPDA	Pre-construction & Construction	Monthly
▪ Social/Cultural and Economic Impact on local population due to influx of construction workers and In migrants during construction period	▪ "code of conduct" for workers and In migrants will be implemented ▪ There will be separate labor colony /camp for the construction workers, away from the villages' population area. ▪ DHP Field Office, will undertake community level consultations to preparing local communities and businesses in relocation planning and distribution of the in-migrants over the project construction period. ▪ Committees consisting of local maleks, business groups, civil society members and representatives of construction contractors/labor agent(s) will be established in right and left banks. Assistant Coordination Officer	Contractors/ DHP	WAPDA	Construction phase	Monthly

EMP Sub-Plan 15. Summary of Social and Resettlement Management Plan					
	(ACO) will chair the Committee. ▪ The Committees will prepare a "master" work plan to distribute the in-migrants to various locations, depending on availability of shelter/housing, access to worksite, markets, schools and other social and support services. ▪ The Committee will work with and advise the contractors and/or local labor agents to design and construct labor camp sites for housing the construction workers/in-migrants so that there is little or no conflict with the existing hamlets/village settlements. ▪ The Committee with encourage local well-off groups to build rental houses for in-migrants, as an opportunity to generate additional income for them ▪ Access to Housing/Shelter, Food Sources and Market ▪ Improvements in the Local Social Infrastructure ▪ Employment and Business Opportunities for All ▪ Community/Area Development Plan				
▪ Rights of Employment	▪ Technical and nontechnical labor will be recruited from the local area of the project equitably from various tribes/castes, and employment procedures will be transparent.	Contractors	DHP	Construction	Monthly
▪ Construction activities near religious and cultural sites	▪ Implement mitigation measures in ECP 17: Cultural and Religious Issues	Contractor	EU-DHC/ EU-DHP	Construction	Monthly
▪ Environmental management and enhancement at the resettlement villages	▪ Support the AHs in the resettled villages for operation and management of infrastructure facilities, such as waste and waste water disposal, water supply, schools, health facilities; and sanitation and hygiene promotion activities	Contractor	EU-DHC/EU-DHP	Construction	Quarterly
▪ Health Issues for workers and local population	▪ Ensure that periodic awareness campaign for HIV/AIDS is under taken for the project staff and workers. ▪ To accompany the resettlement process with adequate public health safeguarding for both relocated and residents population. ▪ To set and operationalize adequate and appropriate measures to minimize adverse effects on health risks of population. ▪ To keep the construction workers safe from the occupational hazards	CSC with the help of EDO,Dasu	DHP	Construction	Monthly

EMP Sub-Plan 15. Summary of Social and Resettlement Management Plan					
▪ Gender Impacts	▪ Gender sensitization and capacity building of project staff, including district administration, This will be a continuous process through workshops and seminars. ▪ Approaching the women as per GAP and implementing GAP action plans	The GAP will be implemented by the Project Resettlement Office (PRO)	DHP	Construction	Monthly

Potential Concern	Corrective Action	Responsibility
▪ Grievances During Implementation Of SRMP	The Project will establish a four-tier GRC system for resolution of grievances and disputes related to social and environmental resettlement safeguard plans. The GRCs are to ensure accessibility, fairness and independence of the procedures.	DHP with the help of GRC

Monitoring and Reporting	▪ Monitoring and Reporting of SRMP implementation will be carried out at four levels. ▪ First, DHP will conduct regular internal monitoring through the Resettlement Monitoring Unit under the supervision of DD (Resettlement). ▪ Second, external monitoring will be conducted by an independent external expert/agency commissioned by DHP. ▪ Third, the Construction Supervision Consultants will also carry out supervision and monitoring to assist DHP and the donors. The donors themselves will also monitor the overall performance of project, including the RAP and ILRP implementation through missions. ▪ Fourth, the Panel of Experts (POE) established for this project will also periodically monitor the implementation of the projects.

9.3 MONITORING PROGRAM

Monitoring program during construction and operation presented in various EMP sub plans are summarized and presented in in Table 9.1.

Table 9.1: Environmental monitoring during construction and operation

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
During Construction						
Landslides	At 37 identified landslide prone areas in EIA	Visual Inspection on stability of landslides	Fortnightly	EMP sub-plan 3	Contractor	CSC, DHP
Erosion	Earthwork areas and material storage sites	Visual inspection of erosion prevention measures and occurrence of erosion	Monthly	EMP sub-plan 3	Contractor	EU-CSC, EU-DHP
Surface water quality	In the rivers and tributaries at the downstream of the construction sites. The locations of sampling can be same locations of baseline water quality or new locations recommended by the CSC. Waste water discharges into the river from the concrete batching plants, tunneling works, etc.	Sampling and analysis of river water quality and waste water discharges for the key parameters given in NEQS (river water quality – DO, BOD, COD, Temperature, pH, Conductivity, TSS, turbidity, nitrate; ' Waste water – BOD. TSS, turbidity, TDS, COD, grease and oil, iron, ammonia, sulfates, chlorides)	Quarterly	EMP sub-plan 4	Contractor	EU-CSC, EU-DHP
			Annually	EMP sub-plan 4	External Monitor (DHP through a nationally recognized Laboratory)	EU-CSC, EU-DHP
		Spot measurements of pH (in presence of EU CSC&DHP) Conductivity, turbidity. Visual inspection on presence of petroleum products.	Monthly	EMP sub-plan 4	Contractor	EU-CSC, EU-DHP
Air Quality (dust, smoke)	Construction sites, quarry areas, along KKH and blasting areas	Visual inspection to ensure good standard equipment is in use and dust suppression measures (spraying of waters) are in place.	Weekly	EMP Sub-Plan 5	Contractor	EU-CSC, EU-DHP
	Material storage sites	Visual inspection to ensure dust suppression work plan is being implemented	Weekly	EMP Sub-Plan 5	Contractor	EU EU-CSC, EU-DHP

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
Air Quality in tunnels	At tunnels	Spot measurements for CO, NOx and SO_2 levels in the tunnels	Monthly	EMP Sub-Plan 5	Contractor	EU-DHP
Air Quality (PM10, NO2, SO2, CO_2, CO)	Near the sensitive sites and settlements at the close to the construction works and along KKH. The locations of sampling can be same locations of baseline air quality or new locations recommended by the CSC.	Air quality monitoring for 24 hours for the parameters specified in NEQS 2000	Quarterly	EMP Sub-Plan 5	Contractor	EU-CSC, EU-DHP
			Annually	EMP Sub-Plan 5	External Monitor (DHP through a nationally recognized laboratory)	EU-CSC, EU-DHP
Emissions from plant and equipment	At all the construction sites for dam, KKH and tunnels	Visual Inspection	Monthly	EMP Sub-Plan 6	Contractor	EU-CSC, EU-DHP
Noise and vibration	Near the sensitive sites and settlements at the close to the construction works and along KKH. The locations of sampling can be same locations of baseline air quality or new locations recommended by the CSC	24 hour noise monitoring	Quarterly	EMP Sub-Plan 7	Contractor	EU-CSC, EU-DHP
		24 hour noise monitoring	Annually	EMP Sub-Plan 7	External Monitor (DHP through a nationally recognized laboratory)	EU-CSC, EU-DHP
		Spot measurements	Monthly	EMP Sub-Plan 7	Contractor	EU-DHP
Waste Management	At the designated rock disposal area	Visual inspection on spoil disposal in accordance with EMP Sub plan on Waste Management	Monthly	EMP Sub-Plan 8	Contractor	EU-CSC, EU-DHP
	Construction camps and construction sites	Visual inspection that solid waste is disposed at designated sites	Monthly	EMP Sub-Plan 8	Contractor	EU-CSC, EU-DHP
Spills from Hydrocarbon and chemical storage	Material storage sites and construction yards	Visual Inspection for leaks and spills	Monthly	EMP Sub-Plan 9	Contractor	EU-CSC, EU-DHP

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
Wild life (including migratory bird)	Project area	Surveys for wildlife and migratory birds in accordance with EMP Sub-Plan on Terrestrial and Ecology Management	Quarterly	EMP Sub Plan 10	DHP through nationally recognized institute	EU-CSC, EU-DHP
	Near all construction sites	Ensure the adherence of the migratory measures proposed in the EMP	Monthly	EMP Sub Plan 10	DHP through nationally recognized institute	EU-CSC, EU-DHP
Fish	Upstream and downstream of the dam	Surveys for fish in accordance with EMP Sub-Plan on Aquatic Ecology Management	Half yearly	EMP Sub Plan 11	DHP through nationally recognized institute	EU-CSC, EU-DHP, External Monitor
Traffic Safety	Along KKH and access roads to the construction areas	Visual inspection to see whether Traffic Management Plan (EMP Sub Plan 12) is implemented	Monthly	EMP Sub Plan 12	Contractor	EU-CSC, EU-DHP,
Local Roads	Approach Roads	Visual inspection to ensure local roads are not damaged	Monthly	EMP Sub Plan 12	Contractor	EU-CSC, EU-DHP,
Cultural and archeological Sites	At the physical and cultural resources identified in the EIA	Visual observation on implementation of EMP Sub Plan 13 on Physical Cultural Resources Management	Monthly	EMP Sub Plan 13	Contractor	EU-CSC, EU-DHP,, External Monitor
Drinking water and sanitation	In construction sites and construction camps	Ensure the construction workers are provided with safe water and sanitation facilities in the site	Weekly	EMP Sub Plan 13	Contractor	EU-CSC, EU-DHP,
Safety of workers	At work sites	Usage of Personal Protective equipment	Monthly	EMP Sub Plan 13	Contractor	EU-CSC, EU-DHP,
Reinstatement of Work Sites	All Work Sites	Visual Inspection	After completion of all works	EMP Sub-Plan 1		

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
Plantation	At all plantation sites	Visual inspection to ensure plantations is growing well.	Monthly	EMP Sub-Plan 10	District Forest Office with support of civil society	EU-CSC, EU-DHP,, External Monitor
Contractors Decommissioning						
Construction yards	Construction work areas and contractor yards	Visual inspection to ensure removal of all buildings and equipment from the site. The site is clean and was restored to original condition	Before contractor demobilization		Contractor	EU-CSC, EU-DHP,
Construction camps	Construction camps	Visual inspection to ensure removal of all buildings and equipment from the site. The site is clean and was restored to original condition	Before contractor demobilization		Contractor	EU-CSC, EU-DHP,
During Operation						
Surface Water Quality	Upstream and downstream of the dam	Sampling and analysis for sediment load, DO and temperature	Half Yearly	EMP Sub-Plan 4	DHP through national laboratory	CSC, External Monitor
	In the reservoir	In situ measurements on DO and Temperature at different depths in the reservoir	Quarterly	EMP Sub-Plan 4	DHP through national laboratory	CSC, External Monitor
Environmental flows	Downstream of dam	Measurements of discharges to the downstream	Monthly	EMP Sub-Plan 4	DHP	External Monitor
Migratory birds	Reservoir area	Surveys for migratory birds in accordance with EMP Sub-Plan on Terrestrial and Ecology Management	Half Yearly	EMP Sub Plan 10	DHP through nationally recognized institute	EU-DHP, External Monitor
Fish	Upstream and downstream of the dam	Surveys for fish in accordance with EMP Sub-Plan on Aquatic Ecology Management Limological conditions in the reservoir	Half yearly	EMP Sub Plan 11	DHP through nationally institute	EU-DHP, External Monitor

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
	Reservoir fisheries	Monthly data on fish catches	Monthly	EMP Sub Plan 11	Fisheries Contractor	EU-DHP,
	Downstream of Dam	Effect of sediment deposition in the on downstream habitat	Half yearly	EMP Sub Plan 11	DHP through nationally institute	EU-DHP, External Monitor
		Effectiveness of minimum flows, in the dam-to-tailrace outlet segment	Yearly	EMP Sub Plan 11	DHP through nationally institute	EU-DHP, External Monitor
Landslides	Reservoir area	Displacement monitoring and visual inspection	Monthly in high flow season	EMP Sub Plan 3	DHP	External Monitor
Erosion	From the spoil disposal areas	Visual inspection	Monthly	EMP Sub Plan 3	DHP	External Monitor
Landscape	In the construction areas, quarry and borrow areas	Visual inspection of long-term degradation, visual impacts, change of drainage pattern	Quarterly	EMP Sub Plan 3	DHP	External Monitor
Dam Safety	At the dam site	Monitoring of data from dam safety equipment	Quarterly	EMP Sub Plan 2	DHP	Dam Safety Organization of WAPDA
		Survey, inspection and testing	Yearly	EMP Sub Plan 2	Dam Safety Organization of WAPDA	DHP
		Survey, inspection and testing	Once in 3 years	EMP Sub Plan 2	External Monitor (through an internationally recognized institute)	DHP

9.4 CAPACITY BUILDING PROGRAMS

9.4.1 Environmental Awareness and Training

The objective of the environmental awareness and training program is to provide all personnel working on the Project with:

- An understanding of what their responsibilities are as outlined in the EMP;
- A means of developing a culture of compliance with the Project environmental requirements; and
- A means to improve the environmental awareness of the workforce through the education of Project field personnel.

9.4.1.1 Project Induction

A site specific environmental Project induction will be developed by the EU-CSU. An environmental training register will be kept, maintained and used to verify that all personnel working on-site have completed the environmental induction.

The content of the site induction is to include, but not be limited to:

- An overview of the Project environmental policy;
- Relevant details of the EMP including potential significant impacts;
- Identification of relevant Project stakeholders;
- Conditions of any environmental licenses, permits and approvals;
- Roles and responsibilities of all personnel in achieving environmental conformance;
- Any identified environmental sensitive areas;
- Definition and management of environmental incidents and operation of pollution / spill control equipment;
- Definition and management of waste and an explanation of a waste minimization and recycling strategy;
- Processes for refueling and the management and use of hazardous substances; and
- Response to environmental incidents.

9.4.1.2 Construction Environmental Toolbox Talks

A toolbox talk involves the dissemination of information to Project personnel at the field level. Generally toolbox talks focus on safety aspects with reference to certain Project jobs or tasks. They can be used to disseminate environmental management information. Environmental toolbox talks should cover aspects such as:

- Explanation of new project requirements;
- Explanation of the key environmental risks associated with an activity or specific procedures which could have potential environmental impacts;
- Explanation of mitigation strategies with reference to an activity or specific procedures which could have potential environmental impacts;
- Reminder of the importance of specific or generic environmental commitments;
- To obtain feedback related to environmental issues; or
- Any other purpose related to the implementation of the EMP.

Toolbox training will help to ensure that relevant information is communicated to the workforce and will also provide a forum for feedback on issues of interest or concern. Toolbox training will generally be prepared and delivered by the Contractor but may also be delivered by EU-CSC. Possible Toolbox Talk topics include:

- Management of works in and near waterways;
- Noise and vibration minimization

- Wildlife conservation;;
- Soil erosion and sediment control; and
- Waste management, minimization and recycling.

A register of toolbox talks and attendance records shall be maintained on-site.

9.4.2 Capacity Building of WEC and PMU

A series of capacity building programs are recommended for WEC and PMU/DHP to improve their capacity in understanding and managing environmental impacts with DHP and other future hydropower development projects in Pakistan. The training programs will cover

- Social and Environmental issues with the construction and operation of DHP, and addressing their impacts
- Monitoring and auditing of implementation of EMPs during construction and operation of DHP
- Social and Environmental laws & regulations, norms, procedures and guidelines of Pakistan, World Bank and other international financiers
- Catchment management and sedimentation control
- Preparation of environmental documentation
- Reservoir fisheries development and management
- Climate change impacts and adaptive planning
- Early flood warning system
- Hydropower reservoir impacts on geomorphology and sedimentation
- Hydropower impacts on migratory birds
- GIS, MIS, database management Methods of sampling and testing various environmental parameters

DHP will be associated with set of esteemed international organizations (IUCN, WWF, etc.) and education/training institutes (Punjab University, WAPDA Engineering Academy, etc.) which will act as 'twinning institutions' for capacity building and development. These institutions will support DHP and WEC with providing their laboratories for analysis, trained human resources, and other technical facilities available with them. These training programs can be conducted biannually basis.

Some of the senior representatives should receive environmental and social safeguard training under a recognized program (national and/or overseas).

DHP will establish and maintain MIS system in the implementation of the Project. DHP will hire the services of MIS specialists for development and maintenance of MIS system.

9.5 COST ESTIMATES

9.5.1 EMP Cost Estimates

The cost estimates for various mitigation, monitoring and management plans proposed in the EMP are presented in the Table 9.2. The table also includes resources required for implementing these plans and the phase (pre-construction, construction and operation) of the Project. The cost estimates also include the budget for environmental monitoring, consultants for EMP implementation, institutional strengthening and capacity building and environmental enhancement/compensation measures. Detailed breakup cost estimates are shown in Annex 9.2. These costs will be financed by the Project and will be included in the overall project costs of the DHP during operation. Further an environmental fund with the revenue of DHP for long term environmental development activities in the Project Area.

Table 9.2: Cost Estimates of EMP

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
A	**Contractors Bill of Quantities for Implementation of EMP**					
1.1	Contractors implementation of EMP	Contractor will prepare and implement following plans (Contractors Environmental Action Plan) in accordance with Project's EMP and World Bank Group EHS Guidelines : • Site specific sediment and erosion control plan for each construction site and quarry; • Site specific camps management plan for each camp; • Spoil management and disposal plan for each site; • Waste management plan for each construction site and quarry; • Site specific pollution control (water, air, noise) plan for each construction site and quarry; • Site specific traffic management plan for each construction site and quarry; • Site specific decommissioning and landscaping plans for quarry sites, spoil disposal sites, temporary roads and other disturbed areas; • Occupational health and safety plan and training programs; • Emergency Response Plan and Early Warning System ; • HIV-AIDS Preventive Management Plan and training programs; • Complaints logging system and response plan; • Standard Operating Procedures for blasting operations; • Standard Operating Procedures for pollution spills, and management of fuels and hazardous goods; and • Demobilisation plan after completion of works		All Phases of Construction	24,285,000	Table A1 of Annex 9.2
1.2	Environmental Staff of Contractors	To ensure contractors have dedicated environmental staff to implement EMP	Environmental Specialist & OHS specialist and other required staff to implement CEAP			

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
2	Water Quality Laboratory	Monitoring of water and waste water quality	Laboratory establishment by contractor with necessary equipment to monitor water and waste water quality	201-2022 (Phase 1&2 Construction)	540,000	Table A2 of Annex 9.2
3	Air, Noise, Vibration and Potable Water Quality Equipment	Spot measurements for air, noise and water quality meters will assist supervision staff to ensure compliance with EMP	10 sets of portable kits for pH, turbidity, noise, vibration, conductivity meter, PM, CO, NOx and CO_2 with equipment operator	201-2022 (Phase 1&2 Construction)	441,000	Table A3 of Annex 9.2
Sub Total: A. Environmental Staff and Consultants					**25,266,000**	
B	**PMU Budget on Environmental Staff and Implementation of Mitigation and Monitoring Measures**					
1	Environmental Staff of EU-DHP	Environmental staff of WAPDA's Project Management Unit of DHP	Environmental, Ecology and OHS specialists	2014-2025 (Phase 1&2 Construction and operation)	2.900.000	Table B1 of Annex 9.2
2	Environmental Staff of Construction Supervision Consultant	Environmental specialists (national and international) will be hired under Construction Supervision Consultant for effective implementation of EMP	3 international (intermittent – 2 years each) and 3 national (5 years) environmental specialists will be hired.	2015-2022 (Construction)	4,338,000	Table B2 of Annex 9.2
3	Panel of Experts – Social and Environment	To advise DHP on EMP and SRMP implementation issues	International experts on social and environment	2015-2022 (Phase1&2 Construction)	425,000	Table B3 of Annex 9.2
4	External Monitoring Consultants	Air, noise and water quality at the construction sites shall comply with NEQS	External monitoring of air, noise and water quality annually	2015-2022 (Phase 1&2 Construction)	500,000	Table B4 of Annex 9.2
5	Internal Auditing	Internal Auditing by WAPDA Environmental Cell	Travel and field allowances	2015-2022 (Phase1&2 Construction)	200,000	Table B5 of Annex 9.2
Sub Total: B. PMU Budget on Environmental Staff and Consultants					**8,363,000**	

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
C. Aquatic Ecology						
1	Studies to establish detailed baseline data on the native fish species in Upper Indus Basin, their biology and migration pattern; and long term monitoring – construction, construction and operation stages of the Project	To understand the fish movement upstream and downstream of the dam to assess the requirement of provisions for fish passage and fish screens at spill way/intake if required	A one year continuous study will be undertaken by a team of experts (fish expert, surveyors, and technical assistants) through field (tagging of fishes) and laboratory studies.	2014-2015 (pre-construction)	233,000	Table C1 of Annex 9.2
		To obtain movement patterns and seasonal habitat use (especially over-wintering habitat in the Indus River main-stem) of snow carp and catfish to assess the environmental flow requirements from the dam	Quarterly monitoring by a fish expert (with support of surveyor and a technical assistant) through field and laboratory studies	2015-2019 (Construction)	335,000	Table C1 of Annex 9.2
		Monitoring of fish condition in the reservoir and tributaries, fish entrainment, effectiveness reservoir fishery, etc.	Same as above for a period of 5 years. The study will be continued further if required from revenue of fish hatcheries	2020-2025 (Operation)	400,000	Table C1 of Annex 9.2
2	Fish capture and stocking	Design, installation and operation of methods for capture of brood stock fish and supply to hatcheries and stocking of fingerlings in the tributaries and Indus	Cost of facilities	2015-2019 (Construction)	200,000	Table C2 of Annex 9.2
		Operation	Vehicles, training and operational protocols	2020-2030 (Operation)	500,000	Table C2 of Annex 9.2
3	Installation of screens to avoid injury to fish at various outlets.	Installation of fish deterrent devices or screens at spillway entrance, intake to lower level outlets and penstocks to powerhouse gates, end of tail race	Cost of civil and mechanical works	2015-2019 (Construction)	400,000	Table C3 of Annex 9.2
4	Fish Hatchery and R&D	Given weakness in biological	An R&D hatchery with all	2018-2025	2,034,800	Table C4 of

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
	facility	knowledge of indigenous fish species, a R&D hatchery is recommended to undertake applied research.	necessary civil works, facilities and human resources. 2 years of research and 5 years O&M costs are included in the budget. The budget for the hatchery maintenance after 5 years comes from the revenue of reservoir fisheries	Construction and Operation		Annex 9.2
5	Fish habitat improvement of the tributaries	Improvement of fish habitats in the tributaries	Construction of pools/riffles in tributaries and staff for collection of brooders and leaving them in pools	2020-2025	108,000	Table C5 of Annex 9.2
6	Capacity building of local Fisheries Departments	The objective is to build capacity for KP Fisheries Department, for reservoir fisheries management and community awareness programs for habitat protection	Training and awareness programs	2020-2025 (Operation)	100,000	Table C6 of Annex 9.2
Sub-Total: C. Aquatic Ecology					**4,310,800**	
D. Terrestrial Ecology						
1	Tree Plantation	A compensation plan for the loss of 21,000 trees with 5-10 new trees for each affected tree. 100,000 trees and planned in the buffer areas of the reservoir.	Nursery to be established for 300,000 saplings (3 saplings for each tree to be planted). Tree plantation and conservation for 3 years with support of local community	2015-2019 (Construction)	1,620,000	Table D1 of Annex 9.2
2	Strengthening of Community Protected Area in Kaigah and studies for developing new CCAs	Strengthening management of Kaigah CCA and conducting additional studies to develop new CCAs. Additional studies for establishing baseline condition for migratory birds. Capacity building programs for forest and wildlife	Conservation agencies like WWF and IUCN will be involved to conduct feasibility studies and establish conservation areas.	2016-2025 (Construction and Operation)	1,000,000	

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
		departments				
3	Afforestation and forest regeneration program	Supporting local communities in the management of community forestry Enhancement of forest cover in the project area	Nursery and plantation programs to be designed with the support of district and provincial government forest departments	2022 onwards	3,000,000	
Sub-Total; D. Terrestrial Ecology					**5,620,000**	
E. Physical Cultural Resources						
1	Protection of Shatial Rock Carvings	Protection of designated archeological sites in the project area and construction of tourist facilities	Procurement of land, construction of fencing, office and tourist facilities; hiring and training of guides.	Pre-Construction and Construction (2015-2016)	1,359,435	Table E1 of Annex 9.2
2	Relocation of historical mosque at Seer Gayal	Disassembling and reassembling of historical wooden mosque at Seer Gayal that will be submerged under reservoir.	Procurement of land at new site, and civil works for dismantling and re-erection.	2016-2017 (Construction)	29,000	Table E1 of Annex 9.2
3	Protection of Graveyards that will be submerged in reservoir	Protect the graveyards with civil works to avoid the bodies to float in to the reservoir.	Civil works Stone pitching and mud plastering will be done and religious ceremony will be held in every graveyard	2017-2018 (Construction)	6,240	Table E1 of Annex 9.2
4	Enhancement of Seo Mosque	Enhance the facilities at 400 year old and widely revered mosque in the project area	Civil works for enhancement facilities including toilets and firefighting facilities.	2015-2016 (Construction)	25,880	Table E1 of Annex 9.2
5	Chance finds	Retaining a consultant to advise WAPDA in dealing with chance finds	Retaining archeologist	2014-2022	48,000	Table E1 of Annex 9.2
Sub Total: E. Physical and Cultural Resources					**1,648,555**	
F. KKH Traffic Management						
1	Traffic Management	Traffic management along KKH to	Establishment of traffic units at	2016-2019	389,200	Table F1 of

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
		avoid any traffic congestion and accidents.	Dasu and along KKH with necessary staff and communication facilities for traffic control	(Phase1 Construction)		Annex 9.2
Sub Total: F. KKH Traffic Management					**389,200**	
G. Climate Change, GLOFs and Sedimentation in UIB						
1	Early Flood Warning and Climate Monitoring	Establish flood telemetry network in Dasu catchment for early warning of floods and better management of floods	Installation of 18 telemetric equipment with automatic recorders (river level, rainfall, temperature) and network connection. Operational expenses (including training and staff remunerations) for a period of 10 years	2014-2020 (Construction)	2,500,000	Table 6.10 (Also given in Table G1 of Annex 9.2)
2	Glacier Monitoring Program	Glacier monitoring program for monitoring and research on the Upper Indus Basin glaciers		2015-2020 (Construction)	4,000,000	
3	Integrated Watershed Development Studies	Identifying and implementing possible solutions for control of sedimentation in UIB	Procurement of consultants and conducting studies and implementation of plans for control of sedimentation and landslides in UIB	2016-2025	4,000,000	
Sub Total: G. Climate Change, GLOFs and Sedimentation in UIB					**10,500,000**	
H. Capacity Building						
1	Capacity Building of environmental staff of DHP and WAPDA Environmental Cell (WEC)	Capacity building programs through association with universities or organizations	Twinning arrangements with the institutions and universities for regular training.	2014-2025 (Construction and Operation)	200,000	
		Training through special programs at national level	National level training programs	2014-2025	200,000	

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
		International training to the key staff	International training programs	(Construction and Operation)	200,000	
Sub-Total: H. Capacity Building					**600,000**	
I. Institutional Strengthening						
1	Establishment of GIS/MIS	GIS and MIS capability enhancement of DHP/WEC	Procurement of equipment, software and manpower	2014-2019 (Construction)	100,000	
2	Institutional strengthening of WEC	Providing computers, software and portable environmental testing equipment	Procurement of computer, software and instruments	2014-2016	200,000	
Sub-Total: I. Institutional Strengthening					**300,000**	
J. Environmental Management and Enhancement of Resettlement Villages						
1	Environmental Manage-ment and Enhancement of the Resettlement Villages	Support the AHs in the resettled villages for operation and management of infrastructure facilities, such as waste and waste water disposal, water supply, schools, health facilities; and sanitation and hygiene promotion activities	At 35 villages at the rate of 500 USD per month per 10 years	2015-2022	2,100,000	Table J of Annex 9.2
Sub-Total: J. Environmental Management of Resettlement Villages					**2,100,000**	
K. Studies and Measures to Address Cumulative and Induced Impacts						
1	Studies and measures to address cumulative and induced impacts in Upper Indus Basin	Comprehensive research and implement best management practices described in Vol 7: Cumulative and Induced Impact Assessment		2015-2022	10,000,000	
Sub-Total: J. Environmental Management of Resettlement Villages					**10,000,000**	
				Grand Total	**69,097,555**	

9.5.2 Environmental Fund of DHP

It is proposed that WAPDA should create an Environmental Fund (EF) for promotion of environmental development activities' to assist in protection and conservation of environment in the Project area; and to ensure sustainability of all environmental enhancement measures recommended in the EMP.

Scopes of Activities Supported
The fund can support the environmental enhancement projects that directly preserve, enhance or restore environmental resources in the project area. The projects should be located within permanent Project area as defined in EIA report and should have a measurable outcome within predetermined timeframe. The can also be used to support:

- Implementation of mitigation measures during operational stage in accordance with EMP
- Design and implementation of any additional mitigation measures, if required based on future environmental monitoring during operation
- Protection of important habitats and other important species in the project area;
- Promotion of environmental education and awareness;
- Reduction of environmental degradation;
- Environmental benefit to fish and wildlife and air and water quality. Tangible biophysical enhancements that provide an on-the-ground environmental return.
- Potential good news stories and communications. Opportunity to promote positive environmental stewardship information via internal and external media.
- Goodwill considerations. Forging and strengthening working relationships between partners, including with environmental agencies and community groups.
- Studies to identify and evaluate areas within project area worthy of protection, restoration, improvement, creation, or procurement
- Other environmental enhancement projects approved by the Environmental Enhancement Committee (EEC).

Environmental Enhancement Committee
DHP will form and setup an Environmental Enhancement Committee (EEC). The committee can consists of the following members

- Project Director (Chairman)
- Head of Environmental Unit at DHP (Secretary)
- Representative of Finance Unit, WAPDA
- Representative of WAPDA Environmental Cell (WEC)
- Representative of provincial EPA
- DCOs of the Project districts
- NGOs/CBOs /Community representatives

The EF can also fund project proposals from local governments, voluntary groups, community and conservation organizations, universities, and scientific research groups. The EEE shall establish a process for the solicitation, submittal, review, and selection of environmental enhancement projects. Selection criteria shall be developed to ensure that projects meet the intent of the fund. The application for project shall include the following information.

- Project and Project Cost
- Objective of the Project and how meets the objective of EF
- Organization and its details
- Brief description of the project
- How the environmental issues or enhancements will the project address
- Previous experience and capability of the organization

- Key results and Measurable indicators on outcome of the project
- Time frame
- Detailed budget

Source of Fund and Management

The EF will be generated from revenue generated from sale of power. A 0.1% of revenue collection will be deposited into this fund. Approximate projected revenue has been calculated and presented in Table 9.3. The 0.1% of revenue collection as EF is also shown in this Table. Payments designated for the EF officially will begin from the date when the power will be sold to the grid. EF for the first year of operation will be 70 million rupees. The Environmental Unit of DHP and WEC will be jointly responsible for the management and administration of the EF.

Table 9.3: DHP Revenues and Environmental Fund

Year	Annual Energy from DHP, Gwh	DHP Annual Revenue (Million Rs) (@Rs.8.87/kwh)	Environmental Trust Fund (0.1% of DHP Revenue) (million Rs)
2020	8,058	71,474	71
2025	12,225	108,436	108
2030	15,544	137,875	138
2035	18,440	163,563	164

Chapter 10
POTENTIAL IMPACTS OF RELOCATION OF KKH

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10. POTENTIAL IMPACTS OF RELOCATION OF KKH

10.1 INTRODUCTION

About 52 km of existing Karakoram Highway (KKH) will be submerged by the proposed reservoir of DHP. To compensate this loss, the Project will relocate the existing KKH to higher elevation above the reservoir high flood level, within the elevations between 960-1000 masl. The realignment of the KKH is selected in such way that it should be located within the reservoir buffer area (less than 1,000 masl) to avoid additional land acquisition and to meet the geometric requirements of the design. In addition, to facilitate the smooth construction at the damsite and avoid obstruction to the regular traffic, a bypass will also be constructed along KKH to avoid the construction areas near the damsite. The relocated KKH will start from about 3 km north of Dasu-Komila Bridge and end at about 11 km south of Shatial.

Total length of the relocated KKH will be 61.7 km and it will be constructed in two phases. The first package (KKH-01) will consists of 15.575 km of relocated KKH plus a link road of 3.028 km length from existing KKH at lower level at Barseen (upstream of the damsite) to the relocated KKH at higher altitude. This total length of 18.575 km KKH-01 will act as a Bypass to the damsite and facilitates the smooth construction of works at the damsite without interruption from the traffic plying on the existing KKH. Construction of Package 1 is the first construction activity in DHP and will be expected to start sometime in the third quarter of 2013. The construction period of KKH-01 is one year. The construction activities in the first package also includes construction of 2 bridges (20m and 30 m length), 29 causeways, 4 culverts and 4.26 km of retaining walls at 47 locations.

Length of KKH covered by second package (KKH-02) is 46.119 km and it will be constructed over a period 3 years and the construction activity will be expected to start in 2014. This package includes construction of 6 bridges (20m to 35m length), 23 culverts, 19 causeways, and 9.02 km of retaining walls at 139 locations. Guard rails will be constructed all along KKH towards the valley side.

Though the overall impacts of the Project are covered in Chapters 7 to 9, some significant impacts related to relocation of KKH are discussed in this section. While the general construction related impacts are already covered in EMP sub-plans and ECPs. The significance of each of the potential impact is already given in Table 7.1.

10.2 POTENTIAL IMPACTS ON PHYSICAL ENVIRONMENT

10.2.1 Landslides

Project road passes through sensitive geological formation consisting of abundant distribution of rockslide material and colluvial deposits. Construction activities in these sections may trigger landslides, rock falls, and soil erosion.

About thirty major landslide areas are identified along the KKH alignment. These landslide areas are divided in to three categories of hazardous zones by considering geological, hydrological and geomorphologic conditions. High risk Widths of these landslides vary from 38 m to 384 m. Locations of major potential landslides along KKH are shown in Figure 10.1.

Mitigation Measures: Land sliding issues are considered in the road design and will include retaining walls, cross drainage, toe protection, rock anchoring and other similar structures/measures.

During construction, any blasting activities near the potential landslide areas will be controlled and contained within defined limits. Special attention will be paid to the blasting areas, where rock mass conditions are poor due to presence of shear zones.

Careless blasting could increase the requirement of slope stabilization measures in the area. During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down the slope. After blasting a riser, it will be stabilized by pre-designed support systems such as shotcrete, mesh and rock bolts prior to drilling the next riser for excavation. Where there are confinement issues, cushion blasting will be the method applied. Extreme care will be taken in designing the blasting pattern and blasting will be controlled so as to avoid disturbance of nearby slopes where stability is in a critical condition.

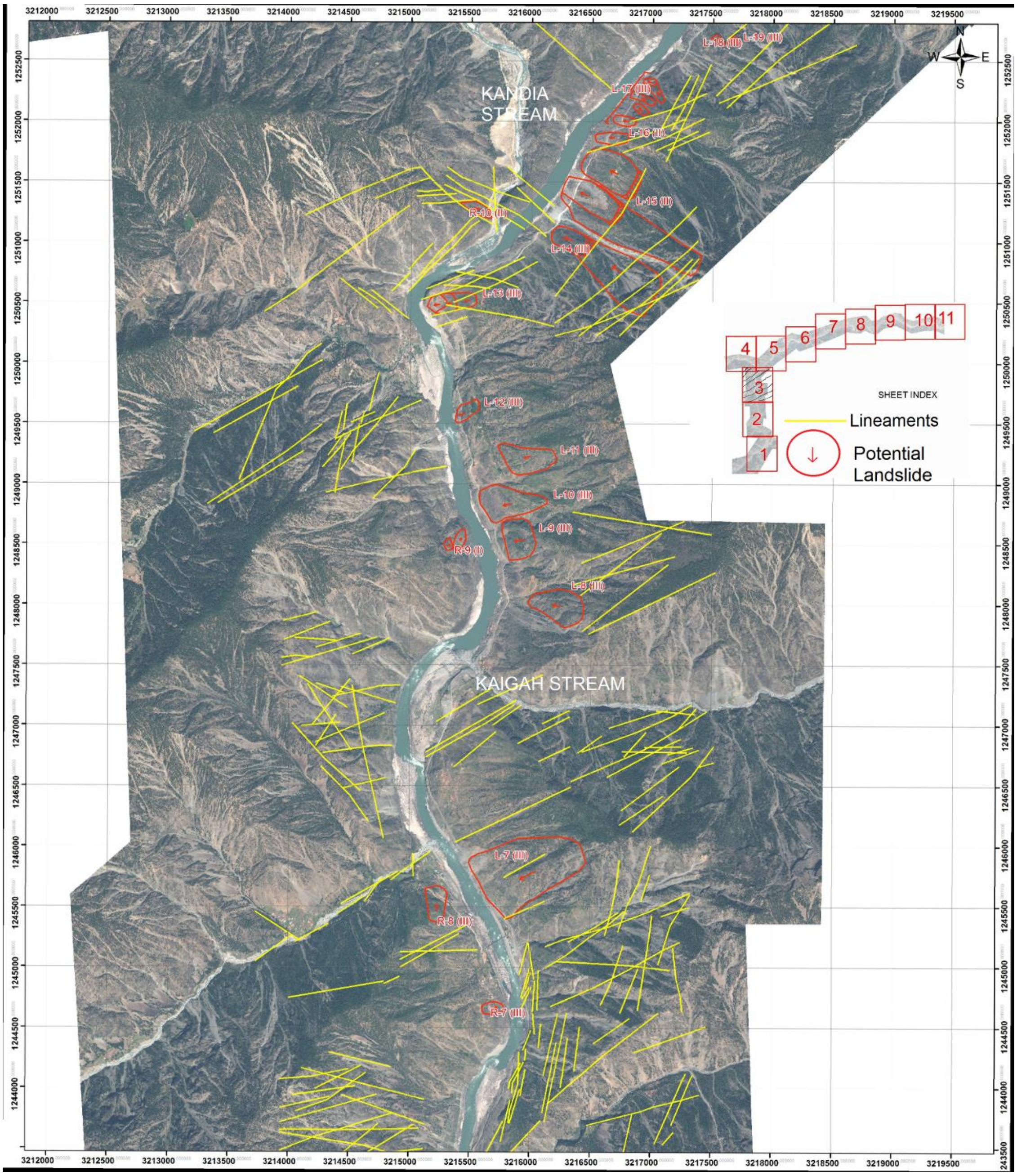

Figure 10.1: Location of Potential Landslides and Lineaments

Surface water management is considered as a major mitigation factor for increasing the stability of potential landslides and thus prevention of landslides. Temporary drainage systems will be installed to prevent water entering in to these areas with adequate maintenance and monitoring. Seasonal aspects such as snow melting and flooding periods will be considered while planning and maintaining the drainage system. Further, slope stabilization techniques (berms, biomats, vegetation, etc.) to prevent erosion, and further triggering of landslides will be applied.

Landslide areas prone area will be monitored for displacement by installing crack gauges to check the status of landslide movement for the first five years. The frequency of monitoring for the rockslide will be at least once a month. It may be adjusted depending on slope conditions, ongoing status of the landslide and the deformation structures (roads), meteorological change (rainfall and snowmelt), and earthquake. If any new deformation is observed to be due to landslide movement, structural measures will be considered. The conceivable measures are (i) Partial removal of the rockslide materials from the upper slope, and (ii) Concrete retaining wall to support the toe part of the rockslide. The contractor will develop Emergency Preparedness Plan and Early Warning System to set out response actions in the event of a landslide.

10.2.2 Seismicity

According to seismic zoning map of Pakistan, the road passes through Seismic Zone 3 with peak horizontal ground acceleration of 0.24 to 0.32 g. The road and bridges are designed for an earth quake force of 0.32g.

10.2.3 Spoils

Since the road passes through steep hill slopes, large scale excavation is required. Some of the excavated material will be used for formation of road embankment (filling). The excavation quantities and fill volumes are given Table 10.1. The total excavation volume is estimated to be 9.69 million cubic meters (MCM), in which only 0.98 MCM will be used as fill. Hence, nearly 8.7 MCM of spoils will be generated due to construction of KKH.

Table 10.1: Cut and Fill Volumes of KKH Construction

Description	Unit	Quantity for KKH-01	Quantity for KKH-02	Total Quantity
Excavation in Hard rock	m^3	1,368,295	3,024,360	4,392,655
Excavation in Medium rock	m^3	487,294	2,646,315	3,133,609
Excavation in Soft rock	m^3	276,185	1,890,225	2,166,410
Total Cut Volume	m^3	2,131,774	7,560,900	9,692,674
Fill Volume	m^3	237,580	747,000	984,580
Spoils (Excess Cut)	m^3	1,894,194	6,813,900	8,708,094

Source: DHP Detailed Engineering Designs

Mitigation Measures: Generation of spoils will be minimized by reusing them as maximum extent as road fill and aggregates for concrete works to use in the construction of Dam, underground structures, retaining walls and bridges. Some of the spoils can be used for filling behind retaining walls and filling of low level areas along KKH. The remaining spoils will be deposited in the Project`s disposal area (Section 7.3.1.3). If new disposal sites are required, they will be identified within the reservoir buffer area and fenced on the riverside so that there will be no rock or sediment laden flows into the river. Excavated material will be placed in layers of about one meter depth and each layer is slightly compacted by earth compaction machinery. A spoil management and disposal plan will be developed and implemented by the contractor for control of erosion and stability of the spoil piles. The plan shall also include landscaping and vegetation development through planting of shrubs and grasses by providing sufficient top soil on the spoil mounds.

10.2.4 Quarry and Borrow Areas

Development of quarry areas is not required for KKH since the part of the cut volumes will be used for construction of road embankment. Borrowing of some sand (about 2,500 m^3) is required for KKH-01 for construction of bridges and retaining walls. Government approved and existing borrow areas will be used for procurement of the sand. No new borrow areas will be developed for KKH-01. Manufactured sand from Kaigah quarry will be used in construction of KKH-02. Other material required for the construction of KKH such as bitumen (about 116,000 m^3), steel (about 400 tons) and cement (about 1,000 tons) will be procured from Islamabad and 'down county' and will be transported along KKH.

10.2.5 Water Quality

Relocated KKH crosses 6 tributaries and could affect the surface runoff flow pattern. The water quality could be impacted by: (i) bridge construction which will increase silt load in the river during construction at bridge sites and accidental spillage of concrete into the river, (ii) sediment laden runoff from excavation and construction activities (iii) hydrocarbon leakage and spills from diesel/petrol storage, washing of mixing plants, vehicles and equipment, and (iv) discharge of sewerage from work sites and construction camps to the Indus or its tributaries.

Mitigation Measures: The culverts and bridges are designed for a design discharge of 100 years return period and additional runoff from possible increase of 15 percent rainfall due to climate change. Since the length of proposed bridges are small (20 to 35m), single span bridges are designed to avoid construction of any piers in the tributaries, and blocking or altering of natural stream flows.

During construction, the contractor will be responsible for management and monitoring of water quality which will be based on the application of best management practices, and good site 'housekeeping' to prevent contaminant releases at the outset. The key mitigation measures are, (i) silt fences, sediment barriers or other devices will be provided to prevent migration of silt during construction within streams, (ii) material stockpiles are to be covered to reduce wash-way material; (iii) hydrocarbons will be stored minimum 100 m away from tributaries, in covered areas with impervious base and containment dikes; (iv) construction and work sites will be equipped with sanitary latrines that do not pollute surface waters and contractors will submit a waste management plan; (v) discharge of sediment-laden construction water directly into surface watercourses will be forbidden.

Water quality monitoring will be taken up during construction works at all major bridge sites quarterly to assess the impact of bridge construction on water quality and implementation of necessary mitigation measures.

10.2.6 Air Quality

During construction of relocated KKH, air quality is likely to be degraded by exhaust emissions from the operation of construction machinery; fugitive emissions from asphalt plants; and dust generated from unpaved roads, exposed soils and material stock piles. The dust will settle on trees and crops, and may cause some degree of respiratory stress for nearby residents and livestock.

The equipment used in the construction of KKH is given in Annex 10.1. The estimated air quality emissions from these equipment are listed in Table 10.2. The construction activities will generate about 0.03 million tons of greenhouse gases.

Table 10.2: Emissions from KKH Construction Equipment

Year	Emissions (tons)							
	ROG	CO	NO_X	SO_X	PM	CO_2	CH4	N_2O
2014	4.8	21.7	32.2	0.0	1.9	3,581.9	0.4	0.2
2015	11.7	54.2	81.7	0.1	4.7	9,170.8	1.1	0.5
2016	11.7	54.2	81.7	0.1	4.7	9,170.8	1.1	0.5
2017	11.7	54.2	81.7	0.1	4.7	9,170.8	1.1	0.5
Total:	**40.0**	**184.2**	**277.3**	**0.4**	**16.0**	**31,094.2**	**3.6**	**1.6**

Source of Emission Factors: AQMD, 2008

Mitigation Measures: The key mitigation measures include: (i) Construction equipment will be maintained to a high standard to ensure emissions are minimized, for example by cleaning fuel injectors. The vehicles used in the construction activities shall comply with NEQS exhaust emissions. Machinery causing excessive pollution (e.g., visible smoke) will be banned from construction sites. Vehicle refueling will be undertaken through the use of fuel nozzles and pumps so as to avoid fugitive emissions of volatile organic compounds. Asphalt plants will have dust suppression mechanism such as wet scrubbers; (ii) The contractor will submit a dust suppression program prior to construction. The plan will detail action to be taken to minimize dust generation (e.g., spraying of roads with water), and will identify equipment to be used; (iii) Construction materials will be stored away from the residential areas and will be properly covered. Materials will be transported to site in off peak hours and will be covered/wetted down to reduce dust. Asphalt plants to be setup minimum 1 km away from settlement areas; and (iv) continuous air monitoring will be carried out near the sensitive receptors to ensure compliance with NEQS.

10.2.7 Noise

During construction, the potential sources of noise are operation of construction related vehicular traffic, earth moving equipment, heavy machinery and blasting. Noise and vibration will have impact on people and fauna.

Predicted noise levels from the construction activities at various distances (100m, 250m and 500m) are estimated and presented in Table 10.3. Noise levels are expected to exceed the NEQS within 500m distance from the construction areas.

Table 10.3: Predicted Noise Levels During KKH Construction

Sr. No.	Construction Activity	Leq[1h] (dBA)		
		Distance from activity in meters		
		100m	250m	500m
1	Road way Excavation	71	63	57
2	Formation of Embankment	70	62	56
3	Base Course (WBM)	69	61	55
4	Asphaltic Base Course/Wearing Course Plant Mix	72	64	58
5	Bituminous Prime Coat/Tack Coat	58	50	44
6	Concrete Production	67	59	53
7	Pre-stressed Concrete Equipment	62	62	48
NEQS Standards for Residential Areas: Day time 55 dBA and Night time 45 dBA				

Source: FWHA Roadway Construction Noise Model

Mitigation Measures: The construction and road machinery used during the construction process shall comply with NEQS requirements with respect to emission and noise pollution. Regular maintenance of construction equipment and vehicles in accordance with manufacturers' maintenance procedures will greatly reduce the noise levels. Contractors are required to monitor the noise levels regularly at the nearby sensitive areas, such as settlements and Kaigah conservation area and take necessary measures to comply with the national standards. Contractors will adopt appropriate noise attenuation measures to reduce the noise generation from construction activities. The noise attenuation measures will include, (i) fitting of high efficiency mufflers to the noise generating equipment; and (ii) keeping acoustic enclosures around drilling equipment. The construction activities, near the settlements, will be stopped during night times if high noise values are observed. All vehicle used in the construction activities will comply with NEQS exhaust and noise standards (85 dBA at 7.5m from the source).

10.3 IMPACT ON FLORA AND FAUNA

10.3.1 Impact on Vegetation

There are no threatened, endemic or rare plants species recorded during field surveys or were reported in the literature. About 700 trees and shrubs will be cut from right of way of KKH. They do not represent much of natural flora, other than as a source of firewood for the local community. These trees do not serve the purpose of primary habitat for wildlife species. There might be pressure on the local forest resources due to increased demand for firewood for cooking and heating purposes.

Mitigation Measures: Clearing of natural vegetation will be avoided as far as possible. Complete record will be maintained for any tree cutting. The loss of trees will be compensated by planting 5 trees per each tree cut as a part of plantation development program. Details of tree species lost and will be replanted are described in Section 7.3.4.1. The construction crew will be provided with LPG as cooking (and heating, if required) fuel. Use of fuel wood will not be allowed.

10.3.2 Impact on Fauna

Wildlife in the Project area is located at higher elevations above 3,000 masl. Relocation of KKH from lower elevation (800-950masl) to higher elevations (960-1000masl) will not interfere with any wildlife corridors. However, they may provide increased access to hunting and poaching. Dust, Noise and vibration from construction activities may affect the wildlife and migratory birds. Noise generated through drilling and blasting during construction activities have potential to impact on the birds' hearing and behaviour. Community conservation area near Kaigah is the closest wildlife area near the construction activity and the wildlife in the conservation area may be subjected to dust and noise pollution.

Mitigation Measures: During migratory bird season; if there is concentration of birds near high noise generation activities, the contractor can deter the birds from those areas by using light reflective devises, waterfowl simulation gunshots, bird deterrent distress and alarm calls, etc. Noise standards given in Table 7.16**Error! Reference source not found.** will be considered as performance indicators for the environmental monitoring of the Project.

Noise levels will be monitored at the border of Kaigha CCA and if noise levels exceed the national standards, acoustic enclosures for noise attenuation are recommended for drilling and high noise generating equipment. Construction activities near the CCA will be limited to daytime. Contractors shall employ appropriate methods to control dust from the blasting and other construction activities. Poaching from construction workers can be affectively curtailed by conducting wildlife awareness programs. Temporary access roads will be decommissioned after completion of the Project.

10.3.3 Impact on Fish

The fish and other aquatic species in the tributaries will be affected by noise and water pollution from construction activities. The sources of such impacts are construction of bridge abutments, erosion from earth works, discharges from construction sites and camps; and hydrocarbon spills. Sediment concentrations above natural levels can cause mortality of biota directly; for fish, damaged gills and sediment clogging of gill chambers eventually leads to death. Indirectly, sediment deposition downstream can affect biota by altering habitat features for example by covering previously clean rock habitat used for spawning or feeding, causing impairment of those areas including smothering and mortality of freshly laid eggs or newly hatched larvae and reduced benthic production and food abundance for herbivorous fish such as snow carp and fish preying on algae-feeding invertebrates. Toxic compounds can have direct lethal and sub-lethal effects on organisms or have indirect effects for example by reducing food-organisms. Solid wastes can be ingested causing injury or death and can impair habitat.

Mitigation: Mitigation measures proposed in Section 10.2.5**Error! Reference source not found.** to control sediment releases in construction areas will minimize potential adverse effects on aquatic resources. Similarly measures outlined in environmental management plans in Section 7.4.2.6**Error! Reference source not found.** regarding use and handling of fuels, explosives and other hazardous materials and control and disposal of solid waste will also minimize potential adverse effects on aquatic biota.

10.4 IMPACT ON SOCIAL RESOURCES

10.4.1 Land Acquisition and Resettlement

Land acquisition for KKH construction is covered under the land acquisition for the reservoir areas. However, about 11 ha of additional land acquisition is required for right of way of KKH outside the reservoir buffer area on the downstream side of the damsite. This additional land acquisition will cause resettlement of 24 houses. Compensation for land acquisition and resettlement will be paid to the affected households in accordance with the Project’s Resettlement Action Plan (Section 8.2).

10.4.2 Community Impacts

Construction of KKH-01 will require about 90 workers for one year and construction of KKH-02 will require about 180 workers for 3 years. Immigrant workforce and in-migrants to the project area will have potential negative impacts on social and cultural aspects such as potential conflicts between the local and the immigrant workers and additional pressures and stresses on the already poor infrastructure and social/civic amenities available in Dasu area.

The Contractor will hire the local and affected community for all the unskilled works and also for the skilled works if available. Keeping in view the local customs, traditions and considerations, a set of “rules” have been identified through stakeholders meetings that provide guidelines for “code of conduct” for the workers – both local and outsiders. These codes of conduct must be respected by the workers, contractors, WAPDA staff and consultants engaged for project construction (Section 8.5.4).

The contractor will establish a camp for the immigrant workforce that should have adequate housing for all workers, safe and reliable water supply, fuel supply, waste disposal facilities, hygienic sanitary facilities and sewerage system, treatment facilities for sewerage of toilet and domestic wastes, storm water drainage facilities, adequate health care facilities, and in-house community/common entertainment facilities.

10.4.3 Health, Safety and Hygiene

The steep terrain and difficult work conditions at the construction areas will create a number of occupational risks and hazards. Accidental fall in to the Indus will be a major risk for the construction workers because of steep slopes. Large scale excavation, blasting activities and vehicular traffic may pose health and safety hazards to the workers at site.

Construction sites are likely to have health and safety impacts. There will be a potential for diseases to be transmitted, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading socially transmitted diseases such as HIV/AIDS.

Mitigation Measures: PMU, construction supervision consultant and contractors will have an OHS specialist in their respective teams to plan and execute OHS related issues and risks. Each contractor will establish a comprehensive OHS Plan aimed at preventing accidents, injuries and work-related diseases. This plan will be submitted to PMU and supervision consultant for review and approval before construction. Each contractor will also prepare an Emergency Response Plan defining procedures to be followed during any emergency. This plan will be submitted to PMU and supervision consultant for review and approval. The following measures will be taken by the contractor to minimize the OHS risks:

- All workers must be provided with and use appropriate personal protective equipment (PPE) such as safety boots, helmets, gloves, protective clothing, goggles, and ear protection. First aid must be provided and there would be procedures in place to access appropriate emergency facilities;
- Contractors will be responsible for developing procedures to address the OHS hazards. Signage related to hazards and risks must be in place at the work sites.
- Management procedures to address temperature stress, for instance in relation to extreme heat will be required;
- Health screening of employees would be a Contractor obligation prior to laborers working on site and living in the temporary accommodation facilities. The health screening would entail normal review of physical fitness and also include a review of appropriate vaccinations. Workers would be given vaccinations where required;
- All employees need to carry out induction health and safety training prior to commencement of work. OHS issues would be part of the employee training plan. Training would include the provision of appropriate written or visual materials to reinforce learning. Where illiteracy levels are high, OHS issues need to be covered more frequently than normal in toolbox talks;
- An emergency response team and plan must be identified. Training and drills based on the accident and emergency preparedness and response plan must be carried out quarterly. Training requirements, including for emergency preparedness, will need to be updated annually;
- It is essential that all personnel likely to be involved in the Project at the construction site undergo a basic training program prior to performing assigned work.
- Standard operation procedures for handling accidents related to electrocution, movement of plant equipment; falls from height, falling objects, working in confined spaces and dealing with hazardous materials

The contractor will follow closely the IFC Performance Standards on Labor and Working Conditions and IFC's EHS Guidelines. Special attention will be focused on safety training for workers to prevent and restrict accidents and the knowledge how to deal with emergencies.

10.4.4 Cultural and Archeological Sites

Though no known archeological sites are located within the construction corridor of the KKH alignment, there is a potential that these works may unearth the underground archaeological remnants.

Chance-find procedures, described in Antiquity Act of 1975, are included in the contact documents. In the event of the unexpected discovery of archaeological objects during construction operations the Contractor shall immediately inform DHP who will notify the KP DOAM and obtain their further instructions. In this case, the construction works would be stopped until the KP DOAM has given clearance for the continuation of operations. Works would only resume after appropriate measures have been taken as requested by the DOAM and confirmation has been received that works may continue. An archeologist will be retained by DHP to guide the Project authorities to comply with regulatory requirements in case of chance finds.

10.5 KKH ENVIRONMENTAL MANAGEMENT PLAN

10.5.1 Institutional Mechanism

Institutional mechanism for overall implementation of the Project is described in Section 9.1.2. Specific to the construction and operation of KKH, the institutions responsible for implementation of mitigation and monitoring of environmental aspects are:

- National Highway Authority (NHA) is the owner of KKH. Frontier Work Organization (FWO), a wing of Pakistan army, is responsible for maintaining the KKH. The KKH realignment will be built by DHP and handed over to NHA, for their regular maintenance.
- DHP and its Project Management Unit (PMU) will be responsible for implementation of the KKH Relocation Project and hiring of contractors and consultants.
- Environmental Unit in DHP (EU-DHP) will be for routine and random monitoring of implementation of EMP.
- Environmental Unit in CSC (EU-CSC) is responsible for supervision of implementation of EMP.
- Contractors will be responsible for implementation of EMP during construction. Each contractor will be recommended to have one Environmental Specialist and one Occupational, Health and Safety (OH) Specialist, who will be working in close coordination with the environmental staff of CSC and DHP.

The Contractor will prepare a ‘Construction Environmental Action Plan’ (CEAP) demonstrating the manner in which they will comply with the requirements of mitigation measures proposed in the EMP Sub-plans, ECPs and World Bank Group EHS Guidelines. The CEAP will form the part of the contract documents and will be used as monitoring tool for compliance. Violation of the compliance requirements will be treated as non-compliance leading to the corrections or otherwise imposing penalty on the contractors. The Contractor should ensure that all sub-contractors and site supervisors are aware of EMP of the Project. Responsible personnel and communication links should be established and described in the CEMP prior to commencement of civil works.

Monitoring and reporting mechanism of KKH construction will be similar to overall Project and described in Section 9.1.

10.5.2 Mitigation and Monitoring Measures

A summary EMP of the construction of KKH, highlighting potential impacts and mitigation measures, and monitoring measures are given in Annex 10.2. Cost estimates for mitigation and monitoring measures are given in Section 9.5.

Chapter 11
CUMULATIVE AND INDUCED IMPACT ASSESSMENT

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11. CUMULATIVE AND INDUCED IMPACT ASSESSMENT

11.1 INTRODUCTION

DHP is one of the several hydropower projects planned in Upper Indus Basin (UIB) as part of WAPDA's Vision 2025. DHP in combination with other proposed hydropower and storage projects has potential to cause significant cumulative and induced impacts on physical, ecological and social resources in the UIB. A cumulative and induced impact assessment (CIIA) report is prepared (EMAP Volume 7) to address the incremental environmental/ecological impacts of hydropower projects in the UIB between 2013-2022 in relation to DHP, including potential effects on biodiversity and ecological integrity of the riverine ecosystem and surrounding areas, environmental vulnerability of the river system and water availability for agriculture and other uses in the system. The CIIA is a step beyond the EIA, as it incorporates an integrated approach to assess the incremental impacts due to developments in hydropower projects including DHP over the next 10 years. A comprehensive study under WCAP has been planned on Strategic/Sectoral Environmental and Social Assessment of the Indus Basin (SSESA) and procurement of consultants for this study is in progress. In the absence of the SSESA the CIIA is intended to provide an indicative and framework assessment of potential cumulative and induced impacts of DHP in the UIB.

The CIIA has followed basic EIA steps: scoping of spatial and temporal boundaries and valued environmental components; identification of baseline conditions; assessment of potential effects; identification of mitigation measures and assessment of significance; identification of summary recommendations and follow-up information needs. Two types of impact are considered:

- Incremental effects of DHP on the type and magnitude of other (recent and future) developments in the area – Incremental project impacts.
- Effects of development in other sectors that are induced by DHP activities and components - Induced impacts.

Also two development scenarios are assessed: Scenario A reflects hydropower development as 'business as usual'; and, Scenario B reflects hydropower development 'best practices'

11.2 SPATIAL AND TEMPORAL COVERAGE OF THE STUDY

The spatial coverage of the CIIA study (study area) is UIB in Pakistan (Tarbela catchment area in Pakistan). The temporal coverage of the study is: existing plus potential hydropower projects to be developed over the next 10 years, from 2013 to 2022.

The existing and proposed hydropower projects expected to be implemented up to 2022 are listed in Table 10.1 indicating their status: i) existing / in operation; ii) under construction; iii) ready for implementation; and, iv) detailed engineering design and tender documents in hand.

Given variability in environmental, social and economic components along the Indus River, the study area is divided in to three zones (shown in Figure 11.1), governed mainly by biophysical variations (e.g., Tarbela Reservoir differs from most of the remainder of the basin; the upper portion of G-B is at higher elevation and has lower flows than the Indus River in lower portions of the study area).

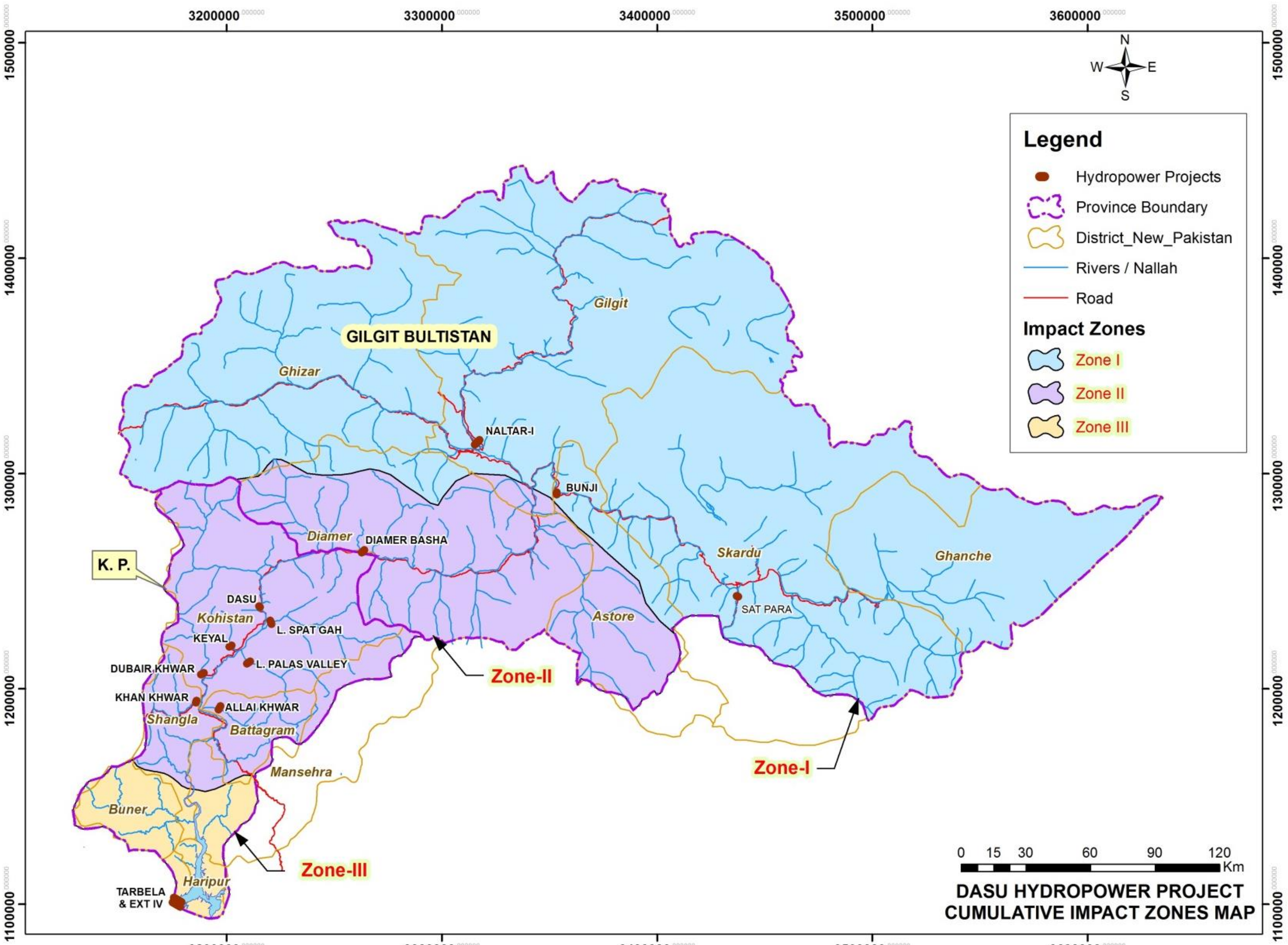

Figure 11.1: CIIA Study Area

Table 11.1: Hydropower Development Plan in Upper Indus Basin (up to 2022)

Sr. No.	Name of Project	River	Location (District)	Storage (BCM)	Installed Capacity (MW)	Expected Completion Date	Status as on Oct. 2012			
							Existing / in operation	Under Construction	Ready for Construction	Detailed Design and Tender Documents in hand
IMPACT ZONE – I										
1.	Satpara	Indus	Skardu	RoR	17	2012	√			
2.	Bunji	Indus	Astore	RoR	7100	2022				√
3.	Naltar	Naltar	Gilgit		27	2012	√			
IMPACT ZONE – II										
4.	Diamer Basha	Indus	Diamer / Kohistan	10	4500	2020-21			√	
5.	Dasu	Indus	Kohistan / Diamer	RoR (1.14)	4320	2019			√	
6.	Keyal Khawar	Indus	Besham	RoR	122	2016				√
7.	Dubair Khawar	Indus	Besham		130	2013		√		
8.	Khan Khawar	Indus	Besham		72	2011	√			
9.	Allai Khawar	Indus	Besham		121	2012	√			
10.	Lower Spat Gah	Indus	Kohistan	RoR	496	2017				√
11.	Lower Palas Valley	Indus	Kohistan	RoR	665	2017				√
IMPACT ZONE – III										
12.	Tarbela	Indus	Tarbela	8.63 (as on 2012)	3478	1976	√			
13.	Tarbela Ext-IV	Indus	Topi	-	1410	2019			√	
Total				**19.77**	**22,458**		**3,715**	**130**	**10,230**	**8,383**

11.3 POTENTIAL CUMULATIVE AND INDUCED IMPACTS

Broad topics considered for the CIIA are: i) water-hydrology, water use and quality; ii) vulnerability to flooding, flood management aspects; iii) forestry and bio-diversity; iv) agriculture and livelihood; v) social issues (i.e., involuntary resettlement, loss of income, ethnic minorities, cultural impacts considering religious and cultural values associated with Indus and health risks including risk of HIV/AIDS); vi) fisheries; transport; vii) water supply and irrigation; vii) urban development; viii) power transmission and industry; and ix) institutional issues and capacity.

Detailed assessments of impacts are presented in Volume 7: CIIA. A summary of the assessment along tithe the recommended best practices to address these impacts are presented in Table 11.2

Table 11.2: Summary of Potential Cumulative and Induced Impacts and Recommended Best Practices

Potential Impacts	Recommended Best Practices
1. River Hydrology and Water Quality	
Hydrology: Total average annual flow at Tarbela is 78.92 BCM. About 19.77 BCM of water (25%) will be retained in the reservoirs of the proposed projects (including the existing Tarbela). Operation of reservoirs (storage and release of water from reservoirs, either for irrigational purposes at Basha or peaking operations at Dasu) will alter the natural flow pattern. Presently high flows in Indus occur in summer and low flows occur in winter season. Downstream of Tarbela, a considerable increase of 42 % can be seen in low flow season when storage capacity of Basha is released into the system. With Basha, flows between Dasu and Tarbela will not change considerably due to possible peaking operation and overall effect will be negligible. However, during peaking a few hours surge will occur. No flow change is anticipated between Basha and Tarbela during regular operation.	Comprehensive examination of downstream flow changes (including both minimum flows and surge flows) resulting from all existing/planned main-stem and tributary hydropower and storage projects and opportunities to coordinate operational releases to minimize potential combined effects of flow and water quality changes on in-stream and riparian resources and human activities.
Water quality: Degradation of downstream of the dams is expected to increase due to release of sediment free water (sediment laden water has less potential for erosion). Water quality in the reservoirs is going to change due to thermal stratification and dissolved oxygen content in the lower parts of the reservoir. The water released from the reservoirs will be an altered water quality due to changes in temperature, oxygen and sediment content.	In addition to above, operational plans are to be derived; such as flushing of LLOs in combination with spillway releases initially for proper mixing of degraded water quality at the bottom and fresh water quality on the surface of the reservoir.
Floods: Storage of water in the reservoirs will attenuate the floods and save the downstream communities properties and lives. GLOFs are a serious threat and these are to be better managed to protect the hydropower infrastructure and community.	Presently the flood management through reservoirs in Pakistan is limited to the safety of the dam structures and does not include specified provision to attenuate in-coming flood peak. For safety of public and better management of flood waves and safe

Potential Impacts	Recommended Best Practices
Currently there is no early flood warning telemetry network available on the upstream of Dasu. With conjunctive operation of Tarbela, Diamer Basha and Dasu reservoirs, combined flood regulating capability of these dams will significantly increase. For individual 10-daily flows it was assessed that a maximum of about 60% reduction could be expected downstream of Tarbela. ***Sedimentation*:** Annually reservoir entrapment of sediment will be significant. Sediment trap efficiency values calculated for DHP were approximately 60 %. Life of Tarbela will be increased by 50 years due to retention of sediments in Dasu (15 years) and Basha (35 years).	operation of hydropower projects, a glacier monitoring program and flood telemetry network are to be established UIB. Integrated watershed management studies are required to devise plans for control of erosion and sedimentation.
2. Water Use	
Downstream of Tarbela, there will be increased water availability during the low flow season and transition period of Early Kharif. The enhanced supplies downstream of Tarbela reservoir, in tandem operation with Basha and Dasu reservoirs, in low flow period is expected to increase irrigation supplies by 14% on average. Upstream of Tarbela, community drinking water and irrigation supplies are expected not to be affected since they are drawn mainly from tributaries, but may be affected by smaller tributary projects.	Put in place broad-area processes to anticipate and respond to emerging risks and opportunities related to water use especially in Zone 2 and, engagement with potentially affected stakeholders in upper basin areas in an inclusive and participatory manner with thorough and timely feedback on water use issues.
3. Forestry and Biodiversity	
There is a potential of intrusion in to natural habitat and exploitation of flora and fauna due to relocation of 150 km of KKH into higher elevations; and construction workers. Poaching and illegal trapping of wild animals such as Musk deer, Markhor and various migratory bird species refuging in these mountainous habitats may increase. Reservoirs are expected to increase the population of migratory birds as they serve as artificial staging grounds. Mega hydropower projects including DHP are expected to affect community fuel-wood selling activities and through induced urban and industrial growth would increase demand for local wood products. Development of transmission lines will have a potential impact on the migratory birds due to collision and electrocution.	Principles of responsible environmental stewardship; integrated resource management, poverty alleviation and institutional capacity development. Institutional strengthening and capacity of resource agencies, such as forest and fisheries departments to meet expectations of integrated resource management along with responsible energy development. A commission or team should be considered to plan and execute a robust natural resource management strategy. Consistent involvement and interest of all sectors of local communities/ stakeholders. Alignment and design of transmission lines should consider wildlife habitats, morphometric characteristics of large birds
4. Agriculture	
About 1388 ha of agriculture land will be affected (excluding Tarbela, which already affected 17,300 ha of land) due to all the projects.	Put in place broad-area processes: to reduce risks associated with potential cumulative and induced encroachment on agricultural land and effects of agricultural practices

Potential Impacts	Recommended Best Practices
Irrigation supplies on the downstream of Tarbela will increase by 14%.	(including possible increased use of pesticides); and, anticipate and respond to emerging issues and opportunities related to agriculture especially in Zone 2. Engage directly stakeholders in the broadly affected areas in an inclusive and participatory manner with thorough and timely feedback on agriculture issues. The downstream Tarbela agriculture supplies will enhance to overcome water shortages and more area under cultivation.
5. Fisheries	
Nearly 290 km of riverine ecosystems will be converted lake-like ecosystems; segments of the Indus River and tributaries downstream of each dam will be subject to altered flows and water quality. Existing and proposed hydropower projects have potential to adversely affect snow carp and other fish species and fishing activity. There is risk that DHP incrementally will contribute to reduction in population sizes of snow carp and other fish species and amounts of fish caught by local fishermen. Fish movement on the mainstream Indus will be disturbed. Fish movement from the tributaries to Indus is common during low flow season in winter. Due to release of high water flows from reservoirs in winter, there will be a potential effect on the fish movement patterns between tributaries and the Indus. This will also affect the availability of fish for local consumption. Risks to fish habitat will increase as a result of project-induced increases on urban development, agriculture, transport, forestry and industrial activity. Project-induced increases in human populations, especially during the construction stage will increase demand for fish and pressure on fish stocks. Reservoir fisheries development is possible in the larger reservoirs.	Support development and implementation of an integrated basin-wide framework to assist assessment and management of wild-capture fisheries, including identification of long-term strategies to assist fisheries management institutions to address potential effects of multiple hydropower developments in their jurisdictions and engage community stakeholders (especially in Zone 2, where hydropower projects are concentrated). Define and support capacity-building in fisheries management institutions to strengthen capabilities related to both fisheries ecology and management. Support community/stakeholder-awareness programmes that highlight: interaction between hydropower facilities and fisheries resources; life cycle needs/habitat and protection requirements of fish species in the upper Indus River basin; good practices and opportunities for capture-fisheries in the basin area. Support broad-area inventory and analysis of ecological components and fishing activities based on a long-term perspective and, within the basin-wide framework, identification of high priority needs to enable assessment of planned hydropower development over the next 10 years and projects under consideration beyond 10 years.
6. Transport	
Construction of the large dams is expected to create a substantial increase in construction-related traffic and realignment of portions of the KKH. Current heavy vehicles traffic on KKH is about 400 daily. About 1200 vehicles (200-300 for Dasu and 900-1000 for Basha) will use KKH during construction. This increase in heavy vehicle traffic on KKH is expected to cause traffic congestion, safety hazards, air and noise pollution.	Put in place processes: to reduce transport related risks, including traffic safety issues and induced effect of increased roads and traffic on other environmental/social components; and, anticipate and respond to emerging risks and opportunities related to traffic and other transport issues especially for locations where hydropower projects are in close proximity (e.g., Zone 2). Engage directly affected stakeholders over a broadly affected area in an inclusive and participatory manner, with thorough and timely feedback on transport-related issues.

Potential Impacts	Recommended Best Practices
7. Urban Development	
As with DHP, other hydropower developments, particularly larger ones such as Basha and Bunji, likely will lead to "boom town" development in nearby communities, at least over the construction stages. Overlap in construction timing could lead to large population influxes at multiple locations along the Indus River. Large scale urban development is expected around the hydropower projects due to employment and business opportunities. This may create changes in the existing land use, mostly conversion of existing farm land into residential and commercial area. This will also lead to accelerated and unplanned urban development as seen from the development of urban areas like Haripur after Tarbela Dam Project.	Work with affected districts and communities within their broader community planning frameworks as they apply to urban and economic development, and including integrated mechanisms for sharing project benefits and anticipating and managing induced environmental/ecological and social effects; this may require provision of financial and technical support to agencies responsible for community and economic planning and engagement of stakeholders on a multi-district basis where multiple projects exist or are planned in close proximity (e.g., Zone 2).
8. Power Transmission	
Environmental assessment has not yet been undertaken for the Basha power transmission line or completed for DHP. Environmental and social issues include: i) health and biological impacts due to electro-magnetic fields; ii) loss to scenic beauty; iii) collision and electrocution of migratory birds; iv) loss of agricultural land; v) life safety issues; and vi) avalanche damage to the poles. Indus valley is a narrow gorge with limited place for development. There are already 2 existing transmission lines (132 KV and 220 KV) along Indus valley on the downstream of Pattan. There will be two transmission lines of 500 KV for Dasu along Indus up to Manshera (and then to Islamabad). There will be one more transmission line for Basha (765 KV) probably along Indus on the same narrow corridor.	Basin-wide assessment of corridors and routes; and, putting in place processes to anticipate and respond to emerging risks and opportunities related to power transmission issues and induced development, especially where hydropower projects are concentrated. Broad-area engagement of affected stakeholders in an inclusive and participatory manner, with thorough and timely feedback on issues related to power transmission including induced effects. Design of transmission lines should consider morphometric features of the large birds, and electromagnetic radiations from the transmission lines.
9. Industry	
Potential environmental and social effects will be associated with the types and size of industries that expand or are newly attracted to project-affected areas. Local industrial growth has potential to affect water demand, water quality, air quality, ecological services and resource use activities such as fishing and social factors such as workers and community health.	Put in place processes to anticipate and respond to emerging risks and opportunities associated with growth of local industries. Engage directly affected stakeholders in more than one jurisdiction to ensure environmental and social safeguards are adequately anticipated and applied, and with thorough and timely feedback on issues related to industry growth. Integrate with community development and economic planning initiatives.
10. Resettlement, Livelihoods and Income	
Cumulatively, substantial land acquisition and resettlement will be required. DHP will require relocation of 6,953 people. Already 96,000 people were relocated for Tarbela. Another 50,000 people are expected to be	A Social Development Fund (SDF) has been recommended for establishment by DHP to support the long-term livelihood development activities. During the operation of the DHP it is expected that SDF will receive funds from

Potential Impacts	Recommended Best Practices
relocated by Bunji and Basha. There are still about 400 unresolved court cases on compensation for Tarbela. Relocation of people will often lead to adverse impacts on their livelihood. Large presence of immigrant workforce will lead to community related impacts. In both near and long-term, considerable development is anticipated in and will benefit local populations and improve their income and standards of living significantly.	the benefit sharing mechanism proposed for the project. This concept could be broadened to incorporate and coordinate long-term livelihood development activities on a basin or sub-basin basis, particularly in Zone 2 (where a cluster of hydropower projects are located) over the near term. Engage economic planning agencies and community stakeholders in planning and execution of community development activities within a framework integrating provincial/district policies, community aspirations and hydropower project compensation and benefit sharing.
11. Other Social Effects	
Population Growth: Population booms are expected during construction, for example Diamer Basha Dam is a mega project and an estimated 11,000 people will be hired for the construction activities for the period of 10 years. Some in-migrants will possibly permanently settle in the areas. ***Health:*** At present the health facilities in the project area is are not adequate. It is anticipated that the health conditions in project-affected communities might deteriorate. ***Ethnic Minorities:*** Ethnic minorities like Soniwal in the DHP and Basha project areas likely will be severely affected due to reservoir inundation as they will have to shift themselves to new places for their livelihood. ***Social Disparity:*** The presence of construction workers with rather good salaries and other habits than the local population, and their followers, as well as easier access, may cause a change of attitude and behavior regarding alcohol and substance abuse. The long-term outlook appears beneficial to the communities affected.	Put in place broad-area processes, in addition to initial project-specific mitigation and compensation planning, to anticipate and respond to emerging risks and opportunities related to social issues especially in Zone 2 where two large projects have overlapping areas-of-influence (Diamer Basha, and DHP). This would include: coordinated engagement with directly affected stakeholders in overlapping affected areas in an inclusive and participatory manner with thorough and timely feedback on social issues; and, adequate planning to ensure increased demands, especially near-term during construction, are met for factors such as power, food supplies and transport/infrastructure.
12. Physical Cultural Resources	
The rock art complex in KP and GB, which is spread over 100 km distance from Shatial to Raikot, consists of more than 30,000 petroglyphs. Most of them will be flooded by the proposed reservoir of the Diamer-Basha dam. The natural weathering process and vandalism are threats to these rock carvings. The potential for vandalism may increase due to increase of traffic along KKH due to construction traffic of the Project.	A museum will be established at Chilas, by Diamer Basha Dam Project, to relocate the Rock carvings (if feasible) that will be submerged by Basha project. 3D replica models for all submerged carvings will also be placed in the museum The development and security of the Shatial site is more important as it will be the only site portraying the original and authentic specimens of rock art in the face of the fact that all such petroglyphs at the Basha Dam would be submerged in water leaving no trace of genuine antiquity at that site.

11.4 SUMMARY OF RECOMMENDATIONS

Detailed recommendations are given in Section 7 of Vol. 7: CIIA on management of social and environmental issues for sustainable development of the UIB; business solutions for effective environment management in UIB; and project-specific recommendations on environmental management. The recommended best practice mechanism to reduce risks of cumulative an induced impacts of DHP and other hydropower and storage projects on affected environmental/social components is to undertake coordinated and integrated basin-wide research, mitigation-measure development, and monitoring by means of a single coordinating body. Consideration should be given to:

i. development of guidelines on best practices that will be applied to hydropower and storage projects basin-wide and will be developed through stakeholder engagement;

ii. following best practices approach in planning and design of future hydropower projects and associated facilities such as transmission lines, quarry sites, etc.;

iii. formation of an upper-basin impact management/compensation program similar to such basin-management programs elsewhere where multiple hydropower and storage development exists;

iv. consultations with affected community and relevant stakeholders for planning and design of future project facilities;

v. creation of a steering committee or board to guide design and execution of the program environmental and social effects-management activities, in concept comprised of WAPDA, government regulatory and resource management agencies, and representatives of affected communities;

vi. development of a broad-area monitoring and adaptive management framework to be applied to hydropower and storage development in the upper-basin;

vii. development of guidelines on best practices that will be applied to hydropower and storage projects basin-wide and will be developed through stakeholder engagement;

viii. basin wide studies on aquatic biodiversity; in particular, comprehensive examination of combined effects and adequacy of environmental flows planned for main-stem and tributary hydropower projects in Zone 2 – based on bottom-up understanding of the aquatic resources at risk;

ix. Management of floods through glacier monitoring program and development of flood monitoring network;

x. integrated watershed management studies for control of erosion and sedimentation;

xi. development of long term benefit sharing mechanism, both monetary and nom-monetary, with the affected community;

xii. examination of entities elsewhere to develop a program-management modality and composition appropriate for the social, political and jurisdictional setting in the Indus River upper-basin; and

xiii. institutional strengthening and capacity development of the implementing and executing agencies in social and environmental management.

Chapter 12
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12. PUBLIC CONSULTATIONS AND INFORMATION DISCLOSURE

12.1 OVERVIEW OF CONSULTATIONS

Extensive consultations were carried out during the detailed design phase of the project, primarily through community consultations, *jirgas* and stakeholder consultation workshops. Community consultations involved multiple methods – for example, household level interviews, participatory rural appraisal, community meetings, and focus group discussions. Given the cultural context, key issues were largely addressed by community elders at *Jirga* meetings. In some sense, standard participatory tools are constrained by the tribal political and decision-making systems. Therefore, *Jirga* meetings are the predominant modes for disclosure and decision-making in the project area. The framework for consultation process is presented in detail in SRMP Volume 4: Public Consultation and Participation Plan to ensure effective participation from the primary and secondary stakeholders. Objectives of the consultation process are:

- Analyze household and community level issues and draw early attention for mitigations and/or resolution of the same issues
- Promote participation of the local people, local level government stakeholders, elected representatives and other community representatives to create opportunity to play a role and express their views
- Acquire suggestions of the community for mitigating any anticipated adverse environmental and social impacts and expected benefits of the Project;
- Obtain the views of various categories of vulnerable groups, discuss project impacts and benefits on these groups, and ascertain their expectations regarding project benefits
- Develop strategies to minimize potential social and environmental adverse impacts in conjunction with government stakeholders
- Promote pro-people and community-based resettlement and development strategies
- Socially prepare the community with confidence and capacity to deal with displacement, environmental and resettlement management.

2,392 persons were involved in various consultation meetings at the project sites and consultation workshops (Table 12.1) between April 2012 and October 2012.

Table 12.1: Number of Persons Covered In By Various Consultation Meetings

Sr. No.	Activities	No. of participants
1.	Social environmental surveys and inventory survey	1,435
2.	*Jirga* meetings, consultation meetings	718
3.	National consultative workshops	239
Total		**2,392**

12.2 DETAILS OF CONSULTATIONS

12.2.1 Community Consultations

Community consultations were also held during feasibility study in 2007. A summary of consultations undertaken during feasibility study is given in Table 12.2.

Table 12.2: Summary of the Consultations undertaken during Feasibility Study

No.	Date	Objectives	Person/agency consulted	No. of participants
Social survey conducted in the reservoir area only				
1	2007	Social economic survey	602 households	602
2	2007	Business survey	25 business activities	25
Group discussions at scoping sessions				
2	Apr. 29, 2007	To share the perceptions and develop a better understanding and contribution towards preparation of the Feasibility Study Report	Representatives, Village Seo	11
3	Jun. 24, 2007		Representatives, Village Segal	15
4	Nov. 3, 2007		Representatives, Village Seglo and Commercial Activities	22
5	Nov. 3, 2007		Representatives, Village Seo	25
6	Nov. 4, 2007		Representatives, Village Khashai and Choochang	21
7	Nov. 4, 2007		Representatives, Village Kaigah	14
8	Nov. 6, 2007		Representatives, Village Sazin	10
9	Nov. 6, 2007		Representatives, Village Shatial	15
10	Nov. 6, 2007		Representatives, Village Darel Bridge	10
11	Nov. 6, 2007		Representatives, Village Summar Nullah	18
			Total	**788**

Source: Feasibility Study EIA, 2009

During detailed design phase, consultation meetings were conducted in 34 villages during June 2012. Details of the consultations are given in Table 12.3. List of participants in these meetings are given in Annex 12.1. Some photographs of these consultation meetings are shown in Figure 12.1.

In addition to the consultation meetings, one on one consultation was held with 1,487 people during environmental and social surveys. Details of these consultations are given in Table 12.4.

Table 12.3: Consultations with Community Representatives

Sr. No.	Date	Side of the River	Name of Village	No. of Participants
1	27-06-2012	Right Bank	Kass	9
2	24-06-2012	Right Bank	Rango	10
3	24-06-2012	Right Bank	Seo	13
4	11-06-2012	Right Bank	Siglo	6
5	02-06-2012	Right Bank	Melar	12
6	03-06-2012	Right Bank	Kuz Kai	2
7	03-06-2012	Right Bank	Kai Dogha	4
8	04-06-2012	Right Bank	Seer Gayal	8
9	05-06-2012	Right Bank	Kot Gal	11
10	06-06-2012	Right Bank	Not Bail	13

Sr. No.	Date	Side of the River	Name of Village	No. of Participants
11	06-06-2012	Right Bank	Sluch	12
12	10-06-2012	Right Bank	Thuti	16
13	08-06-2012	Right Bank	Warisabad	8
14	25-06-2012	Right Bank	Doonder	12
15	17-06-2012	Right Bank	Gummo	9
16	09-07-2012	Right Bank	Cheer Chial	12
17	12-06-2012	Right Bank	Khaliqabad	7
18	26-06-2012	Left Bank	Chuchang	12
19	24-06-2012	Left Bank	Khoshi	25
20	23-06-2012	Left Bank	Logro	27
21	10-06-2012	Left Bank	Uchar Nallah	6
22	09-06-2012	Left Bank	Barseen	10
23	10-06-2012	Left Bank	Largani	10
24	08-06-2012	Left Bank	GulBagh/Maidan	12
25	06-06-2012	Left Bank	Kaigah	15
26	12-06-2012	Left Bank	Pani Bagh	12
27	09-06-2012	Left Bank	Gadeer	2
28	29-06-2012	Left Bank	Chalash	9
29	21-06-2012	Left Bank	Looter	14
30	19-06-2012	Left Bank	Shori Nallah	14
31	15-06-2012	Left Bank	Summar Nallah	15
32	18-06-2012	Left Bank	Lachi Nallah	7
33	14-06-2012	Left Bank	Sazeen Camp	5
34	20-06-2012	Left Bank	Shatial	26
			Total	**385**

Table 12.4: Summary of the Consultations undertaken during Detailed Design

No.	Date	Objectives	Persons Consulted
1	May-July, 2012	Social economic survey	319 households
2		Resettlement Inventory survey	763 households
3		Environmental baseline survey	63 persons
4	Aug. 2012	Gender survey	250 women respondents interviewed at Basic Healthcare Unit (BHU) and Rural Healthcare Center (RHC),
5	July.-Sep. 2012	Ecological Survey	Focus group discussions on fish and wildlife. With 40 persons
6	Aug-Sep. 2012	Consultation on availability of relocation sites	52 village leaders participated
Total			**1,487**

Consultation at Barseen

Consultation at Sigloo

Consultation at Thooti

Consultation at Gummo

Consultation at Kaigah

Consultation at Kaigah

Figure 12.1: Photographs of Community Consultations

12.2.2 Jirga Meetings

The *Jirga* is like a local "workshop", in which the tribal elders deliberate on important political, legal and development issues. As an important political instrument and political process, the *Jirga* system plays a vital role in the social, economic and political spheres. Local *jirgas* in a tribal setup is called by an elder of a tribe for settling local affairs within the family, clan, sub-tribe and tribe. The *jirga* exercises both judicial and executive roles to settle all disputes pertaining to the distribution of land, properties, blood feuds, blood money and other important inter-tribal affairs on the basis of tribal conventions, traditions and principles of justice. Often grand *jirgas* are convened to resolve issues of regional and national interests.

Prior to starting of detailed design, a grand *Jirga* meeting was held on 28th July 2011, in which a list of demands (Charter of Demands) were submitted to the Project Director, DHP on behalf of the affected people of the Project. The list was signed by Abdul Sattar Khan, Member of Province Assembly, KP.

Three *Jirga* meetings were conducted during detailed design to inform the community leaders about the Project, its details and potential impacts, and seek their participation in social and environmental assessment. Details of *Jirga* meetings are given in Table 12.5. In the first *Jirga* meeting held in March 2012, a committee of 'List of Notables' was formed by the *Jirga* to assist in environmental assessment. Members of this committee are given in Annex 12.2. A new committee of 'Affectees of Dasu' was formed during the *Jirga* meeting in September 2012. Members of this new committee are given in Annex 12.3. List of *Jirga* members participated in the *Jirga* meetings are given in Annex 12.4. Some photographs of a *Jirga* meeting are shown in Figure 12.2.

Table 12.5: Details of Jirga Meetings

No.	Date	Details of Participants
1	28 July 2011	Members of Grand *Jirga* (35 members) Abdul Sattar Khan, Member of Province Assembly, KP;
2	2 March 2012	Total participants: 114 persons 1. Project affected tribes/sub-tribes; 2. *Jirga* members 3. Relevant governmental agencies
3	8 June 2012	20 participants (*Jirga* members)
4	27 September 2012	112 participants (*Jirga* members and community)

Figure 12.2: Consultations at a Jirga

12.2.3 Stakeholder Consultation Workshops

Considering the significance of DHP in the national context and its potential impacts on Indus basin, provincial level stakeholder consultation workshops were conducted in Peshawar, Karachi and Lahore in September 2012. These workshops were attended by the respective provincial EPAs, wildlife, fisheries, forest, archeology, and public health departments, universities, NGOs and civil societies. A national level workshop was held in Islamabad on October 2, 2012, which was participated by the provincial EPAs from Baluchistan and KP; development agencies such as ADB, JICA and World Bank; national government departments such as Planning Commission, Ministry of

Climate Change, Federal Flood Commission, National Highway Authority, NGOs and universities. Details of workshops are given in Table 12.6. List of the organisations participated in the workshops are given in Table 12.7. List of participants of the workshops are given in Annex 12.5 for Peshawar, Annex 12.6 for Lahore, Annex 12.7 for Karachi and Annex 12.8 for Islamabad.

Table 12.6: Details of Stakeholder Consultations

Sr. No.	Date	Location	Participants
1	September 9, 2012	Peshawar	41
2	September 17, 2012	Lahore	88
3	September 24, 2012	Karachi	37
4	October 2, 2012	Islamabad	73
Total			**239**

Table 12.7: List of Organizations Participated in Consultation Workshops

Peshawar	Islamabad	Lahore	Karachi
• Environmental Protection Agency (EPA), KP, Peshawar • Wildlife Deptt., Govt , KP, Peshawar • Conservator Forest, Govt., KP, Peshawar • Saalik Foundation, Peshawar (NGO) • C.R.G. Caravan (NGO), Peshawar • Energy & Power Dept., KP, Peshawar • Health Department, Govt. ,KP, Peshawar • Sarhad Hydel Development Organization (SHYDO), KP, Peshawar • University of Peshawar • Highway Authority, KP, Peshawar • Deptt. of Archeology, Govt., KP, Peshawar • Deptt. of Fisheries, Govt. of KP, Peshawar • WAPDA	• World Bank, Islamabad • World Bank, Washington, • ADB, Islamabad • JICA, Islamabad • Pakistan Environmental Protection Agency, Islamabad • Environmental Protection Agency (EPA), KP, Peshawar • Environmental Protection Agency (EPA), Balochistan • Indus River System Authority (IRSA) • Irrigation Deptt., Balochistan • Project Management unit (PMU), WCAP • Deptt. of Social Welfare, Rawalpindi • Pakistan Engineering Council (PEC), Islamabad • Sungi (NGO), Islamabad • PMPIU / WCAP, Ministry of Water & Power, Islamabad • Arid Agriculture, University, Rawalpindi (AAUR) • P&D Division, Govt. of Pakistan, Islamabad • Private Power Infrastructure Board (PPIB). Govt. of Pakistan, Islamabad • United Nations Development Program (UNDP), Islamabad • 100 Small Dams Organization, Balochistan • Federal Flood Commission, Islamabad • Pakistan Agriculture Research Council (PARC), Islamabad • Duaa Foundation (NGO), Islamabad • Ministry of Climate Change ,Islamabad • Deptt. of Archaeology Govt. Pakistan. • Comsats Institute of Information Technology (CIIT), Islamabad. • National Disaster Management Authority (NDMA), Govt. of Pakistan, Islamabad • WAPDA	• Pakistan Engineering Council (PEC), Lahore • Punjab Agriculture Research Board (PARB),Lahore • Space & Upper Atmosphere Research Commission, (SUPARCO), Lahore • Sustainable Development Study Centre, Govt. College University, Lahore • Punjab Deptt. of Fisheries, Lahore • Aurat Foundation (NGO),Lahore • Dept. of Agriculture Punjab, Lahore • World Wildlife Fund (WWF), Lahore • Veterinary University and Animal Science, Lahore • Environmental Protection Agency, Punjab, Lahore • University of Engineering and Technology, Lahore • Deptt. of Archaeology, Punjab University, Lahore. • Energy & Power, Govt. of Punjab • WAPDA	• University of Sindh • Nadirshaw Edulji Dinshaw (NED) University • Mehran University, Jamshoro • Livestock & Fisheries, Govt. of Sindh • Project Coordination and Monitoring Unit (PCMU), P&D, Sindh • Engg. Review Magazine • Pakistan Telecommunication Corporation Limited (PTCL) • Environmental Protection Agency, Sindh • Social Welfare Deptt, Sindh. • Wild Life Deptt, Govt. of Sindh • Culture Deptt.,Sindh • State Life Insurance • Shirkat Gah (NGO) • WAPDA

The formats of the consultations meeting were as follows: (i) brief presentation on the technical/engineering design; (ii) presentation on the project environmental assessment; and finally (iii) brainstorming session with round table discussions and/or question and answer session on project impacts and mitigations. The participants were provided with booklets on project information and maps. In the brainstorming sessions, participants were given discussion points on the potential impacts of the project. Copies of the presentations and discussion points are given in Annex 12.9.

Workshop at Peshawar

Workshop at Lahore

Workshop at Karachi

Workshop at Islamabad

Figure 12.3: Photographs of Stakeholder Workshops

12.3 FEEDBACK OBTAINED AND INCORPORATED

12.3.1 Community Consultations

The main issues discussed with affected persons and communities are listed in Table 12.8 and how these issues are addressed and incorporated is also shown in this table.

Table 12.8: Key Issues Raised in Community Consultations

Issues	Description	Action Point
Compensation for land and other assets	The compensation issues and rates are of importance both to APs and WAPDA. The local demands have been for the rate applied in the case of Basha Diamer Dam upstream. LA notification has not been set yet by Dasu DRO. In view of the absence of cadastral surveys/maps, it is important to prepare the maps and records first with community and *jirgas* inputs. However, the affected communities want WAPDA to fix the rate prior to Section 4 notification. A recent *jirga* formed a committee to discuss this with WAPDA Project Office.	Compensation rates will be finalised based on the negotiated rate between the community and Dasu DRO. Details are given in Annex 8.1
Resettlement Site development	Affected communities want to relocate to higher elevations, to sites of their own choosing in the hills with basic amenities to be built at project costs. People expressed their concerns regarding access roads to new sites at upper elevations, water, power and irrigation systems for terrace cultivation.	Resettlement sites will be developed with all basic amenities and access roads. Provisions for land development for terrace cultivation and irrigation are included in the resettlement sites design. Details are given in Section 8.3
Job and Employment	The affected communities/sub-tribes demand full employment in the project during construction and in post-construction periods. In one of the *jirga* meetings, a request was made for vocational schools for boys and girls to prepare the affected persons for employment in the project. Accordingly, In addition, some outside employment or overseas employment opportunities are also expected by local APs.	WAPDA has already taken initiatives to conduct pilot training for candidates selected in batches from project affected households.
Livelihoods	The traditional terrace cultivation by the sub-tribes will be affected due to relocation and lack of terraced land in upper elevations. Thus, alternative livelihood after relocation must be explored since the vocational training mainly focuses on the limited scope of APs, namely, youth with at least completed primary education. Despite community-based preferred relocation, it will bring some disruptions-for example schooling, access to market and health clinic. Two suggestions were made at meetings: (i) reforestation as an alternative livelihood after relocation, and (ii) the agro-ecosystem of the affected area and need for new irrigation support.	A long term livelihood restoration plan is developed. Details are given in Section 8.4

Issues	Description	Action Point
Health and safety issues	The health and safety issues during dam construction were discussed. Local people are concerned about migrant workers for dam construction, noise and air quality issues, and heavy traffic on KKH during the construction period. It was claimed that the dam will affect community health and well-being and will impact on their limited and fragile social infrastructure.	A Public Health Action Plan (SRMP Vol. 8) and an EMP sub plan on Traffic Management is prepared to address the health and safety related issues of the Project
In-migrants and Outsiders	This has been flagged in the community level meeting as a very big concern by the affected communities. The "outsiders" – for example, construction workers, construction material suppliers and service providers (such as chefs, grocers, barbers, etc.) are required, in addition to local human resources. However, local villagers have "mixed" feeling about the outsiders moving in to work, including potential cultural and social conflict.	A plan on In-Migrant Management is prepared (SRMP Vol 9).
Physical and Cultural Resources	A historical mosque with wooden structure located at Seer Gayal will be submerged. The affected community wants this mosque is to be relocated at the new resettlement site by disassembling and reassembling. 17 graveyards will be submerged under reservoir. The communities want these graveyards will be allowed to submerge in the water, but are to be protected against collapse and floating of the human remains as a result of submergence. These graves are to be covered with mud and stone filling before filling of the reservoir.	Seer Gayal Mosque will be rebuilt on the new resettlement site. Graveyards will be protected with mud plastering.
Wildlife	Community based conservations should be promoted. The conservancy at Kaigah where Markhor is protected by private arrangement and selling one trophy annually for US$100,000 is good example.	Studies are recommended for identification suitable areas for development of community conservation areas

12.3.2 Jirga Meetings

Charter of Demands submitted by Abdul Sattar Khan, Member of KP Province Assembly on behalf of affected people of DHP on 28th July 2011 and official response of WAPDA on these demands are given Table 12.9.

Table 12.9: Charter of Demands of 2011 and Responses by WAPDA

Sr. No.	Charter of Demand	Response from WAPDA
1	A modern vocational training Centre for local should be established before start of construction of DHP	Provision of vocational Training Institutes for male and female have been kept in feasibility study
2	Provision of jobs for skilled and qualified locals should be accepted as the right of inhabitants of District Kohistan	Priority of jobs will be given to local inhabitants of District Kohistan on merit basis by following the codal procedures.

Sr. No.	Charter of Demand	Response from WAPDA
3	20% Of the royalty of Dasu HPP should be fixed for the development of Kohistan District	Matter relates to Federal and Provincial Governments
4	Establishment of new modern Hospital should be completed before construction of DHP	Provision of New Hospital for Dasu HPP have been kept in feasibility study and would be the part of WAPDA O&M colony.
5	Establishment of new colleges and Universities in different areas of District Kohistan should be completed before construction of DHP	Provision of New college have been kept in feasibility study and would be the part of WAPDA O&M colony
6	Establishment of new roads and tracks in different valleys of District Kohistan should be completed before the construction of DHP	Provision of New roads and tracks for Dasu HPP have been kept in feasibility study and would be completed during project construction
7	Provision of supply of free electricity to all areas of District Kohistan	Matter relates to GOP and Provincial Government
8	Twice of the existing market rates should be considered for the acquisition of land ,property and trees etc.	Assessment and application of rates relate to District Revenue Officer (DRO) District Kohistan and according to prevailing law
9	Provision of fixed quota for people of District Kohistan should be considered in all educational Institution of WAPDA all over the country	Matter relates to education policy, which is a Provincial Government subject
10	Revised survey for the acquisition of land, properties, houses etc. should be conducted by involving the nominated committee by the affected owners of area	During Detail Engineering Design, the survey will be completed as proposed by the local committee
11	After construction of Dasu HPP, proprietary rights of fishing should be given to local people of area.	Fishing is a subject of Provincial Government
12	Affectees of Dasu HPP should be resettled in modern residential colonies in different parts of the country	Resettlement colonies with all modern facilities in nearby Dasu town have been proposed in feasibility study
13	Special overseas employment quota should be fixed for the local people of Kohistan District	Matter relates to Federal and Provincial Governments
14	As District Kohistan is a non-settlement area therefore the prices of all properties should be considered doubled than the existing local market values	Matter relates to Federal and Provincial Governments
15	Honorary certificate for their sacrifice should be given to all people of District Kohistan	Matter relates to Federal Government

Source: WAPDA

These charters of demands are the basis for discussion in all further *Jirga* meetings. The main concerns raised in the *Jirga* meetings are implementation of these demands. A list of updated demands was given by the *Jirga* on 27th September 2012. These demands were signed by the recently formed committee, ‘Affectees of Dasu Dam’. The updated charter of demands is given in Table 12.10.

Table 12.10: Updated Charter of Demands of Sept 2012

Sr. No.	Charter of Demands	Recommendations to WAPDA to Respond
1	Local roads in the affected villages should be constructed along with the general roads on both sides of the Indus River up till Basha Dam.	KKH will be constructed (62 km) along the left bank. A right bank access road will be constructed from Komila to Dudishal. Wherever feasible access and linked roads will be constructed from KKH to relocated villages.
2	For affectees of Dasu Hydropower project, the local area should be declared as tax free zone from where, precious stones, wood and wood byproducts etc. may have the liberty to market in rest of all areas of the country and for such business; interest free loans may also be provided.	WAPDA has no jurisdiction in these areas. However, WAPDA will forward this demand to appropriate authorities of the national and provincial government. A benefit sharing program, with both monetary and non-monetary benefits is proposed (SRMP Vol. 13: Benefit Sharing in Dasu Hydropower Project).
3	For affectees, technical vocational training institutes, schools, colleges and some similar centers should also be established.	Vocational training centers will be established at Dasu. WAPDA has already started vocational training in the trades required for construction of Dasu project for the affected communities.
4	For Dasu Dam, all jobs should be for the affectees as being their right and; this may be accepted. For so, Dasu, Kandia and Pattan Tehsils should be prioritized at 1st, 2nd and 3rd and; any deputation/hiring or employment from outside these areas should be banned whereas; deployment of vehicles and machinery etc. may also be prioritized, likewise.	The affected community will be given preferential employment in the construction activities. However, the project involves construction of dam and tunnels, which require highly skilled and experienced labour (production and placement of RCC, rock drilling and blasting, tunneling, heavy equipment repair, batching plant and conveyor belt operation, etc.). The skilled labour will be a mix of expatriates and local technicians. It will be contractors' responsibility to bring such manpower. For all other jobs, affected community will be given high priority followed by the residents of Dasu, Kandia and Pattan. The project will be implemented and performed by international tendering procedures, and specific recommendations such as hiring local machinery and vehicles cannot be included in these type of contracts
5	In all colleges and the universities of country, a special quota of Kohistan should be for professional education. And by giving priority to the children of affectees, an allowance should be fixed by WAPDA	Special quota will be provided to the children of all affectees in WAPDA's run educational institutes. Government of Kohistan can establish a special education fund with the royalty they receive from the Project. (see point 9 in this table)
6	Keeping in view the backwardness of District Kohistan, special quota for jobs should be fixed in both provincial and federal government departments including the Public Service	WAPDA has no jurisdiction on these matters. However WAPDA will forward these demands to the appropriate national and provincial authorities.

Sr. No.	Charter of Demands	Recommendations to WAPDA to Respond
	Commissions and; an age relaxation may also be given.	
7	For the assets of the affected community which include houses, cultivated and barren lands, both fruiting and non-fruiting trees; special package should be announced according to the expectation of the affected community	Compensation will be provided based on the negotiated rate between the community and District Revenue Officer (DRO) of Dasu.
8	For affectees, government should develop plots according to the pattern and standards of a developed society in which, all facilities like schools, colleges, hospitals, electricity and water should be available and; their costs should not be on the part of affectees	WAPDA is committed to develop resettlement sites to all the affected villages with all necessary infrastructure facilities such as water supply, mosques, sanitation, roads, and all other facilities that were previously available in the affected villages.
9	20% royalty as being the right of affectees should be accepted and; electricity without any charges free of load shedding in all Kohistan should be provided	Benefit sharing is being introduced first time in hydropower projects in Pakistan through Dasu Project. WAPDA will share revenue of the Dasu Project with the government of KP. It is recommended that the Government of KP to pay 20% of its revenue as a royalty to Kohistan. Details are given SRMP Volume 9: Benefit Sharing in DHP
10	In District Kohistan, hospitals should be built at tehsil levels and for the promotion of education, modern colleges and a university should be established	District Government of Kohistan has to build these facilities from the royalty they receive through this project.
11	In Tehsil Dasu, the establishment of a cadet college should immediately be announced in which, the children of affectees may get a special quota	WAPDA has no jurisdiction in this matter. Government of KP has to build these facilities from the royalty they receive through this project.
12	For employment outside the country, a special quota for District Kohistan should be fixed in which, priority should be given to the affectees	WAPDA has no jurisdiction in this matter. Government of Pakistan has no such quota on overseas employment except in its diplomatic missions outside the country. WAPDA will coordinate with 'Overseas Employment Corporation' of Pakistan. to help the affectees to get jobs through them.
13	After construction of Dasu dam, the right of fishing should be accepted for local people.	Affected community will be given priority in the fishing. However, provision of fishing right to local people is not a good idea if the fisheries potential of the reservoir is to be exploited. It would be better to involve the government or a commercial fisheries company (taking care of stocking, stock management, harvesting, processing and marketing). Employment of affected

Sr. No.	Charter of Demands	Recommendations to WAPDA to Respond
		people by such companies provides more (and more sustainable) jobs.
14	By accepting the devotion, special honorary certificate should be awarded to the affectees	WAPDA will provide certificates to all the affectees.

12.3.3 Stakeholder Consultation Workshops

A summary of comments and suggestions received in the consultation workshops is given in Table 12.11.

Table 12.11: Summary of Discussions in Consultation Workshops

Stakeholders Comments and suggestions	Action Point
Development of an agricultural terrace in the hilly areas will take several years of effort and hard work. Development of agricultural terraces to be considered for the affected households in their new resettlement areas.	Agricultural terraces will be developed in the resettlement sites.
Physical cultural resources in the area are to be properly documented.	Covered in Volume 5: Physical Cultural Resources
The people in Kohistan have unique social culture, which may be affected by resettlement.	The social structure of the affected people will not be disturbed and will remain same. Relocation of the affected people will be still within their winter migration range.
It is apprehended that existing health facilities will not be enough to meet local and inward migrant worker’s need. How the Project will address these health needs?	A public health action plan has been developed (SRMP Volume 8). Public health issues such as safe drinking water, safe disposal of sewage, safe collection and disposal of solid waste, protection against dust and community health are considered as part of EMP.
Protection of aquatic flora and fauna should be considered in project design. Requirement of environmental flows for the sustainability of downstream habitat is to be assessed.	Environmental flows will be designed for the Project. But the assessment on how much flows to be released require further studies. It is an established practice in Pakistan to design 10% of average minimum monthly flow as environmental flows. But actual assessment should be based on the habitat requirement.
KKH is life line of northern areas as it is only highway connecting northern areas with reset of the Pakistan. Impact of construction traffic on KKH to be assessed.	A traffic management plan is prepared to address the traffic related issues along KKH and along the access roads to the Project sites.
Impacts during demobilization of contractors are to be considered in the EIA	Contractors’ demobilization is considered in the EMP and ECPs.
WAPDA shall have an Environmental Monitoring Unit at Project Site for supervision of EMP implementation.	An Environmental Unit is recommended for both DHP (WAPDA) and supervision consultants.
Initial filling of reservoir may affect the downstream release of water to Rabi crops	The first water filling of reservoir will be carried out during mid-June slowly at the rate of 2 m/day. The rest of the river water will be allowed to flow downstream of the dam through LLO. During the initial days of first filling, there will be no flows on downstream

Stakeholders Comments and suggestions	Action Point
	for first one or two days. No impact on Rabi crop will be expected.
Low flow season operation of the dam and its impact on aquatic life to be considered.	Environmental impacts on the downstream ecology are assessed during low flow season for both run of river operation (pre-Basha) and peaking (post-Basha) operation (Section 7.4.3).
Project design shall consider geohazards (landslides and earth quakes) in the area.	The Project is designed complying with guidelines of International Commission on Large Dams (ICOLD) to deal with geological and geomorphological hazards. State of art engineering modeling was carried out for design of dam.
Floods from GLOFs will be a serious risk to the Project. Early warning system for flood forecasting is necessary for the safe operation of the Project.	Design flood (Probable Maximum Flood) of the Project considered extreme flood events from GLOFs and extreme rainfall events. A flood telemetry network will be established in the upstream of Dasu for early warning system and better management of floods.
Security issues are to be considered during implementation of the Project.	Security situation in the Project area is assessed and a plan is prepared to address these issues in one of the SRMP Vol. 3: Analysis of Poverty, Conflict and Development Nexus.
Historical and archeological sites are to be protected. DHP should support the Archeology Department of Peshawar for protection of Shatihal rock carvings, a designated archeological site.	The PCR plan considered the protection of Shatihal rock carvings.
Impact on the community and their livelihood due to relocation to higher elevation.	A livelihood restoration program is proposed in RAP with both short term and long term goals to mitigate any impacts on livelihood.
Community based conservations should be promoted. The conservancy at Kaigah where Markhor is protected by private arrangement and selling one trophy annually for $100,000 is good example.	The Project identified a suitable site in the Project area (Kandia valley) for development of similar community based conservation.
Traffic on KKH requires careful planning if construction of Basha and Bunji projects start along with Dasu.	Currently there is no confirmed schedule available on construction of Basha and Bunji. Recommendations are made in the CIIA.
There are no proper health facilities in Kohistan. Health and safety of construction workers and host community need to be planned.	A public health action plan is prepared to address these issues.
Indus valley is a flyway for migratory birds from Siberia to Sub Continent. Impact of transmission line on birds' migration to be assessed.	Bird collision and electrocution are potential threats on migratory birds. These issues will be addressed in the Transmission line EIA
Electromagnetic waves from transmission lines and their impact on human health to be assessed.	These issues will be addressed in the Transmission line EIA
Cumulative impacts of hydropower development on Upper Indus Basin on	The present assessment limits its scope of Upper Indus Basin (Tarbela Catchment). A

Stakeholders Comments and suggestions	Action Point
Lower Indus Basin should be monitored.	detailed study is in pipeline from WCAP on 'Strategic/Sectoral Environmental and Social Assessment of Indus Basin'
Impact on migratory birds and important bird areas (IBA) to be assessed.	Impacts on migratory birds are assessed during construction phase of the project. During operation stage, the project will not have any impact on migratory birds. Dasu reservoir might act as a staging ground for a variety of migratory birds that come under the Indus flyway and flying south from the northern latitudes. Large water bodies have traditionally attracted diverse migratory birds in northern Pakistan.
Indus river ecology should be protected. Feasibility of fish ladders should be studied.	Impact of both Dasu and other projects on Indus on the Indus river ecology are assessed and necessary mitigation measures are recommended in the Aquatic Ecology, Terrestrial Ecology and CIIA reports.
The Project design should consider geological hazards (seismic activity and faults) in the Project area.	The Project is designed complying with guidelines of International Commission on Large Dams (ICOLD) to deal with seismicity and faults. State of art engineering modeling was carried out for design of dam.
Climate change impacts may trigger GLOFs, high erosion and sedimentation; and finally may affect the Project.	A climate change assessment study was under taken as part of EA.
Habitat management plan for endangered species is to be proposed.	The Project will not affect any wildlife habitats. However, programs are proposed for protection of important fauna in the project area such Markhor, musk deer, monal pheasant and Tragopan peasant (EMAP Vol 3: Terrestrial Ecology).
Lost community facilities in the affected villages are to be restored in the new resettled villages.	All basic amenities like roads, water supply, irrigation, sanitation, schools and any other facilities that were lost will be built in the new resettlement areas.
Involvement of local community in planning and development process is very important.	Consultation meeting were carried out in all the project villages.
Ensure timely & frequently stakeholders meetings for suggestion and feedback.	WAPDA has established a full time office at Dasu which is constantly providing a forum to consult on any and all issues. An Executive Engineer of WAPDA heads the office. DCO is also involved. Two 'Project Information Centers' will be established in Dasu and Komila for dissemination of project information and continued consultations.
Proper compensation of affected community is needed, to make it more transparent & clear; affected persons be given proper guidance.	Recommended in RAP (SRMP Vol. 6).
Capacity of WAPDA in term of human resources needs to be increased to address social and environmental issues.	Field level social and environmental units will be established in DHP.

Stakeholders Comments and suggestions	Action Point
Potential livelihood and income generation activities to start	Short term and long term livelihood restoration plans are recommended in RAP (SRMP Vol.6)
Education sector is very important in this area. Focus on Education & Health sector.	Education and heath will be considered in the social development plan and benefit sharing of the Project
Involvement of women is very important. Design livelihood livestock related activities for women.	A Gender Action Plan is prepared (SRMP Vol 7).
Mobilization of women for capacity building related to income generation activities need to be more focused	A Gender Action Plan is prepared (SRMP Vol 7).
Invertebrate fauna / aquatic flora should be addressed	Invertebrates are studied within the domain of aquatic ecology.
Establishment of fish hatchery	Fish hatchery is recommended to promote reservoir fishery.
Motivate local people for terrace farming.	Recommended in RAP (SRMP Vol. 6).
Livestock farming through providing quality animals breeds	Recommended in RAP (SRMP Vol. 6).
Downstream communities are generally beneficiaries of the hydropower and irrigation projects. These benefits are perpetual and will pass on to their next generation. The upstream communities are the affected communities by the project and will not the benefit by the project. There should be a planning mechanism to take the perpetual benefits to upstream community.	A perpetual benefit sharing mechanism is proposed (SRMP Vol. 13)
Climate change and global warming to be dealt in a comprehensive way	Climate change impacts and risks are addressed in Section 6 of EIA
Management and governing mechanism to transfer the benefits and mitigate adverse impacts is recommended	An organization chart and governing mechanism is proposed for implementation of social and environmental management plans (Section 9 of EIA).
Carbon foot prints are to be calculated	Greenhouse gas emission from the project is calculated (Section 6 of EIA).
Other government departments are to be consulted	All relevant departments of the Project are invited to the stakeholder consultation workshops.
Pre and post effect monitoring should be presented	Pre and post monitoring is proposed for implementation of EMP
Disaster risk reduction checklist that was approved by the government is a requirement for approval of planning documents and PC1. These components are to be considered in the study	The checklist is prepared and attached with PC1.
Long term benefit for the affected population shall be contemplated and recommended	A benefit sharing mechanism is proposed
Cumulative impacts on river, and biodiversity should be made part of the study	Cumulative and Induced Impact Assessment is prepared covering these issues.

Stakeholders Comments and suggestions	Action Point
Pakistan signed conference on climate change and hence has access to climate and adaptation fund. The project has to be conceived in a way to access to the funds. No project in Pakistan was able to get these funds.	The Project's importance in terms of carbon reduction is discussed in Sections 5 and 6 of EIA. CDM potentiality is also presented in Section 6 of EIA. The discussion would be sufficient, if WAPDA would like to purse the finance from climate and adaptation fund.
Invertebrates and aquatic flora are the food sources of migratory bird. They should be studied.	Dasu reservoir will not support these features because of high water velocities and rapid sedimentation
Fish hatcheries to be established to conserve the local species	Fish hatcheries are recommended for reservoir fisheries development and livelihood restoration plan
Motive local farmers in livestock farming and provide them quality breeds for sheep and goat	Livestock farming is included in the livelihood restoration plan of the Project
Motivate local people for terrace farming. NARC help can be taken	These recommendations will be included in livelihood plan of the project.
Community should be educated about Infectious diseases. Necessary vaccination should be provided.	The recommendation is included in Public Health Action Plan of the Project.
Sedimentation in catchment area should be covered and properly addressed	Landslide prone area in Dasu reservoir areas are identified and will be protected. Further studies are recommended for integrated watershed management in UIB for control of sedimentation.
National heritage should be properly conserved	Conservation measures are proposed for Shatial rock carvings.

12.4 INFORMATION DISCLOSURE

The proposed mode of disclosure of EMAP and SRMP documents are summarized in Table 12.12.

Table 12.12: Mode of Information Disclosures

No.	Activities	Purpose	Intended stakeholders
1	Information Dissemination through Public Information Centres	Leaflets or pamphlets containing EMAP and SRMP (entitlement matrix, compensation rates, etc.) in local language to be distributed to all APs. Project information on detailed design, EMAP and SRMP documents, urdu translations of executive summary of EIA and RAP will be made available.	APs, local media, local government, mosque leaders, village heads, and *jirgas*
2	Public Disclosure of Project-related Documents	EMAP and SRMP documents on WAPDA's and World Bank websites.	Wider circulation for national and international population
3	Public Disclosure Consultation	Public consultation will be conducted by the design consultant in early 2013 at Dasu.	APs, local media, local government, mosque leaders, village heads, and *jirgas*

12.4.1 Information Dissemination through Public Information Centre

The nature and details of the Project will be made available in easily understood terms and local languages to inform as many stakeholders as possible. To maintain transparency and keep the communities informed, WAPDA will establish two Public Information Centres (PICs) in Dasu (one each in Right and Left bank).The centres will have a key role in disseminating project-related information and will house an array of Project related documents like EMP, Resettlement Action Plan, Land Record, Safeguard Documents, informative booklets and Information, Education and Communication material etc. The centres will be managed by DHP (or consultants), and the DHP staff will be available at PICs for interacting with the Project communities and providing them with necessary information. A register will be maintained at the PIC for registering the queries, suggestions and grievances of the Project communities and the APs. All the queries, suggestions and grievances recorded at the PIC will be forwarded to the DHP's Resettlement Unit.

12.4.2 Public Disclosure of Project-related Documents

EMAP and SRMP documents will be disclosed in WAPDA's and World Bank's website. Executive summaries of these documents will be translated into Urdu and will be made available to the affected people by WAPDA prior to project loan appraisal. An information booklet will be designed for distribution among the affected persons as the primary tool for disclosure. For illiterate people, other suitable communication methods will be used. These materials will also be available in Project Information Centres at the project site. Disclosures will also be continued using the following instruments:

- Advertisement in newspapers;
- Advertisement in radio and television;
- Billboards and posters;
- Community workshops;
- Information brochures;
- Information dissemination through Public Information Centres
- Village level meetings.

12.4.3 Public Disclosure Consultation

Public Disclosure Consultations will be conducted by the design consultant after the preparation of draft EIA and translation of executive summary of EIA into Urdu. Local people and government will be made aware of the meeting at least one month of the consultations through advertisement in newspapers, radio or television.

Chapter 13
CONCLUSIONS

Contents

13. CONCLUSIONS

The Dasu Hydropower Project (DHP or the Project) is a major investment project proposed by the Government of Pakistan to inject about 18.44 million kWh (18,440 GWh) to the national grid and expand the energy sector of the country, while shifting from thermal generated electricity to low cost and high reward, clean generation of hydropower. Power shortages are crippling Pakistan's economic development prospects, so the Government has no choice but to take strong action to increase power supply. The consequences of a "no-project" counterfactual are unacceptable, since increased reliance on oil-based self generation in face of grid supply shortages further worsens oil dependence as well as having highly damaging environmental effects that are much more difficult (and costly) to mitigate than those that arise at hydropower projects.

Among the available options, DHP is the preferred choice because of its least cost compared to other alternatives such as thermal and renewable energy including other large hydropower candidates in the country; as a domestic resources improves energy security; less dependence on imported fuel, which effect foreign exchange requirements; and reduces greenhouse gas (GHG) emissions compared to all thermal alternatives (17 million tons of GHG from Thar coal).

An environmental assessment (EA) of DHP has been carried out to describe the existing physical, biological and social environment; identify and evaluate potential environmental risks and impacts of the Project; examine project alternatives; identify measures required to prevent, minimize, mitigate or compensate for adverse impacts for inclusion into the environmental management plan; and conduct consultations with all relevant stakeholders. The assessment went a step beyond the general EA process by conducting four national level workshops (at Peshawar, Lahore, Islamabad and Karachi), and incorporating an integrated approach to assess the cumulative and induced impacts due to developments in hydropower sector in Upper Indus Basin (UIB) in relation to DHP over next 10 years. Thus, the scope of the project impact assessments was comprehensive to cover all potential social and environmental aspects to comply with safeguard planning requirements of the World Bank and the Government of Pakistan

A set of following eight volumes has been prepared as a part of EA documentation in the form of Environmental Management Action Plan (EMAP):

- Vol. 1 Executive Summary
- Vol. 2 Environmental Impact Assessment
- Vol. 3 Terrestrial Ecology
- Vol. 4 Aquatic Ecology
- Vol. 5 Physical and Cultural Resources
- Vol. 6 Cumulative and Induced Impact Assessment
- Vol. 7 Environmental Baseline Quality
- Vol. 8 Environmental Management Plan

EMAP provides comprehensive coverage to the different environmental issues and project impacts, including mitigations and management plans. Similarly a set of 15 volumes has been prepared to address the social and resettlement issues of the Project under Social and Resettlement Management Plan (SRMP). The environmental and social assessment carried out under the Project is self evaluated against the international best practices defined by the Hydropower Sustainability Assessment Protocol (IHA, 2010). The results of the test (see Annex 13.1) reflect high quality project preparatory works of DHP against global benchmark.

Environmental issues are given due consideration throughout the Project planning, and wherever possible environmental concerns are mainstreamed in the Project designs. These include:

- Environmental considerations were a significant factor in selection of the damsite. The chosen dam location reduced about 50% of resettlement; 7% of excavation and 1.8% of concrete volume.
- Quarry area to produce 14 million tons of aggregates is selected from reservoir submergence areas thus avoiding additional land acquisition and environmental impacts. Manufactured sand will be used (5 million tons) instead of river sand deposits recommended in the feasibility study to avoid impacts on aquatic ecology. Spoils from underground excavations (partly from surface excavations) will be used as aggregates.
- Transport of concrete, material and spoils (7 km for excavated rock and 13 km for aggregates) through belt conveyor system, thus avoiding about 1100 vehicles per day and related air pollution.
- Run of river operation of the project by always maintaining 950m of reservoir water level, thus always maintaining outflow at a rate equal to inflow to avoid any impacts due to reduced downstream water flows. Environmental flow (will be established by further studies and tentatively recommended 20 m^3/sec) will be released in low flow season to maintain the aquatic habitat between dam and tailrace.
- Impounding of reservoir will be done in high flow season to avoid reduction in flows in downstream. Similarly flushing will also be done in high flow season to reduce the impact of sediment load in downstream (97% of sediment load in Indus occurs in high flow season).
- Reduction of turbine size to suit the transportation capacity of KKH. The smaller unit capacity could also contribute to the energy production at low flow season, and could accommodate reduced river flows due to climate change. Further, the smaller units can be used to release continuous minimum flows if the DHP chose to operate as `storage or peaking` plant in Stage 2.
- Design of single span bridges on tributaries to avoid construction piers in rivers and disturb natural stream flows and aquatic habitat.
- Resettlement site selection and design in consultation with the affected community.
- Enhancement of environmental features in the Project area, though they were not impacted by the Project activities. For example, procurement and protection of historical rock carving site (1st to 7th Century AD) at Shatial (52 km upstream of DHP damsite and located adjacent to the reservoir), which is currently located in a private property and being subjected natural erosion and vandalism.
- Design of benefit sharing mechanism, with both monetary and non-monetary benefits, to share the project revenues with the affected communities and natural environment.
- Environmental criteria will be followed for shortlisting of contractors for major works under this Project. The environmental criteria include contractors compliance with ISO 14001, 2004 Environmental Management System (EMS), OHSAH 18000 (2007) related Occupational Health and Safety (OHS) and SA 8000 (Social Accountability); and experience in working with World Bank or other donor projects. Contractor team will include Environmental Specialist and Occupational Health and Safety (OHS) Specialist.
- Contractors bidding documents will include implementation of environmental management plans as paid items in the bills of quantity.
- Design of project implementation structure with strong emphasis on social and environmental staff. DHP will consist of a safeguard unit headed by a Deputy

Project Director with social and environmental units. The environmental unit headed by Director with three sub units: environmental, ecology and OHS. Construction supervision consultant team also consists of an environmental unit with international and national specialists in environment, ecology and OHS.

The environmental impacts resulting from implementation of the DHP will be unusually limited in a number for a mega project of this size, due to the following environmental features and circumstances specific to the Project area, and engineering designs adopted for the Project to reduce the Project's environmental footprints:

- Limited inundation area under the reservoir (only 23.85 km^2 at full supply level) due to the dam's location in a narrow gorge and steep slope of the river bed. The power density of the Project (installed capacity per unit area) is 181 $W/m^{2,}$ which is the highest in the world among hydropower projects of such high capacity;
- The Project area is sparsely populated with a population density of 150 $persons/km^2$ (6,953 affected people from 4,643 ha of land acquisition). The affected people are mainly transhumant agro-pastoralists. They migrate vertically along the hill slopes with winters in lower valleys (from the river to 1500 masl) and summers in higher elevation (1,500 to 2,000 masl) with houses and agriculture lands on both lower and higher elevations. Thus the livelihood losses due to the Project are partial (only 5% of their total income will be affected) due to land acquisition is limited to elevation of 1,000 masl;
- Low biodiversity in the Project impact area (within 1,000 masl elevation) with 67 percent barren land rocks and limited vegetation. Significant biodiversity is located on the higher altitudes (forests above 2,000 masl and wildlife above 3,000masl), well away from project impact area. Forests are communally owned;
- Limited fish diversity and quantity (3 indigenous snow carp species) in the Project impact area due to high sediment load, glacier melt and turbulent waters with very high discharge rates during summer; and low discharge rates during winter. Mahaseer, IUNC listed endangered fish species, habitat is located 70 to 80 km downstream of DHP dam site;
- Quarry sites for aggregates (14 million tons) required for construction of the Project are located within the future reservoir submergence area;
- Being run-of-river project, the operation of the dam will not affect the daily downstream flows and downstream ecosystem;
- The run-of-river and large volume of water inflow limit the residence time of inflowing water in the reservoir (1 to 6 days during high flow season, and about 19 days during low flow season). This reduced the impacts usually associated with large hydropower projects such as changes in water quality, GHG emissions and disruption of downstream flows.
- The Project has a power density of 181 W/m^2, which is 18 times higher than threshold limit of UNFCCC (10 W/m^2) for ignoring greenhouse gases emissions from a reservoir. yearThe net emissions of DHP are estimated to be minus 233 million tons of CO2 equivalent.

Potential impacts of the Project during various stages of implementation are assessed. Potential significant impacts during pre-construction stage are:

- Acquisition of 4,643 ha of land, including 143 ha of agricultural land and 280 ha of grazing land.
- Relocation of 767 households consisting of 6,953 persons from 34 villages, 17 from right bank villages and 17 from left bank.
- Effect on various civic amenities: 31 mosques, 7 schools, 1 motel, and 2 Basic Health Units

- Cutting of about 21,000 trees from the construction areas and reservoir inundated area.
- Submergence of 46 Km of KKH, 2 suspension bridges on Indus (at Largani, and Kandia).
- Submergence of an historical wooden mosque at Seer Gayal and 17 graveyards.

Potential significant impacts during construction stage are:

- Increased traffic on KKH and along on access roads due to the Project related vehicles. About 200 to 300 construction vehicles use KKH and access roads to the construction sites. The anticipated impacts are traffic congestion, safety hazards due to the increased traffic and increased air and noise pollution.
- Potential air, noise, soil and water pollution from the construction areas, including yards, quarry areas, and worker camps.
- Effect on fish movement upstream and downstream due to construction of coffer dams, and on fish habitat due to increased load of sediments from in river construction activities.
- Influx of about 2700 immigrant construction workers and induced migration from the service providers will create a boomtown scenario in Dasu, which is a small town without any major infrastructure.

Potential significant impacts during Operation and Maintenance (O&M) stage are:

- Changes in natural flows especially for 4.4 km section between the dam toe and tailrace during low flow seasons.
- Effect on fish movement upstream and downstream due to dam, and fish mortality when fish passes through intake tunnels, tail race tunnels and spill ways. Potential for reservoir fishery development.
- Changes in the downstream water quality due to lack of sediment flow from the reservoir or high sediment content during reservoir flushing.
- Risk of reservoir induced landslides.

Mitigation measures are recommended for the above environmental issues. If all these mitigation measures are applied only a few environmental issues have some residual impacts. These risks can be accommodated in the project of this size, however comprehensive and effective monitoring and control measures would need to be employed such that activities may be appropriately moderated as necessary.

The Environmental Management Plan (EMP) will form the primary mechanism for management of the Project’s environmental performance. It is also presented as a stand-alone document which outlines mitigation measures, accountability, monitoring and institutional arrangements for the environmental management of the Project. The EMP also provides information on environmental decisions which need to be made during both construction and operational phases of the Project. It provides the basis for evaluating the efficiency of mitigation and enhancement measures and suggests further actions that need to be taken to achieve the desired Project outcomes.

The EMP is made up of a series of sub-plans which as a whole directs environmental management procedures and the implementation of prescribed mitigation measures for the construction and operational phases of the Project. The following sub-plans have been developed:

- EMP Sub-Plan 1: Construction Management
- EMP Sub-Plan 2: Operational Management
- EMP Sub-Plan 3: Physiography and Geology
- EMP Sub-Plan 4: Hydrology & Surface Water Management
- EMP Sub-Plan 5: Air Quality Management

- EMP Sub-Plan 6: GHG Emission Reductions and Climate Change Monitoring
- EMP Sub-Plan 7: Noise and Vibration Management
- EMP Sub-Plan 8: Waste Management
- EMP Sub-Plan 9: Hazardous Substances Management
- EMP Sub-Plan 10: Terrestrial Ecology (Flora and Fauna) Management
- EMP Sub-Plan 11: Aquatic Ecology Management
- EMP Sub-Plan 12: Traffic Management
- EMP Sub-Plan 13: Physical Cultural Resources Management
- EMP Sub-Plan 14: Occupational Health and Safety Plan
- EMP Sub-Plan 15: Summary of Social and Resettlement Management Plan

Environmental Code of Practices (ECPs) are also prepared to address all general construction related and common environmental impacts and will be included in all construction contracts of the Project.

An environmental enhancement fund is proposed to be established with 0.1% of revenue from DHP. This fund will be utilized for promotion of environmental development activities' to assist in protection and conservation of environment in the Project area; and to ensure sustainability of all environmental enhancement measures recommended in the EMP.

The key institutions responsible for the successful implementation of the EMP of the project are contractors, construction supervision consultant (CSC), and Environmental Unit EU of DHP (EU-DHP). A series of capacity building programs are recommended for PMU/DHP and WEC to improve their capacity in understanding and managing environmental impacts with DHP and other future hydropower development projects in Pakistan.

The total environmental management and monitoring budget proposed for the Project is US$ 69 million, which includes (i) contractors budget for implementation of EMP, (ii) PMU budget for its staff and implementation of EMP, (iii) environmental consultants for CSC, (iv) institutional strengthening and capacity building, (v) early flood warning system, (vi) environmental management and enhancement of resettlement villages, and (vii) monitoring during operation and maintenance stages of the Project.

The Project will have overall positive impacts and some negative impacts. Most of these negative impacts can be mitigated by the successful implementation of the EMP. Therefore, the completion of this environmental assessment fully meets the safeguard requirement of the World Bank and the Government of Pakistan.

Chapter 14
REFERENCES

14. REFERENCES

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