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Kurram Tangi Dam Construction

Environmental Assessment
Volume I: Main Report (Final)

December, 2013
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Map to Kurram Tangi Dam Project Documents

Shown below is the suite of documents submitted to USAID under Contract AID-391-C-13-00002 for the KTDP. This report is shaded in red in order to show its relationship to the full set of documentation.

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	SUPPLEMENTAL REPORT ON CLIMATE CHANGE

All documents may be read as stand-alone documents, but the reader should be aware of the full set of documents available. Any one document may reference other documents in the suite in order to avoid duplication.

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Kurram Tangi Dam Construction
Environmental Assessment

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List of Acronyms

Acronym	Term
ACE	Associated Consulting Engineers
ADB	Asian Development Bank
AOI	Area of Influence
CCA	Cultivable Command Area
CFR	Code of Federal Regulations
CFRD	Concrete Faced Rockfill Dam
CHPP	Cultural Heritage Preservation Plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CGD	Concrete Gravity Dam
DCO	District Coordination Officers
DEM	Digital Elevation Model
DO	Dissolved Oxygen
EA	Environmental Assessment
ECA	Employment of Child Act 1977 and 1991
EIA	Environmental Impact Assessment
EHS	Environmental Health and Safety
EMMP	Environmental Mitigation and Monitoring Plan
ESIA	Environmental and Social Impact Assessment
Eto	Evapotranspiration
FATA	Federally Administered Tribal Areas
FCR	Frontier Crimes Regulations
F.R.	Frontier Region
FWO	Frontier Works Organization
GCM	Global Circulation Model
GIS	Geographic Information System
GPS	Global Positioning System
ICOLD	International Commission on Large Dams
IDC	International Development Consultants
IEC	International Electrotechnical Commission
IEE	Initial Environmental Examination
IFI	International Financing Institution
IPCC	Intergovernmental Panel on Climate Change
IPM	. Integrated Pest Management
IUCN	International Union for Conservation of Nature and Natural Resources
KP	Khyber Pakhtunkhwa
KTDC	Kurram Tangi Dam Consultants
KTMDP	Kurram Tangi Multipurpose Dam Project
KTDP	Kurram Tangi Dam Project
LAA	Land Acquisition Act, 1894
LAC	Land Acquisition Collector
MCE	Maximum Credible Earthquake (MCE)

MDE	Maximum Design Event
MMP	Mott MacDonald Pakistan
MWH	MWH Global, Inc. or MWH, Inc.
NESPAK	National Engineering Services Pakistan
NEQS	National Environmental Quality Standards
NGO	Non-governmental Organization
O&M	Operation and Maintenance
OBE	Operating Basis Earthquake
PA	Political Agent
PAP	Project Affected Person
Pak-EPA	Pakistan Environmental Protection Agency
PERSUAP	Pakistan Pesticide Evaluation Report and Surface Use Action Plan
PGA	Peak Ground Acceleration
PHABSIM	Physical Habitat Simulation Model
PID	Provincial irrigation Department
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PPERSUAP	Pakistan Programmatic Umbrella Pesticide Evaluation Report and Safer Use Action Plan
RAP	Resettlement Action Plan
RCCD	Roller Compacted Concrete Dam
RCM	Regional Climate Model
REA	Rapid Environmental Assessment
RHABSIM	Riverine Habitat Simulation
RMR	Rock Mass Rating
RPF	Resettlement Policy Framework
RTS	Reservoir-triggered seismicity
SAFRON	Federal Ministry of States and Frontier Regions
SEE	Safety Evaluation Event
SSEA	Strategic/Sector Environmental and Social Assessment
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
UN	United Nations
UNEP	United Nations Environment Program
USAID	United States Agency for International Development
USAID/Pak	United States Agency for International Development/Pakistan
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
VTP	Vulnerable Tribes Plan
WAPDA	Water and Power Development Authority
WUA	Water Users Associations
WWF-P	World Wide Fund for Nature – Pakistan

Conversion Tables

Length				
3.28	ft	=	1	m
5,280	ft	=	1	mile
1	km	=	0.62	miles
1	yard	=	0.91	m
1	inch	=	25.4	mm

Area				
1	acre	=	43,560	ft^2
1	ft^2	=	0.09	m^2

Pressure				
1	MPa	=	145.038	psi
1	GPa	=	1000	MPa
1	Kg/cm2	=	0.098	MPa
Volume				
1	acre-ft	=	43,560	ft^3
27	ft^3	=	1	yd^3
35.3	ft^3	=	1	m^3
1	Imperial gallon	=	4.55	Liters
1	Gallon		3.79	Liters

Others				
1	cusecs	=	1	cfs
1	ton (US)	=	2,000	lbs (US)
1	Lugeon	=	1	Liter/minute/m at 10 kg/cm^2 pressure
1	Metric Ton	=	2204.6	lbs

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EXECUTIVE SUMMARY

Purpose and Need: This Environmental Assessment (and other accompanying documents[1]) analyses the potential effects of the implementation the Kurram Tangi Dam Project (KTDP), a multipurpose water development project, on the physical, natural, and human resources of its surroundings. The Project is located on the Kurram and Kaitu Rivers in northwest Pakistan, with its principal structure, Kurram Tangi Dam, about 30 kilometers north of Bannu City (See Map 1-1).

The Project has three principal components as shown in Map 1-2. In this document, the sources of design information to describe the components are the Tender Documents (Pakistan Engineering Services (PES, 2011b), the Detailed Engineering Design (PES, 2011a) and the Feasibility Report (KTDC, 2004), in that order. These components are briefly described below under Project Description.

This Environmental Assessment (EA) analyzes the effects of the KTDP, on the physical, biological, and human resources of its surroundings. It is accompanied by: an Environmental Mitigation and Monitoring Plan (EMMP) with six annexes as follows: a Health and Safety Framework Plan; a Watershed Management Framework; a Waste Management Plan; an Emergency Preparedness Plan for downstream communities in the event of a dam failure; a Fisheries Management Plan; and, an Instrumentation and Monitoring Plan. At the same time a series of additional documents focusing on key social issues are being prepared separately. These include: a Resettlement Policy Framework (RPF); a Resettlement Action Plan (RAP); a Gender Plan; a Cultural Heritage Preservation Plan; and, a Vulnerable Tribes and Peoples Plan.

This EA has been undertaken by USAID as a result of the positive determination in the Initial Environmental Examination (IEE) prepared in accordance with 22 CFR 216 by USAID/Pakistan in 2012 to provide a first review of the reasonably foreseeable effects on the environment of the project and to recommend threshold decisions for additional environmental analysis. To the extent feasible requirements of international donors as well as USAID have been followed.

Approach to EA and Related Data Collection: From the start of the EA program, it was known that the tribal people of the portions of the Project Area within FATA are hostile to intruders from outside the region. It also was known that local customs in the region prohibited women from talking to strangers and that even within the tribe or clan certain subjects were taboo.

The uncertain security situation in the area and continuing counter-terrorism activity by the Pakistan Army and by the United States, especially in the North Waziristan Agency, has increased local hostility toward strangers and delayed the initiation of the field program. Despite the issuance of a No Objection Certificate (NOC) in May, the program could not start, due to the fear that cameras, Global Positioning System (GPS) instruments, and other equipment would upset the local people.

The EA field survey was conducted in two rounds from 20 July to 6 August, 2013 and from 15 August to 31 August, 2013. A total 153 sites were studied during the physical environment field survey. Meetings were also held with federal, provincial and district agencies.

During conduct of EA field activities, the security situation in Components 1 and 2 frequently deteriorated and collection of primary data became difficult or activities were halted due to curfew, a situation exacerbated by the Army's refusal to provide security to the field staff. As a result, the baseline descriptions provided in the EA rely to a large extent on interpretation of satellite imagery and the use of Geographic Information Systems (GIS).

[1] A list of all the reports is provided in the "Map to Kurram Tangi Dam Project" at the beginning of this report

Under such circumstances, MWH used best efforts to interact with the local people and to collect the maximum feasible information for various environmental parameters. Nevertheless, the field data that it was possible to collect may not be considered sufficient by some funding institutions for the EA of a project of this magnitude, because of the limitations on access and the lack of seasonal sampling.

PROJECT DESCRIPTION

The Project has three principal components, which are described below.

Component 1: A diversion weir on the Kaitu River to provide water to two new irrigation commands, on the Sheratalla and Spaira Ragha Plains, and to divert water into a reservoir on the Kurram River. This component also generates power. This component is located in the North Waziristan Agency of the Federally Administered Tribal Areas (FATA), with the exception of the 30-mile power transmission line from Powerhouse IV to the Domail substation, which traverses part of the Bannu Frontier Region to connect with the substation near the Main Dam. The transmission line takes electricity from Powerhouse I, at the toe of the dam, to the substation of Powerhouse II, thence to Powerhouse III and south to the substation at Domail, about seven miles east of Bannu (Powerhouses I, II and III will be constructed as part of Component 2). Component 1 also includes Powerhouse V which will supply power to the pump station serving the Spaira Ragha irrigation area.

A low-head weir will be constructed in the Kaitu River about 400 feet upstream of the Mir Ali -Thal Road Bridge. The weir will form a pool of water facilitating the diversion of water for the Sheratalla Canal on the right bank and to the Kurram Tangi Dam Reservoir via Powerhouse IV.

There will be two separate off-takes at the Kaitu Weir for the Sheratalla and Spaira Ragha Canals. The Spaira Ragha and Sheratalla Canal Systems will be located on the left and right banks of the Kaitu River respectively.

The Mir Ali-Thal Road and the bridges along the road will be upgraded to make them suitable for handling the design loads required to transport the heaviest pieces of equipment used in the project. Bridges will be strengthened if necessary.

Component 2: A concrete-faced rockfill dam, 322 feet high, will be constructed on the Kurram River, where it enters a range of folded ridges; the dam will result in the formation of a reservoir with an area of 10,939 acres and a live storage of 1.2 million acre-feet (MAF). The Main Dam is on the border between the F.R. Bannu and North Waziristan; the reservoir is entirely in North Waziristan; and the downstream units are in the Bannu Frontier Region.

The purpose of the proposed Kurram Tangi Dam is the storage of water for irrigation and for power generation. At present, up to 50 percent of the flows from Kurram River are underutilized, as there is a lack of storage capacity within the river basin. By constructing the proposed Kurram Tangi Dam, flows from Kurram River will be regulated. Water will be released according to the irrigation requirements and downstream user demands, while the excess water available will be stored for use during low flow periods. A 38 MW powerhouse (Powerhouse I) will be located at the toe of the dam.

Two weirs on the Kurram River downstream of the dam will create small reservoirs for power generation. Weir II, located approximately 8,000 feet downstream of the main dam, will divert water to the 10.4 MW Powerhouse II. Weir III, about 30,000 feet downstream of the main dam, will divert water to Powerhouse III.

Component II also includes road improvements including the relocation of roads that will be submerged by the reservoir and new access roads to the planned infrastructure.

Component 3: A new head regulator will be constructed at the Kurram Garhi Headworks to service the new Thal Canal to provide irrigation water to a new command area of 68,000 acres. The canal system will have 19 distributaries, 4 minors, 2 sub-minors totaling in length about 73 miles. The project will also upgrade about 200 miles of old canals (collectively called the Civil Canals and built by landowners) with a command area of approximately 107,000 acres, and the Marwat Canal with a command area of 170,000 acres. The head works lies on the border between F.R. Bannu and the Bannu District with its existing canals within Bannu District. The new Thal Command Area is mostly within the Bannu District.

DESCRIPTION OF THE ENVIRONMENT

The dominant drainage features in the Project area of influence (AOI) are the Kurram, and Kaitu Rivers, which have their sources at elevations greater than 14,000 ft msl in Afghanistan. The Kaitu Weir and Kurram Tangi Dams are at elevations of 2,353 and 2,142 ft msl respectively. At the junction of the Kurram and Indus Rivers the elevation is about 639 ft msl.

The AOI is underlain by sedimentary and metamorphic formations that are fluvial to marine in nature and include sandstones, siltstones, shales, and marls, ranging in age from Upper Paleozoic to Recent. The canal areas comprise recent piedmont plains and alluvial deposits. The area is tectonically active. The peak ground acceleration (PGA) developed for the feasibility level design (0.20g) is significantly lower than the PGA developed following current ICOLD guidelines (0.80g).

Irrigation is the basic and critical condition for development of the project region, particularly for agricultural development. Average rainfall is not even sufficient to supply the half of the crop water requirements. Crop yields are generally low, with much of the production destined for family consumption. Crops grown in the AOI include wheat, maize, fodders, rice, gram and sugarcane. There are reports of current water logging and salinity problems in the Civil Canals and Marwat Canal command areas. Agriculture is also practiced in the lower riparian areas of the Kaitu and Kurram Rivers.

The climate of the KTDP area is directly related to its altitude besides latitude. The temperature changes from subtropical in the south to temperate-cool, cold and very cold in the north and northeast. Rainfall varies 330 mm at Bannu in the south to 810 mm at Parachinar in the north. Total mean annual evaporation at Bannu and Parachinar are 1,752 mm and 900 mm respectively.

Snow-melt water in spring when combined with rainfall runoff, the accumulative water in most rivers, causes flash floods damaging property and infrastructures and sometimes loss of human life and livestock.

Seasons are hot in the low altitude zones. June, July and August are the hottest months when peak temperatures vary between 39°C and 41°C.

The climate change analysis shows that the region is likely to experience hotter summers and shorter winters. Average annual precipitation is likely to increase by 4 percent by 2099. There is no overall seasonal shift in projected scenarios. The average projected air temperature increase is between 3-4°C above the 1990 base by 2065, and 5°C by 2099. The increase in temperatures appears to be relatively uniform across the seasons.

Air quality is generally described as being good. Dust from high winds, sandstorms and emissions from generators and vehicles are sources of air pollution. Vehicles and locally generators are the main sources of noise.

Flow duration curves are not available for Kaitu River. The calculated synthesized average annual flow volume of the Kurram River is 987 thousand AF, higher than the 833 thousand AF of the

Feasibility Report. The mean annual sediment yield may also have been underestimated in the feasibility study.

Surface water is generally fit for irrigation. Groundwater is marginally fit to hazardous for irrigation.

The AOI lies within the Dry Sub-Tropical Forest Zone and the Hot Sub-tropical Thorn Forest Zone. The former is subject to much anthropogenic pressure and is severely degraded, while the latter has almost ceased to exist within the AOI of the KTDP, except in remnant patches. Owing to human exploitation, the overall forest cover in the watersheds above the Kaitu Weir and the Kurram Tangi Dam is about two percent. As a result of erosion slopes have lost fertility irreversibly. Runoff carries very high sediment loads which could negatively impact the life of the Kurram Tangi Reservoir.

There are no endemic wildlife species or protected areas in the Project AOI.

Upstream of the Kurram Garhi Headworks the aquatic habitat appears to consist of a series of riffle/rapids, runs, glides and a few pools flowing through braided channels. Downstream of the Headworks glides and pools dominate. No data are available on the aquatic vegetation in the Kaitu and Kurram Rivers. A total of 64 fish species are recorded in the Kurram River system. Of these, 28 are present above the Kurram Garhi Headworks, and 45 downstream of the Kurram Garhi Headworks.

The KTDP will affect human populations in five districts/areas in Northwest Pakistan, namely North Waziristan, Frontier Region Bannu (F.R. Bannu) and Bannu, Karak and Lakki Marwat Districts. The first two districts are located in the Federally Administered Tribal Area (FATA), the last three in the settled areas of the Khyber Pakhtunkhwa Province (KP). Components 1 and 2 (with the exception of minor parts of the access roads and transmission line) lie in the FATA, while, Component 3 (plus minor parts of the access roads and the transmission line of Components 1 and 2) are located in the Districts of Bannu, Karak and Lakki Marwat. These five Districts have a total population of around two million people.

The main source of income in Component 1 area is agriculture, while 25 percent and upwards of 50 percent of people in Components 2 and 3 respectively have some other form of employment. However, the amount of agricultural land available per person/household in the five Districts is only one-third of what is available in other parts of Pakistan

Key health challenges in the project area are access to purified drinking water and to physicians. The literacy level in the region is generally low, and women are significantly disadvantaged.
As in many extremely poor regions, sanitation and waste management are not a priority and access to fuel and clean water are key challenges for everybody. In general waste management procedures are not implemented correctly. Domestic sewage or wastewater mostly drains into open ditches and there is no collection, treatment and reuse system. Open dumping of solid waste is common.

The region is rich in cultural heritage. Research suggests that the Bannu plain as well as the Kurram and Kaitu Valleys have been inhabited since the Upper Paleolithic Period (50,000-10,000 BCE) and might contain important cultural heritage sites. With respect to living culture, the most important site is the Shrine of the Fakir of Shewa.

The existing road network in the AOI of the KTDP is generally in very poor condition. Very little maintenance has been carried out to preserve the assets. Bridges show signs of structural damage to the point where three have collapsed. Roads have pot holes and failures that disrupt the smooth flow of traffic. Some of the Katcha (dirt) roads are barely wide enough to accommodate a single heavy vehicle and require a 4 wheel drive vehicle to safely traverse them. Roads passing through settlements do not show clear separation between pedestrian access and vehicle access.

POTENTIAL IMPACTS OF THE KURRAM TANGI DAM PROJECT

The following tables summarize the potential[2] significant (high significance) and less significant (medium significance) impacts of the KTPD by component and phase. Impact significance has been assessed on the basis of magnitude, extent, duration, intensity, probability and legal requirements as described in Section 5.1.2. The phases discussed are pre-construction, construction, operation and decommissioning. The term Pre-Construction Phase as used in this report refers to tasks that are carried out during detailed design and planning as well as other activities that may be carried out prior to the start of project construction. For example, it may be necessary to upgrade roads prior to the start of construction so as to allow the main construction activities to be carried out.

Resettlement requirements for the KTDP, if implemented, would be significant. Land acquisition requirements for the entire project would be 190,000 acres resulting in the potential physical displacement of up to 72,000 people and the potential economic displacement of up to 610,000 people.

For Component 1 nearly 24,000 acres of land would need to be acquired. This would trigger the potential physical relocation of up to 6,000 people and the potential need for livelihood restoration of up to 95,000 people. Most of these people are expected to benefit in the long run from the transformation of 23,000 acres of presently rain fed agricultural land and pasture into fully irrigated canal command areas.

For Component 2 potential land acquisition needs would be about 14,000 acres. Potentially up to 15,000 people would be need to be physically relocated and the livelihoods of up to 22,000 people restored.

Potentially more than 145,000 acres would need to be acquired in Component 3. Up to 50,000 people might potentially need to be physically relocated although this number can be reduced by careful alignment of primary, secondary and tertiary canals. Nevertheless, rehabilitation and enhancement of the livelihoods of the up to 500,000 people that presently use the area earmarked for the CCAs and main canals would be required.

Mitigation of the impacts of resettlement will require implementation of the measures in the Resettlement Policy Framework and Resettlement Action Plan (Component 1) as well as the RAPs that shall be developed for Components 2 and 3.

A stand-alone Environmental Management and Monitoring Plan (EMMP) has been developed for the KTDP. This EMMP identifies measures and procedures for mitigating potential significant adverse environmental and social impacts and enhancing beneficial effects of the Project identified in this EA. The EMMP also presents the monitoring and surveillance programs required to ensure sound environmental performance of the project and defines the institutions responsible for environmental management of the KTDP.

[2] Throughout this report "potential impacts" means "potential significant environmental and social impacts". These potential impacts can be either adverse (negative) or positive.

Table 1: Summary of Potential Impacts Related to Component 1 and their Mitigation

Phase	Aspect	Potential Impact	Significance (without mitigation)	Mitigation
PRE-CONSTRUCTION[3]	Land Resources – Agriculture and Irrigation	Planning and coordination is deficient and could delay use of irrigation systems.	High	Coordination between WAPDA Agriculture and Irrigation Department of KP for design and planning of systems.
	Land Resources – Waste management	Inadequate waste management planning leads to poor or inappropriate disposal of waste.	High	Develop comprehensive waste management plan before construction. Select and develop appropriate landfill site. Develop quarry management plan. Design sewage system (collection plus soak pits and septic tanks) for camp. Contractor waste and wastewater management plan.
	Land Resources – Geology, Geotechnical and Seismicity	Inadequate geotechnical field investigations lead to poor design, siting and stability of infrastructure. Could cause cost overruns in construction. Current design earthquake ground motion parameter is too low so infrastructure may not withstand the Maximum Credible Earthquake (MCE).	High	Carry out geotechnical tests to feed into design. Update design to account for higher earthquake ground motion parameter.
	Water Resources - Hydrology	No synthesized flows or design flood analysis. May affect flows to irrigation and/or downstream during operations Flow releases need refining	Significant	Develop synthesized flows for Kaitu River Update design Analyse flood design Revised flow releases and schedules shall be part of operating procedures Significant
	Water Resources - Hydrology	No information on sedimentation in Kaitu RIver	Insufficient information to allow	Sediment ingress measurement program nd modelling

[3] The term Pre-Construction Phase as used in this report refers to tasks that are carried out during detailed design and planning as well as other activities that may be carried out prior to the start of project construction. Such activities could include development of infrastructure necessary for the construction activities.

			assessment	Update design and/or operating procedures
	Biological Resources – Aquatic Resources	Insufficient baseline data to evaluate potential impacts on fishery resource.	High	Conduct the fish and water quality survey.
	Socio-economic Environment	Land acquisition (24,000 acres), physical displacement of 6,000 people and economic displacement of 95,000 people. Conflict between tribes about territorial boundaries in the Culturable Command Areas (CCAs). Exposure of tribal society to external influence and control.	High	Implement RAP and Vulnerable Tribes Plan.
	Socio-economic Environment	Influx of workers and security personnel into remote tribal lands.	Medium	Implement Vulnerable Tribes Plan.
CONSTRUCTION	Roads, Bridges and Traffic	Detailed design provides no road alignments, profile or cross sectional details. Could impact construction schedule. Land acquisition required for new roads and road works. Road requirements in new resettlement sites unknown. Will likely require land acquisition.	High	Determine road alignments, cross sectional details/designs, ROW and carry out topographic surveys. Consult with communities on alignments. When known implement RAP.
	Land Resources – Geology, Geotechnical Issues and Seismicity	No downstream cofferdam; no dewatering; lack of lining or support during tunneling; disposal of excavated material or suitability for reuse in cofferdams not known.	High	Construct cofferdam if necessary. Provide lining and tunnel support. Test spoil for suitability.
	Land Resources – Land Use	Land acquisition for Kaitu Weir, feeder tunnel, powerhouses, canal networks, roads and borrow pits.	High	Implement RAP.
	Land Resources – Agriculture and Irrigation	Gender issues: presence of outsiders may make women reluctant to carry out agricultural activities; contact between local women and construction personnel could lead to social conflict.	Medium	Restrict personnel to work areas and the construction camp and/or residential colony.
	Land Resources – Waste Management	High sediment loads in run off from spoil heaps affecting downstream use in Kaitu River. Pollution of soils, surface water and ground water by contaminated run off (chemicals, fuel and oil spills, blasting residues, slurry from batching and asphalt plants, domestic waste dumps, wastewater from camps).	High	Implement erosion and runoff control measures around spoil heaps. Implementation of and compliance with all waste management plans. Provide appropriate waste bins and collect waste regularly. Run project landfill according to

		Exposure to medical waste could impact construction personnel and local residents' health. Exposure of sanitation workers to pathogens.		accepted best practice. Cover waste and spoil haulage trucks. Wastewater collection and disposal in soak pits and septic tanks. Separate collection of medical waste in appropriate containers. Incinerate waste. Vaccinate sanitation workers and provide them with PPE.
	Land Resources – Waste Management	Contaminated groundwater and wastewater taken up by plants and affects human health.	Medium	Install leachate and stormwater management systems at waste disposal sites. Wastewater collection and disposal in soak pits and septic tanks
	Land Resources – Waste Management	Odors and other nuisances from domestic waste disposal sites. Generation of windblown dust from spoil heaps and stockpiles.	Cannot be determined with any degree of confidence	Best practice management of landfill. Vegetate spoil heaps.
	Air Quality	Gaseous and fugitive dust emissions (vehicles, machinery, dust from tunneling, earth moving activities, excavation, haulage, movement of vehicles and machinery and road construction). Dust emissions due to blasting Particulate emissions from batching plants.	Medium	Mandatory tuning of KTDP vehicles. Provide ventilation and continuously monitor dust levels. Watering of roads, and exposed areas.
	Noise	High noise levels generated by construction machinery and blasting.	Medium	Machinery to comply with NEQS. Monthly monitoring PPE for personnel. Limit machinery movements to daytime to extent possible.
	Water Resources -Hydrology	Change in river morphology	Medium	Residual impact, no mitigation possible
	Water Resources – Water Quality	Increase in Total Suspended Solids (TSS) and turbidity due to excavation of river bed for Kaitu Weir and feeder tunnel to Kurram Tangi. Direct deposition of dust generated by construction activities. Kaitu Weir upstream cofferdam will alter flow regime and affect quality. Failure of the cofferdam could lead to pollution by potentially hazardous materials.	High	No disposal of spoil/waste in river. Rip-rap flooring to control scouring. Treat unmetalled roads. Use silt curtains. Carry out dam break analysis for cofferdam.
	Water Resources – Water Quality	Direct dumping of construction debris and spoil into water bodies.	Medium	No disposal of spoil/waste in river. Treat unmetalled roads.

		Direct deposition of fugitive dust in water.		
	Biological Resources – Terrestrial Ecosystems	Vegetation and habitat destruction.	Medium	Limit clearance to area necessary for construction activities.
	Biological Resources – Aquatic Ecosystems	Permanent loss of aquatic habitat at the site occupied by the Kaitu Weir and at borrow sites in the River. Temporary sediment load will damage fish and benthic macroinvertebrates. Contamination by seepage water will damage fish and macroinvertebrates. Loss of riffle habitat downstream of weir.	Medium	Avoid gravel mining in river bed. Lagoon seepage pump out.
	Socio-economic Environment	Large scale land acquisition. Physical and economic displacement. Conflict between tribes about territorial boundaries in the CCAs. Land allocation in CCAs. Influx of workers and security personnel into remote tribal lands. Exposure of tribal society to external influence and control. Increase in transmittable diseases (workers and residents) Health unit staff not up to the task Loss of cultural heritage.	High	Implement RAP and Vulnerable Tribes Plan. Access to camp only with appropriate heath certificates Maintain Disease Data Sheet Free vaccinations and prophylactic measures Mandatory Health and Safety training Implement Cultural Heritage Preservation Plan (CHPP).
	Worker Health and Safety	Risk of accident, injury and potentially loss of life	High	Implement Health and Safety Plan
	Roads and Bridges	Deterioration of air quality by fugitive dust and vehicle and machinery emissions. Noise pollution by heavy machinery and equipment. Blasting noise. Water pollution by run off contaminated by fuel, oils, heavy metals, sediments and trash. Road works at stream crossings may increase sediment loads. Gender issues due to presence of outside personnel.	Medium	Mandatory tuning of vehicles. Watering of exposed areas. Limit machinery movement to daylight hours. Liaise with community over blasting times. Construct erosion control structures. Isolate works in rivers from flowing water. Restrict personnel to work areas and the construction camp and/or residential colony.
	Roads and Bridges	Blasting vibrations. Erosion, sloughing and landsliding, particularly in hilly terrain. Road safety potentially impacted by increased traffic. Risk of accidents.	High	Carry out dilapidation survey prior to blasting near buildings/houses. Repair any damage. Implement traffic management plan. Provide traffic access.

		Travel disruption and delays.		Enforce strict speed limits.
OPERATION	Land Resources – Topography and Drainage	Changes to the visual aspect of the Kaitu Weir area.	High	Irreversible. Cannot be mitigated.
	Land Resources – Topography and Drainage	Extension of man-made drainage network.	Positive high	Availability of irrigation water could increase farmer incomes.
	Land Resources – Geology, Geotechnical Issues and Seismicity	Failure of Kaitu Weir under MCE causing downstream flooding and loss of life, livestock and crops.	High	Design structures for higher earthquake ground motion parameter.
	Land Resources – Soils	Waterlogging and salinization.	High	As per Agriculture and Irrigation.
	Land Resources – Land Use	Permanent inundation of area upstream of Kaitu Weir. Reduced ability to conduct gravity irrigation downstream of weir and loss of nutrients reducing soil fertility. Loss of grazing lands and access to pastures. Pollution of water by excessive use of fertilizers and pesticides.	High	Implement RAP. Further study required. Provide alternate access. Crop rotation, mechanical weed destruction, green manuring (legumes) and use of farmyard manure. Implement IPM Farmer training. Respect requirements of PERSUAP and 2013PPERSUAP
	Land Resources – Irrigation and Agriculture	Waterlogging and salinization.	High	Effective water management. Drip/sprinkler irrigation. Provide subsurface drainage. Monitor groundwater levels and salinity spots.
	Land Resources – Irrigation and Agriculture	Increase agricultural development and earnings for farmers.	Positive high	Formation of Water Users Associations (WUA). Clearly define water rights.
	Land Resources – Irrigation and Agriculture	Lack of capital to purchase inputs leads to suboptimal crop production.	Medium	Provide access to credit or financial assistance.
	Land Resources – Waste Management	Poorly managed waste generates odors, unaesthetic conditions and breeding ground for disease vectors. Leachate can pollute groundwater.	High	Implement best practice procedures for management of landfill.
	Climate and Climate Change	Potential impacts of climate change on project and project area – potential for lower summer productivity, power shortages, but longer growing season may boost agricultural activity.	High	Further studies required.

	Water Resources – Hydrology	Reduced downstream flows	High	Ensure environmental flow releases
	Water Resources – Water Quality	Reduction in assimilative capacity downstream of weir potentially impacts Datta Khel agriculture. Deterioration of water bodies downstream of Sheratalla and Spaira Ragha command areas by pesticides and nutrient laden water.	High	Ensure downstream environmental flow. See Agriculture and Irrigation above.
	Biological Resources – Terrestrial Ecosystems	Extension of bird habitat and feeding grounds.	Positive medium	
	Biological Resources – Terrestrial Ecosystems	Increase in agricultural pests results in increased pesticide use and subsequent water pollution.	High	Implement IPM. Comply with PERSUAP and 2013 PPERSUAP
	Biological Resources – Aquatic Ecosystems	Fragmentation of aquatic ecosystem prevents fish reaching spawning grounds in upper reaches of Kaitu River. Reduction in downstream flows results in severe degradation of aquatic habitat down to confluence with Kurram.	High	Ensure downstream ecological flows. Install fishway if further studies support this.
	Biological Resources – Aquatic Ecosystems	Fish entrainment and turbine-induced mortality.	Medium to low (in function of species)	Design trash rack clear spacing to allow only small fish to pass through and with low approach velocity.
	Socio-economic Environment	Influx of non-local populations into CCAs. Change in land use pattern from rainfed agriculture and pastoral uses to irrigated agriculture. Negative perception towards project as settlements near powerhouse and transmission line don't have electricity Facilitation of vector-borne and other diseases	High	Establish WUAs and Agricultural Extension Services, credit associations, input supply mechanisms, and storage depots and marketing arrangements. Offer health education Offering free vaccinations
	Roads, Bridges and Traffic	Overloading deteriorates road surfaces. Poor road maintenance results in increased accidents.	High	Enforce legal load restrictions. Install Truck Weighing Strips. Maintain roads in safe condition.
	Roads, Bridges and Traffic	Water pollution by pollutant and sediment laden run off from roads.	Medium	Maintain road side drainage and associated structures.
	Roads, Bridges and Traffic	Reduced travel times. Safer roads reduce accidents. Less vehicle wear and tear.	Positive medium	Train vehicle drivers. Apply speed limits. Maintain roads in safe condition.

DECOMMISSIONING	Land Resources - Waste Management	Poor disposal of demolition and other wastes	High	Maintain and upgrade infrastructure to avoid decommissioning or develop and implement decommissioning and abandonment plan
	Water Resources – Water Quality	Reduction in water quality	High	
	Aquatic Resources	Damage to fish and macroinvertebrates	High	
	Socio-economic Environment	Loss of power generation and irrigation benefits	High	

Table 2: Summary of Potential Impacts Related to Component 2 and their Mitigation

Phase	Aspect	Potential Impact	Significance (without mitigation)	
PRE-CONSTRUCTION[4]	Land Resources – Waste management	Inadequate waste management planning leads to poor or inappropriate disposal of waste.	High	Same measures as for Component 1.
	Land Resources – Geology, Geotechnical and Seismicity	Inadequate geotechnical field investigations lead to poor design, siting and stability of infrastructure. Could cause cost overruns in construction. Current design earthquake ground motion parameter is too low so infrastructure may not withstand MCE.	High	Carry out additional geotechnical investigations. Perform seismic analysis stability with 0.8g ground motion parameter. Review foundation designs. Assess reservoir geology.
	Water Resources - Hydrology	Inadequate estimation of Prbable Maximum Flood and inadequate spillway design– potential dam failure during operation	High	Evaluate adequacy of spillway in light of revised PMP and PMF Update design if necessary
	Water Resources - Hydrology	Design sediment yields may be too low – potentially affects seasonal regulation of flows from dam	High	Sediment ingress measurement program nd modelling Update design and/or operating procedures
	Biological Resources – Aquatic Resources	Insufficient baseline data to evaluate potential impacts on fishery resource.	High	Conduct the fish and water quality survey.
	Socio-economic Environment	Large scale land acquisition (14,000 acres), physical displacement of 15,000 people and economic	High	Carry out resettlement based on a component specific RAP based on

[4] The term Pre-Construction Phase as used in this report refers to tasks that are carried out during detailed design and planning as well as other activities that may be carried out prior to the start of project construction. Such activities could include development of infrastructure necessary for the construction activities.

		displacement of 22,000 people. 18 settlements with more than 1,600 houses to be relocated. Influx of workers and security personnel into remote tribal lands. Limited chances to find suitable resettlement sites due to on-going conflicts between clans over land rights. Exposure of tribal society to external influence and control.		RPF. Implement and Vulnerable Tribes Plan.
	Socio-economic Environment	Relocation of the shrine of the Fakir of Shewa.	High	Implement measures outlined in RFP and in CHMP.
	Roads, Bridges and Traffic	Same as Component 1.	High	Same measures as for Component 1.
CONSTRUCTION	Land Resources – Geology, Geotechnical Issues and Seismicity	Lack of lining or support during tunneling; disposal of excavated material or suitability for reuse not known; lack of rock cut slope stability analyses.	High	Provide lining and tunnel support. Test spoil for suitability. Perform slope stability analysis.
	Land Resources – Land Use	Land acquisition for reservoir and resettlement of built up areas in the reservoir footprint.	High	Carry out resettlement in compliance with Component 2 RAP based on RPF.
	Land Resources – Agriculture and Irrigation	Degradation of irrigation water quality downstream of construction activities.	Medium	Contractor to implement its site specific waste management plan.
	Land Resources – Waste Management	Same as Component 1.	High to medium	Same measures as for Component 1.
	Noise	Same as Component 1.	Medium	Same measures as for Component 1.
	Water Resources -Hydrology	Change in river morphology Reduced downstream flow during impounding	High	Residual impact Ensure downstream environmental flows during impoundment
	Water Resources – Water Quality	Increase in TSS and turbidity due to excavation of river bed borrow areas, high sediment loads in run off from spoil heaps or dumping of spoil in drainage lines. Pollution due to release of waste water from the construction camp. Direct dumping of debris from Kurram River. Direct deposition of fugitive dust in Kurram River.	High	Same measures as for Component 1.
	Biological Resources – Terrestrial Ecosystems	Vegetation and habitat destruction.	Medium	Keep clearance to minimum necessary for construction activities.
	Biological Resources – Aquatic Ecosystems	Permanent loss of aquatic habitat at the sites occupied by the built structures, and at borrow sites in the Kurram River. Temporary sediment load increases damage fish and benthic macroinvertebrates. Contamination by seepage water.	Medium	Avoid gravel mining in river bed. Lagoon seepage pump out.

		Loss of riffle habitat due to removal of gravels.		Avoid using gravel from riffle areas.
	Socio-economic Environment	Large scale land acquisition: 18 settlements with more than 1,600 houses to be relocated. Physical and economic displacement. Influx of workers and security guards into remote tribal lands. Conflict between tribes about territorial claims. Increase in transmittable diseases Health unit staff not up to the task	High	Develop and implement Component 2 RAP based on RFP and Vulnerable Tribes Plan. Access to camp only with appropriate heath certificates Maintain Disease Data Sheet Free vaccinations and prophylactic measures Mandatory Health and Safety training
	Socio-economic Environment	Damage to cultural heritage.	High	Implement CHPP.
	Worker Health and Safety	Risk of accident, injury and potentially loss of life	High	Implement Health and Safety Plan
	Roads and Bridges	Deterioration of air quality by fugitive dust and vehicle and machinery emissions. Noise pollution by heavy machinery and equipment. Blasting noise. Water pollution by run off contaminated by fuel, oils, heavy metals, sediments and trash. Road works at stream crossings may increase sediment loads. Spills of concrete in waterways. Gender issues due to presence of outside personnel.	Medium	Same measures as for Component 1.
	Roads and Bridges	Blasting vibrations. Erosion, sloughing and landsliding, particularly in hilly terrain. Road safety potentially impacted by increased traffic. Risk of accident. Travel disruption and delays.	High	Same measures as for Component 1.
OPERATION	Land Resources – Topography and Drainage	Changes to the visual aspect of the Kurram River upstream of Kurram Tangi Dam and Weirs II and III.	High	Cannot be avoided.
	Land Resources – Geology, Geotechnical Issues and Seismicity	Failure of Kurram Tangi Dam or Weir II or Weir III under MEC causing downstream flooding and loss of life, livestock, built infrastructure and crops	High	Design structures for higher earthquake ground motion parameter.
	Land Resources – Land Use	Land acquisition for the reservoir	High	Develop and implement Component 2 RAP Based on RFP.
	Land Resources – Irrigation and Agriculture	Reduced ability to conduct gravity irrigation of riparian areas downstream of dam and loss of nutrients reducing soil fertility.	High	Further study required to determine measures.
	Land Resources – Irrigation and Agriculture	Increase agricultural development and earnings for farmers.	Positive high	Formation of WUAs. Define water use rights.

	Land Resources – Waste Management	Same as Component 1.	High	Implement best practice as for Component 1.
	Climate and Climate Change	Potential impacts of climate change on project and project area – potential for lower summer productivity, power shortages, but longer growing season may boost agricultural activity.	High	Further studies required.
	Water Resources Hydrology	Seasonal regulation of downstream flow	Positive high	
	Water Resources Hydrology	Change in soil conditions downstream of dam	High	Further studies required to determine measures
	Water Resources – Water Quality	Water pollution as a result of accumulation of phosphorus in reservoir; contamination of reservoir by domestic waste; thermal stratification causes low dissolved oxygen and high turbidity levels; accumulation of salts in reservoir. Seepage from reservoir will pollute groundwater.	High	Encourage use of organic fertilizers. Regular maintenance of waste water disposal and treatment facilities. Mixing of surface water with hypolimnial water.
	Biological Resources – Terrestrial Ecosystems	Creation of three standing water bodies could create staging posts for migratory waterfowl and waders.	Positive high	
	Biological Resources – Terrestrial Ecosystems	Waterfowl and waders using water bodies will be exposed to hunting. Migratory waterfowl include three species of concern.	High for species of concern	Enforcement of legal provisions for protected species.
	Biological Resources – Aquatic Ecosystems	Fragmentation of aquatic ecosystem between the dam and Kurram Garhi Headworks into four segments. Dam prevent aquatic fauna in reach below dam reaching spawning grounds in upper reaches of Kurram River.	High	Release of ecological flows Stock Weir III and dam reservoir (Golden Mahseer).
	Biological Resources – Aquatic Ecosystems	Reduction in downstream flows during dam filling results in loss of aquatic habitat.	High for species of concern	Release ecological flows.
	Biological Resources – Aquatic Ecosystems	Fish entrainment and turbine-induced mortality.	Low for most species; High for Golden Mahseer and other species of concern.	Design trash rack clear spacing to allow only small fish to pass through. Approach velocity to the trash rack should be 0.5 fps, clear spacing 2 inches.
	Biological Resources – Aquatic Ecosystems	Increase in populations of fish that adapt to lacustrine environment.	Positive medium	
	Socio-economic Environment	Change in land use pattern from rainfed agriculture and pastoral uses to irrigated agriculture. Negative perception towards project as settlements around reservoir and near powerhouses and transmission line don't have electricity. Insecurity of land rights after relocation of 1,600 households.	High	Component 2 RAP to have livelihood support measures Establish a rural electrification program. Ensure PAPs official receive title deeds

		Facilitation of vector-borne and other diseases		Offer health education Offering free vaccinations
	Roads, Bridges and Traffic	Same as Component 1.	High to medium	Same measures as for Component 1.
DECOMMISSIONING	Land Resources - Waste Management	Poor disposal of demolition and other wastes	High	Maintain and upgrade infrastructure to avoid decommissioning or develop and implement decommissioning and abandonment plan
	Water Resources – Water Quality	Reduction in water quality	High	
	Aquatic Resources	Damage to fish and macroinvertebrates	High	
	Socio-economic Environment	Loss of power generation and irrigation benefits	High	

Table 3: Summary of Potential Impacts Related to Component 3 and their Mitigation

Phase	Aspect	Potential Impact	Significance (without mitigation)	
PRE-CONSTRUCTION[5]	Land Resources -Agriculture and Irrigation	Planning and coordination is deficient and could delay use of irrigation systems.	High	Coordination between WAPDA Agriculture and Irrigation Department of KP for design and planning of systems.
	Land Resources – Waste management	Inadequate waste management planning leads to poor or inappropriate disposal of waste.	High	Same measures as for Component 1.
	Land Resources – Geology, Geotechnical and Seismicity	No geotechnical field investigations or laboratory testing; no geotechnical design parameters, no seepage or stability analysis. Could result in inadequate design, siting and stability of infrastructure. Could cause cost overruns in construction.	High	Implement field investigation program that includes drilling, geological mapping and a construction materials assessment.
	Biological Resources – Aquatic Resources	Insufficient baseline data to evaluate potential impacts on fishery resource.	High	Conduct the fish and water quality survey.
	Socio-economic Environment	Land acquisition (145,000 acres), physical displacement of 50,000 people and economic	High	Develop and implement Component 3 RAP based on RPF.

[5] The term Pre-Construction Phase as used in this report refers to tasks that are carried out during detailed design and planning as well as other activities that may be carried out prior to the start of project construction. Such activities could include development of infrastructure necessary for the construction activities.

		displacement of 500,000 people.		
CONSTRUCTION	Land Resources – Geology, Geotechnical Issues and Seismicity	Loss of water due to seepage and its effect on surrounding areas (waterlogging).	High	See agriculture and irrigation below.
	Land Resources – Land Use	Land acquisition for canal networks, and temporary structures.	High	Develop and implement Component 3 RAP.
	Land Resources – Agriculture and Irrigation	Gender issues: presence of outsiders may make women reluctant to carry out agricultural activities; contact between local women and construction personnel could lead to social conflict.	Medium	Restrict personnel to work areas and the construction camp and/or residential colony.
	Land Resources – Waste Management	Same as Component 1.	High to medium	Same measures as for Component 1.
	Air Quality	Same as Component 1.	Medium	Same measures as for Component 1.
	Noise	Same as Component 1.	Medium	Same measures as for Component 1.
	Water Resources - Hydrology	Increased downstream turbidity	High	As per Water Quality
	Water Resources – Water Quality	Increase in TSS and turbidity due to high sediment loads in run off from construction sites, direct dumping of debris and direct deposition of dust generated by construction activities.	High	No disposal of spoil/waste in River. Treat unmetalled roads.
	Biological Resources – Terrestrial Ecosystems	Vegetation and habitat destruction.	Medium	Limit vegetation clearance to minimum necessary for construction activities.
	Socio-economic Environment	Large scale land acquisition. Physical and economic displacement. Land allocation in CCA. Influx of workers and security guards into remote tribal lands. Increase in transmittable diseases Health unit staff not up to the task	High	Develop and implement component specific RAP based on RPF. Access to camp only with appropriate heath certificates Maintain Disease Data Sheet Free vaccinations and prophylactic measures Mandatory Health and Safety training
	Socio-economic Environment	Late finds of cultural heritage.	High	Implement CHPP.
	Risk of accident, injury and potentially loss of life	High	Implement Health and Safety Plan	Worker Health and Safety
	Roads and Bridges	Same as Component 1.	High to medium	Same measures as for Component 1.
OPERATION	Land Resources – Topography and Drainage	Extension of man-made drainage network.	Positive high	
	Land Resources – Soils	Waterlogging and salinization.	High	As per Agriculture and Irrigation.
	Land Resources – Land Use	Reduced ability to conduct gravity irrigation of riparian areas downstream of Kurram Garhi Headworks Loss of grazing lands and access to pastures.	High	Replace temporary stone weirs by permanent low weirs Provide alternate access.

	Land Resources – Irrigation and Agriculture	Waterlogging and salinization. Pollution of water by excessive use of fertilizers and pesticides.	High	Same measures as for Component 1.
	Land Resources – Irrigation and Agriculture	Lack of capital to purchase inputs leads to suboptimal crop production	Medium	Provide access to credit or financial assistance.
	Land Resources – Irrigation and Agriculture	Increase agricultural development and earnings for farmers. Creation of conditions for improved water management in the Civil Canals command area through the creation of WUA.	Positive high	Formation of WUAs. Clearly define water rights.
	Land Resources – Waste Management	Same as Component 1.	High	Same measures as for Component 1.
	Climate and Climate Change	Potential impacts of climate change on project and project area – potential for lower summer productivity, power shortages, but longer growing season may boost agricultural activity.	High	Further studies required.
	Water Resources – Water Quality	Agricultural runoff and percolation degrade surface water and groundwater quality. This could potentially impact downstream farm production. Low riparian areas will be affected by the reduced assimilative capacity of the Kurram River. Reduced DO and increased BOD will affect cultivation reducing household income.	High	As per irrigation and agriculture above. Release environmental flows.
	Biological Resources – Terrestrial Ecosystems	Extension of bird habitat and feeding grounds, and fish habitat in canals.	Positive medium	
	Socio-economic Environment	Change in land use pattern from transhumant to irrigated agriculture Insecurity of land rights after relocation and in CCAs. Facilitation of vector-borne and other diseases	High	Training, technical and financial support for farmers. Establish WUAs. Offer health education Offering free vaccinations
	Roads, Bridges and Traffic	Same as Component 1	High to medium	Same measures as for Component 1.
	Roads, Bridges and Traffic	Reduced travel times. Safer roads reduce accidents. Less vehicle wear and tear.	Positive medium	Train drivers. Apply speed limits. Maintain roads in safe condition.

PROJECT ALTERNATIVES

Component 1: For all the KTPD Components, compared to the "no project" option, the project's potential adverse impacts would not occur. However, the agricultural production in the region would continue to suffer water shortages. Rainfed agriculture would remain the norm in most of the area. No benefits of increased power would occur As there would be no change in the lifestyles of farmers and herders in the AOI rangeland will likely continue to deteriorate.

There could be a number of other potential alternatives to building the proposed project facilities, e.g., thermal, solar or wind power to generate electricity and ground water to irrigate. Additional power generation and irrigated land could also be developed in other regions of Pakistan, most likely at lower costs and potentially with less negative environmental and resettlement issues. However, due to the long-term history of the project and its strategic location in Pakistan with an urgent need to create jobs and develop adequate and sustainable power generation and agricultural development (food supply), it is expected that local alternatives were not found to be feasible due to the extent of the proposed power generation and irrigated areas and therefore were not further evaluated during the previous and current studies.

As part of the review of previous studies, a number of additional "recommended options" are listed in Chapter 6 under each component. The list is however not exhaustive as it was not part of the scope to enhance and optimize the project design. It is expected that a number of additional field technical, environmental and resettlement investigations and follow-up design studies will be performed by WAPDA and others (Irrigation Department, FATA, etc.) to refine and optimize the proposed project features.

Although the Project has a long history of development, having been conceived in 1955, planning of the present project began with the 1992 Prefeasibility Report (WAPDA, 1992). The 2004 Feasibility Report (KTDC, 2004) contains the major part of the present configuration of the Project, but certain aspects, notably the height of the Main Dam have changed. The Detailed Engineering Design Report (PES, Vol. I Main Report 2011a), raised the dam height to 322 feet, with a corresponding increase in reservoir area and volumes. Small design changes were also made during the preparation of the Tender documents (PES, 2011b).

CUMULATIVE IMPACTS

Potential cumulative impacts on and of the KTDP are discussed in terms of the effect of upstream water withdrawals on the KTDP, water withdrawals from the KTDP in conjunction with planned or proposed water withdrawals that could affect existing water withdrawals of downstream users, major construction activities likely to occur in a similar time frame in the project AOI, and overall potential cumulative impacts of the KTDP itself.

As far as could be determined no new dams are planned upstream of the Kaitu Weir in Afghanistan, and the possibility of large scale water withdrawals above the Kaitu Weir does not seem likely. However, the cumulative effects of erosion due to the lack of watershed management are likely to increase and will cause sedimentation in the reservoir behind the Kaitu Weir.

There are no known major dam or irrigation developments planned or proposed in Pakistan upstream of the Kurram Tangi Dam that would have cumulative effects on the KTDP. Two small dams were completed in 2012; however, the planned withdrawals are low and are unlikely to affect the Kurram Tangi Dam.

As far as downstream water withdrawals are concerned, further studies are recommended to determine the specific, cumulative effects of the impoundment and the water withdrawals on the downstream irrigation below the Kurram Garhi Headworks and in the Kaitu River.

No information has been located about ongoing or planned major projects of similar magnitude of KTDP in FATA, F.R. Bannu or Bannu District, and based on information communicated to NESPAK by the Department of Forestry none are planned. The size and duration of the KTDP are such that any road or social infrastructure projects will be dwarfed in comparison.

The KTDP will result in significant land use change and population displacement that is unprecedented in the region. Because the displaced population will largely remain in the region, these changes do not represent additional cumulative effects on natural resources. Nevertheless, the project aims to transform pastoralism and rain-fed agriculture into irrigated farming, which has the potential to significantly enhance the living conditions and livelihoods of the local people. Thus, the cumulative effects of the project on the social and economic side are likely to be largely positive.

CONSULTATIONS

A series of consultations have been held. These include a series of meetings with various stakeholders culminating in a scoping workshop in March 2013, and consultations with WAPDA and other direct stakeholders, with state officials and with local communities on the EA. Due to the ongoing security concerns in the area, organization of the latter has been hampered by constant delays occasioning rescheduling. The community consultations were completed.

At the grass root level, a series of public consultation sessions were held with representatives of the project affected population having residences, landholding or other stakes in the geographical perimeter of all three Components of the KTDP. Organized in Bannu, Karak, and Lakki Marwat under the banner of sub-contractor, ACE, these meetings were attended by tribal leaders and elders, local Maliks and representatives of landowners. While such consultations are traditionally held at the village level and provide a forum for all individuals, including project affected persons, from the community to attend, the security situation did not allow on-site public events.

Almost all public representatives are well aware of the potential benefits of the project. There is also a visible level of awareness of the socio-economic and environmental implications of the KTDP. The local tribal population is in support of the project and offers a variety of suggestions and recommendations to promote the local interests in the project. During the construction phase the local population look forward to employment opportunities, as well as local contracts for material, logistics and manpower supply. Once the project is operational, the local residents are keen to see that rural electrification and irrigation of local lands are ensured.

PROJECT ECONOMIC BENEFITS

An economic analysis of the Project (Volume II) was carried out for the Project as a whole and for each Component. The economic analysis (project benefits and project costs) was carried out at a constant August 2013 price level.

Results are shown in the following tables.

Table 4: Results of Economic Analysis (Overall)

Economic Indicator	5 % Discount Rate	12 % Discount Rate
Present Worth of Benefits	Rs. 93,862 Million	Rs. 35,940 Million
Present Worth of Costs	Rs. 42,916 Million	Rs. 34,261 Million
Net Present Value	Rs. 50,945 Million	Rs.1,679 Million
B/ C Ratio	2.19: 1	1.05: 1
EIRR	12.5%	

Table 5: Results of Economic Analysis (Component 1)

Economic Indicator	5% Discount Rate	12% Discount Rate
Present Worth of Benefits	Rs.6,725 Million	Rs.2,712 Million
Present Worth of Costs	Rs. 9,503 Million	Rs. 7,843 Million
Net Present Value	Rs. (-)2,778 Million	Rs. (-)5,131 Million
B/ C Ratio	0.70 : 1	0.35 : 1
EIRR	2.20%	

Table 6: Results of Economic Analysis (Component 2)

Economic Indicator	5 % Discount Rate	12 % Discount Rate
Present Worth of Benefits	Rs.22462.1 Million	Rs.9101.0 Million
Present Worth of Costs	Rs.24228.0 Million	Rs.19389.6 Million
Net Present Value	Rs.(-)1765.9 Million	Rs.(-)10288.6 Million
B/ C Ratio	0.93 : 1	0.47 : 1
EIRR	4.34%	

Table 7: Results of Economic Analysis (Component 3)

Economic Indicator	5 % Discount Rate	12 % Discount Rate
Present Worth of Benefits	Rs. 63,652 Million	Rs.23,397 Million
Present Worth of Costs	Rs. 14,078 Million	Rs.11,266 Million
Net Present Value	Rs. 49,574 Million	Rs.12,131 Million
B/ C Ratio	4.52 : 1	2.08: 1
EIRR	20.7 %	

CONCLUSIONS

Construction for the KTMDP would produce significant impacts on the physical and socio-economic environment, which in most case can be mitigated when negative. The principal residual impacts will be the changes to river morphology upstream of the Kaitu Weir, the Kurram Tangi Dam and Weirs II and III. Impoundment of water behind these structures, and the structures themselves will be permanent changes to the landscape. Population displacement will require careful attention to relocation of those losing homes and compensation (cash or in-kind) for those economically displaced. However, the aims of the KTMDP and the role it can play in contributing to poverty reduction, employment, renewable power generation, and agricultural development in the project area, and especially in FATA, are not possible without these basic infrastructure developments.

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1 INTRODUCTION

1.1 Project Overview

This Environmental Assessment (and other accompanying documents[6]) analyses the effects of the Kurram Tangi Dam Project (KTDP), a multipurpose water development project, on the physical, natural, and human resources of its surroundings. The Project is located on the Kurram and Kaitu Rivers in northwest Pakistan, with its principal structure, Kurram Tangi Dam, about 30 kilometers north of Bannu City (See Map 1-1).

The Project has three principal components as shown in Map 1-2. In this document, the sources of design information to describe the components are the Tender Documents (PES *et al*., 2011b), the Detailed Engineering Design ((PES *et al*., 2011a) and the Feasibility Report (KTDC, 2004), in that order. These components are briefly described below

1. A diversion weir on the Kaitu River, to provide water to two new irrigation commands, on the Sheratalla and Spaira Ragha Plains, and to divert water into a reservoir on the Kurram River. This component also generates power. This component is located in the North Warzistan Agency of the Federally Administered Tribal Areas (FATA), with the exception of the power transmission line from Powerhouse IV to the Powerhouse I site, which traverses part of the Bannu Frontier Region to connect with the substation near the Main Dam. The transmission line takes electricity from Powerhouse I, at the toe of the dam, to the substation of Powerhouse II, thence to Powerhouse III and south to the substation at Domail, about seven miles east of Bannu. Powerhouses I, II and III will be constructed as part of Component 2. Component 1 also includes Powerhouse V which will supply power to the Spaira Ragha pump station.

2. A concrete-faced rockfill dam, 322 feet high, will be constructed on the Kurram River, where it enters a range of folded ridges; the dam will result in the formation of a reservoir with an area of 10,939 acres and a live storage of 1.2 Million A-F. Powerhouse I at the toe of the dam will produce 38 MW of electricity. An additional part of this component comprises two downstream powerhouses (Powerhouse II and Powerhouse III) on the Kurram River, producing 10.5 and 16.0 MW, respectively. The Main Dam is on the border between the Bannu Frontier Region and North Waziristan; the reservoir is entirely in North Waziristan; and the downstream units are in the Bannu Frontier Region.

3. Upgrading of the existing Kurram-Garhi Headworks and its offtake canals, with a new Thal Canal to provide irrigation water to a new command of 68,000 acres. The head works lies on the border between F.R. Bannu and the Bannu District with its existing canals, within Bannu District. The new Thal CCA is mostly within the Bannu District.

1.2 Pre-Feasibility, Feasibility and Environmental Studies and Reviews Prior to this EA

1.2.1 Early History of the Project

The Kurram Tangi Hydroelectric Project was conceived in 1955 as a means of providing development in the neglected areas of the North West Frontier Province. Begun in 1952, the Kurram Garhi Headworks was not completed until 1962, with its system of canals in the Marwat Command Area (CA). During this decade the Baran Dam was conceived, in order to store water for the Marwat CA. Completed in 1963, Baran Reservoir received so much sediment that by the turn of century it was unable to support the Marwat CA.

In 1960, WAPDA had produced the Kurram River Planning Report, which recommended the implementation of the KTDP. It was not until 1990 that the conceptual report on the dam was

[6] A list of all the reports is provided in the "Map to Kurram Tangi Dam Project" at the beginning of this report

produced and in 1992 a Prefeasibility Report was produced by a consortium of Pakistani consultants (ACE et al., 1992).

The KTDP was included in the WAPDA "Revised Ten years Perspective Development Plan 2001-2011," with the provision of 9.25 billion Rupees for its construction, but the deteriorating security situation and lack of law and order in the project region rendered implementation impossible.

1.2.2 Feasibility Study (2004)

In 2002, WAPDA commissioned the Feasibility Study of the Kurram Tangi Dam to Kurram Tangi Dam Consultants (KTDC), a consortium of five Pakistani firms and Coyne et Bellier of France. The Feasibility Report appeared in 2004.

In addition to the dam on the Kurram River, planners proposed a diversion weir on the Kaitu River, a right-bank tributary of the Kurram, to irrigate two areas nearby, the Sheratalla and Spaira Ragha Plains. Water not needed for these command areas would be diverted to the Kurram Tangi Reservoir to augment the flow to two downstream powerhouses and to supplement the storage of water provided to downstream command areas.

Electric power would be produced at the main Kurram Tangi Dam and at additional powerhouses downstream, utilizing two bends in the river. This electric energy would be available in an area where it was heretofore in short supply and some would be sent to the substation at Domail.

The Feasibility Study (KTDC, 2004) included, as Chapter 9, a brief environmental assessment and a resettlement action plan. In Annexure 9 these sections were expanded into more complete documents, including a list of villages within the inundation zone and their populations, tribal affiliations, and occupations. The EA includes a list of 52 fish species found in the field surveys and partial lists of mammals, birds and reptiles.

1.2.3 Subsequent Engineering Studies and EA Approvals

In January, 2011, WAPDA released the Detailed Design Report (PES *et al*., 2011a) and in June the Tender Documents (PES *et al*., 2011b). The latter described some aspects of the KTDC not included in the earlier reports (See Chapter 6, below). In July 2011 WAPDA issued the PC-1 Report for the Projects.

After filing an application to the Environment Protection Agency (EPA) Khyber Pakhtunkhwa (KP), a no objection certificate (NOC) for KTDP was issued on 28 May 2005 approving the EIA Report of the project by Director General EPA, North West Frontier Province (NWFP), now KP. The validity of this NOC was for a period of three years which expired on 27 May 2008. Prior to the 18th Amendment in the Constitution of Pakistan, the Federal EPA or the EPA of KP Province was authorized to issue environment-related approvals for the FATA region. The legal authority of the KP EPA for granting approvals in FATA has not yet been documented clearly. Therefore, the NOC issuing authority for the present Environment and Social Impact Assessment (ESIA) has to be identified by the FATA Secretariat. According to information provided by the EPA KP, the monitoring for the implementation of this ESIA shall be conducted by the environment office at KP once it becomes operational. It was informally indicated by FATA Secretariat that EPA KP would be responsible for issuing NOC for the KTDC Project, inclusive for all its components either at NW Agency or at Bannu and F.R. Bannu.

1.2.4 Initial Environmental Examination (IEE) and Rapid Assessment

In 2012, USAID/Pakistan prepared an IEE in accordance with 22 CFR 216 to provide a first review of the reasonably foreseeable effects on the environment of the project and to recommend threshold decisions for additional environmental analysis. The IEE provided the factual basis for the threshold decision leading to a Positive Determination requiring an Environmental Assessment (EA) of the KTDP. Design, studies, field work and forums to discuss the project were "categorically excluded" in

accord with the regulation. The IEE stated that "All other activities were considered to have the potential for significant effect on the environment…" The IEE also required that USAID conduct Rapid Environmental Assessment, because earlier environmental work had been completed several years prior, and required also a Scoping Document as part of the EA process. The IEE was approved February 17, 2012.

USAID commissioned a Rapid [Environmental] Assessment (Elan Partners and Design Consultancy Engineers, 2012) of the KTDP. The REA reviewed existing project documents including the Feasibility Study, EA and RAP (KTDC, 2004) in order to assess the adequacy and status of these documents, identify major gaps and required improvements. Owing to security issues, no field work on the ground was possible. Continuing international activity against militants, especially in the Component 1 region, has resulted in local hostility toward strangers and in a FATA prohibition of foreigners and extra-regional professionals in the area.

The main improvements called for include but are not limited to the following (Elan Partners and Design Consultancy Engineers, 2012):

- Prepare an executive summary
- Include the study methodology
- Review the national and international regulations and policies
- Expand the project description
- Include an analysis of alternatives
- Discuss stakeholder consultations in detail
- Update the baseline chapter
- Include the assessment methodology and characterization of impact significance
- Include mitigation measures
- Include a comprehensive environmental mitigation and monitoring plan (EMMP)

1.2.5 EA Scoping

Pursuant to a Request for Proposal for an EA of the KTDP in August 2012 and a contract between USAID and MWH signed in November 2012, MWH and its sub-consultants, NESPAK and ACE, undertook a scoping process in accord with 22 CFR 216.3(a)(4). The scoping process began with research by experts of MWH, NESPAK and ACE into the resources of the project area. The EA team produced technical papers with discussions of the characteristics and issues related to relevant resources and the potential impacts of the project. A matrix analysis was conducted for the purpose of identifying potential project-resource interactions and deciding which potential impacts were likely to be significant.

As part of the scoping process, the technical papers and matrix analysis were discussed at a consultation workshop held on March 11, 2013 in Lahore attended by representatives of MWH, NESPAK, ACE, USAID, WAPDA, MMP, Diamer Basha Consultants (DBC) and by individual resource specialists from Pakistani agencies. After introductory remarks by major stakeholders, the workshop broke up into discussion groups dedicated to resource topics. At the end of the discussion period the leader of each group gave a summary to the workshop at large agencies. The Scoping statement is discussed in more detail in Chapter 7 of this EA**.** The final scoping document (dated April 22, 2013) identified key significant issues for each project component and discussed approaches to conducting field work for each issue, within the context of ongoing security issues in the project area, particularly Component 1and Component 2. USAID approved the scoping document on May 10, 2013.

1.3 Approach to EA and Related Data Collection

1.3.1 Overall Security Issues

From the start of the EA program, it was known that the tribal people of the portions of the Project Area within FATA were hostile to intruders from outside the region. It also was known that local customs in the region prohibited women from talking to strangers and that even within the tribe or clan certain subjects were taboo. Many of these topics would be among those needed to analyze the effects of the project on health, education, and demography. Nevertheless, it was expected that data for the socioeconomic analyses of the EA and Resettlement Action Plan could be obtained by interviewers from neighboring regions of the FATA or the Khyber Pakhtunkhwa. The Resettlement Policy Framework (RPF) and the Resettlement Action Plan (RAP) accompanying this EA provide additional information on how resettlement and gender data were collected. This section reviews the environmental data collection for this EA.

The MWH team was informed by the FATA Secretariat in the early months of 2013 that a No Objection Certificate (NOC) would only be issued to Pakistanis from within the region and that those from outside the Bannu District would not be allowed to conduct surveys within North Waziristan. In May, 2013 NESPAK contracted the gathering of physical data, including agricultural methods, soils, land use, watersheds, roads, air, noise, and water, in all of the component areas with International Development Consultants (IDC), a survey firm with extensive experience in the FATA. Field data would be collected through primary, as well as secondary sources, with the utmost effort made to have a photographic record of all activities in the component areas.

Associated Consulting Engineers (ACE) were contracted to carry out socioeconomic surveys for the RFP and RAP, as well as biological studies.

Continuing counterterrorism activity by the Pakistan Army and by the United States, through the use of drone aircraft, especially in the North Waziristan Agency, has increased local hostility toward strangers and delayed the initiation of the field program. Despite the issuance of an NOC in May, the program could not start, due to the fear that cameras, GPS instruments, and other equipment would upset the local people.

1.3.2 Primary Data Collection

In June and July, a Project office was opened in Bannu and the recruitment of local interviewers was begun. Selected informants from the Components 1 and 2 areas were interviewed in the Bannu office.

The planning, design and implementation of field surveys included orientation meetings/trainings for IDC staff, review of available project documents and satellite imagery and preliminary field reconnaissance. The upshot was the preparation of action plan for conducting detailed field surveys for both primary and secondary data collection and for tabulation and analysis of the collected data.

Prior to actual field surveys, NESPAK experts held a training workshop for IDC field staff. This focused on filling of checklists during the field survey and understanding of terminology used in the checklists. The IDC team members were recruited amongst local residents in the Project Area of Influence (AOI) and residents in districts adjacent to the AOI. In the case of the North Waziristan Agency and F.R. Bannu a separate survey team was formed comprised of members of local tribes.

The field survey was conducted in two rounds from 20 July to 6 August, 2013 and from 15 August to 31 August, 2013. All data collection tools and techniques including identification of key informants, conducting interviews/ discussions, group discussions, probing, physical observations were adopted for the collection of data. Photographs of selected features were also taken in the field.

A total 153 sites were studied during the physical environment field survey (Table 1-1)

Table 1-1. Sites Visited by IDC during the Baseline Survey of the Physical Environment

Component	District/ Agency	Total Sites	Remarks
1	North Waziristan	33	All sites visited
2	North Waziristan F.R Bannu	30	All sites visited
3	Bannu Lakki Marwat Karak	90	All sites visited
Total		153	

Meetings with officials of the following agencies were held to obtain secondary data:

- APA F.R. Bannu.
- C&W Department, District Bannu and Lakki Marwat.
- Irrigation Department, District Bannu and Lakki Marwat.
- Forest Department, District Bannu and Lakki Marwat.
- PHE Department, District Bannu and Lakki Marwat.
- Soil Conservation, District Bannu and Lakki Marwat.
- Environment Department, District Bannu and Lakki Marwat.
- Wildlife Department, District Bannu and Lakki Marwat.
- Agriculture Department, District Bannu and Lakki Marwat.
- FATA Secretariat, Peshawar.

The consultations covered a brief introduction of the project, present and future development plans and policies of the Government in the project area and concerns/ feedback of the officials relating to the proposed project.

1.3.3 Specific Limitations for Primary Data Collection

1.3.3.1 IDC Data Collection

The following limitations were faced by IDC during primary physical environmental data collection from the Project Area Sites:

- During the due course of EA field activities, the security situation in Components 1 and 2 frequently deteriorated significantly and at times collection of primary data became difficult or activities were totally halted due to curfew, exacerbated by the Army's refusal to provide security to the field staff.
- Field enumerators encountered threats from unknown people in the area and were put in grave danger in doing their work.
- Local tribes advised the field team to avoid the use of satellite imageries and cameras in the field and even advised not to carry sampling equipment.
- Use of Ground Topographic sheets was prohibited by the Surveyor General of Pakistan.
- Seasonal baseline sampling (water quality, noise, flora and fauna) could not be undertaken due to the length of studies permitted for the EA project and air quality monitoring was not possible even for one time sampling due to security hazards of using the monitoring instruments.
- The full project area could not be visited due to accessibility problems, e.g. reservoir area of Component 2 was not accessible due to the persistent security situation.
- Many interviewees (local population) were reluctant to answer the questions fully or at all.
- The catchment of the project area was inaccessible, in addition to physical access difficulties, the security situations in the catchment areas of Kurram and Kaitu Rivers are very vulnerable and

therefore, primary data were not collected from catchment areas of both rivers lying within Pakistan boundary.

1.3.3.2 ACE Socioeconmic and Biological Studies

ACE were also constrained in their work by security issues and a worse than expected slowdown during the holy month of Ramazan. During the field survey period, the incidents and threats of terrorist activities within Pakistan in general increased markedly. The impact on the FATA and the project area where the socio economic surveys were conducted was also heightened. Between June 1, 2013 and September 30, 2013 only 43 out of a possible 123 days were available for field work as a result of curfews and security incidents.

Although the MWH/ACE team vigorously stood up the Bannu office as planned and pursued the socio economic surveys with over 30 enumerators selected from local residents, certain tribal groups summarily refused to participate in the interview process during the month of Ramazan. They simply indicated that such interviews would not be conducted during the holy month.

This was compounded by reluctance of people to share personal or household information as there is a suspicion that this is a means of depriving them of their lands. People are also reticent to answer questions about the names and numbers of females in the households. Fear of drone attacks, military operations and statements of revenge by militants have made people even more scared and sensitive to sharing such information.

Under such circumstances, MWH used best efforts to interact with the local people and to collect the maximum feasible information for various environmental parameters. Nevertheless the field data that it was possible to collect is not considered sufficient for the EA of a project of this magnitude, because of the limitations on access and the lack of seasonal sampling.

1.3.3.3 Coordination with Other Donors

MWH and USAID held a meeting with the World Bank on May 29, 2013. The Bank representatives stated that these policies would apply: OP 4.01(Environmental Assessment), OP 4.12 (Involuntary Resettlement), OP 4.37 (Safety of Dams) and OP 4.11 (Physical Cultural Resources). These policies are addressed in the current EA (see Chapter 2) to the extent feasible.

As discussed in the Scoping Statement, the Environmental Assessment and the documents related to Involuntary Resettlement reflect largely the requirements of the World Bank. There is no Indigenous Peoples Plan per se, because the World Bank does not apply that policy to the FATA (see Section 2.5). However, there are several gaps in the current studies that international financing institutions (IFI) would likely want remedied to satisfy their requirements. The duration and types of data collection conducted are not commensurate with studies usually required (four season sampling, for example) to assess a complex project, because security constraints and the duration of the contract prevented this. Public consultation in accord with the standards of an IFI was inadequate for the same reason. A dam safety panel and an EA advisory panel should already have been appointed to satisfy World Bank requirements. There is no body of historical documentation upon which to base a systematic and comprehensive analysis of alternatives at the requisite level of detail that would typically satisfy an IFI.

1.3.4 Use of Geographic Information Systems and Satellite Imagery

The AOI was demarcated and digitized taking into account all the three components of the project and important features directly affected by the project. The total area of the AOI is 1004495 acres (about 1,570 mi2). Satellite imagery, tender document drawings and other digitized data were used to produce a range of maps for the study.

1.3.4.1 Land Use Mapping

Satellite Imagery of 0.5m spatial resolution was used to determine land use classes in the AOI. However, as it was not possible to fix Ground Control Points in the field owing to the constraints described in Section 1.3.2, ortho-rectification of satellite imagery could not be carried out. Fourteen classes of land use were identified and developed as GIS layers. These are summarized in Table 4-11.

Land use class maps were then prepared on scale of 1:5,000. Moreover, detailed land use mapping of the proposed reservoir area was carried out at a scale of 1:1,000.

1.3.4.2 Pléiades Satellite Imagery with Infrared (IR) Band

The Infrared band of Pléiades Satellite Imagery (0.5m spatial resolution) was purchased for the entire area of Component 1, and only for the proposed Kurram Tangi Dam reservoir in Component 2 and the proposed Thal Canal and its Command Area in Component 3. This imagery was used to investigate and estimate the cropped area and existing canals command areas. The IR band actually records the chlorophyll content in the 740-940 nanometer range of the spectrum. The satellite imagery was further classified by applying Digital Image Classification techniques using the IR band to reveal the cropping density and calculating the area under crops. Cropping intensity and health can easily be determined as shown in red in Figure 1-1.

1.3.4.3 Demarcation of Catchment Boundaries

Catchments boundaries were demarcated at different locations within the project area using Shuttle Radar Topographic Mission (SRTM) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) topographic datasets of 90m and 30m spatial resolution respectively. These topographic datasets were processed using ArcHydro Extension for ESRI ArcGIS developed by the Center for Research in Water Resources, University of Texas. Drainage patterns were also demarcated by using ArcHydro.

Without IR Band
Band Combination 3,2,1

With IR Band
Band Combination 4,3,2

Figure 1-1: Comparison of Satellite Imagery with and without the IR Band

1.3.4.4 Tender Document Drawings

Project Features and their detail were extracted from the Tender Documents, with the exception of the transmission line which was extracted from feasibility drawings. These drawings were prepared in AutoCAD's DWG drawing file format, and then converted to GIS drawings to show the project features.

1.3.4.5 Map Data Accuracy

All the relevant drawings from Tender Documents and Feasibility drawings were overlain on satellite imagery in order to facilitate different specialized studies. Drawings were Geo-referenced and spatially adjusted according to the available information. These drawings not only have a linear shift from permanent features present on the satellite imagery like roads and bridges but also inherit some rotational shift.

Transforming the AutoCAD drawings in the Tender documents and from the Feasibility Study was problematic because of the constraints described in the following paragraphs.

Almost all of the drawings in Tender Documents were prepared using architectural units. Grids present in most of the drawings are in yards and the drawings were prepared in feet; however, corresponding values of the grid in AutoCAD® are in neither yards nor feet. Contour elevation values are written as text not as an attribute associated with a contour line. It was therefore necessary to rely on the graphical scale bar to transform the information into GIS.

In addition, no information about the Coordinate System, Datum and survey benchmarks were provided, although later information indicated that it was probable that the survey was conducted using Lambert Conformal Conic Projection (LmPAK).

2 LEGISLATIVE AND REGULATORY OVERVIEW

2.1 Introduction

This Chapter reviews pertinent environmental and social legislation and regulations of Pakistan as well as international conventions and protocols to which Pakistan has agreed. In addition, relevant environmental and social policies and procedures of the World Bank, USAID and the Asian Development Bank are reviewed. Based on the USAID Scope of Work, this Environmental Assessment (EA) is expected to comply with USAID 22 CFR 216, international procedures and international agreements to which Pakistan is a party.

2.1.1 Relevant Administrative Areas: FATA and Bannu and Other Districts

The project is located in the Federally Administered Tribal Area or FATA (Components 1 and 2) and in the Bannu, Karak and Lakki Marwat Districts of Khyber Pakhtunkhwa (KP) Province (Component 3)[7].

With respect to the parts of the Project that are within the FATA, the ambit of the legal framework of Pakistan does not directly apply to the FATA. The region is recognized as a semi-autonomous region and is regulated through the Frontier Crimes Regulations 1901 (FCR) which is the prime source of judicial system. There is no formal existence of a department such as the Environmental Protection Agency (EPA), to ensure regulation of environmental issues and matters in FATA.

The Kurram Tangi dam site is located in a narrow gorge on Kurram River in North Waziristan Agency, about 11 miles km upstream of Kurram Garhi Headworks and 30 km north of Bannu City. A weir is also proposed at Kaitu River, which is located in North Waziristan Agency in FATA (Component 1). The Dam reservoir lies in North Waziristan Agency in FATA (Component 2). The new areas to be irrigated lie in Bannu and Karak Districts (Component 3 and partially Component 1).

2.1.1.1 F.R. Bannu

The administration of F.R. Bannu tribal area is looked after by the deputy commissioner Bannu district. It is located between 32°56' and 33°16' north latitudes and 70°22' and 70°52' longitudes. It is bounded on the north by Karak district, on the east by Bannu district, on the north by tribal area adjoining Lakki Marwat and on the west by North Waziristan agency. Its total area is 877 square kilometers. The total population of the area in 1998 was 19,593. There is no urban locality in the area. There were 160 villages in 1998.

Administrative Setup of F.R Bannu

F.R Bannu is divided into these administrative units:

- Frontier Region (F.R) (F.R Bannu)
- Subdivision (F.R Bannu)
- Tehsil (F.R Bannu)

The administrative Setup of the F.R is shown below:

Table 2-1: Administrative Setup of F.R Bannu

Appointment / Position of Administrator	Jurisdiction / Authorities / Responsibilities
District Coordination Officer (DCO) Bannu	Overall Charge d'Affaires of the F.R.
Assistant Political Agent, A.P.A	Functional In-charge of Admin / Judicial affairs
Political Tehsildar, (P.T) / Naib Tehsildar, (P.N.T)	Administrative / Judicial affairs of the Tehsil

[7] The construction of three new canals for the Project would require about 1,500 acres, of which about 40 is in the tribal territory of North Waziristan Agency and remaining 60 percent in the settled district of Bannu

2.1.1.2 North Waziristan Agency

North Waziristan Agency is the second largest agency in FATA. The North Waziristan Agency was set up in 1895. The encyclopedia Britannica indicates that the British took control of this area in 1892. In 1910 the North Waziristan Agency was constituted as Agency with its headquarters at Miranshah. The agency lies from 32.35 degrees to 33.22 degrees latitudes and 69.22 degrees to 70.38 degrees longitudes. It is bounded on the north by Afghanistan, Kurram Agency and Hangu District, on the east by Tribal Areas adjoining Bannu District and Tribal Area adjoining Karak and Bannu Districts, on the south by South Waziristan Agency and on the west also by Afghanistan..

2.1.1.3 Administrative Setup in North Waziristan Agency

The Political Agent is the head of the agency. He functions as a District Magistrate and Session Judge and also as Coordinator of the functions of all the nation building departments in the agency. The agency has three Sub Divisions viz. Miranshah, Razmak and Mir Ali with three Assistant Political Agents, nine Tehsildars and a number of other administrative functionaries. The headquarters of the Political Agent is in Miranshah. The Assistant Political Agents have their headquarters in Miranshah, Razmak and Mir Ali respectively.

The administration is run through Maliks, Khassadars and Lundgi holders (Sufaidresh). The tribal administration and system of justice is based on the concept of territorial, tribal (collective) and protective responsibility. Adjudication is through the Jirga system, which is something the tribesmen comprehend and accept. The substantive law is the Pakistan Penal Code whereas the Frontiers Crimes Regulation (FCR) is the procedural law.

In all the criminal and civil disputes two systems are followed i.e. Riwaj (the customary law) and Shariat (Islamic law). Riwaj is the code of tribal customs and almost all the cases are decided under the same. Even in the Frontier Crime Regulation, the council of elders (Jirga) bases its verdict on Riwaj. The administration takes cognizance of only those offenses, which are committed in protected areas, and does not generally interfere in the offenses occurring between the tribes in the tribal territory of which no cognizance is taken. However, the administration does interfere in case of offenses taking place even in tribal territory, beyond the protected area in which state interest is involved. This interference could be direct, through the use of force, or indirect, i.e. through Maliks and Khassadars, by invoking tribal/territorial responsibility depending upon the gravity of the offense. The Maliks used to work as medium between the administration and "Qaum."

2.1.1.4 Bannu and Other Districts

On December 18, 2012 The Khyber Pakhtunkhwa government announced administrative arrangements for the enforcement of the provincial Local Government Act, 2012, from January 1, 2013.

Under the arrangements announced by the government, the district setup of government departments has been separated from local government institutions established under the Khyber Pakhtunkhwa Local Government Ordinance, 2001, and realigned with their administrative departments. Also, all posts of executive district officers were abolished and the District Coordination Officers (DCOs) in 25 districts were re-designated as Deputy Commissioners.

In absence of elected local councils in the province, the Deputy Commissioners were asked to hold the additional charge of the administrators of the respective district councils until further notice. According to the administrative order, the functions of erstwhile DCO (revenue and estate) were integrated into the office of Deputy Commissioner with the provision of an Additional Deputy Commissioner in each district.

The sub-divisional setup of Deputy District Officers (revenue) and Deputy District Officers (judicial) was replaced by Assistant Commissioners and Additional Assistant Commissioners. According to this administrative order, the Board of Revenue is responsible for relocating the functions of

Collector and Assistant Collector in the office of Deputy Commissioners and Assistant Commissioners in accordance with the new administrative setup.

Each district has also been provided a District Officer (finance and planning), a Planning Officer, a Finance Officer and a Secretary District Public Safety Commission, while the positions of Assistant Coordination Officer, Human Resource Development Officer and Deputy District Officer (finance) were abolished.

With the abolition of the Education District Office (EDO), the elementary and secondary education department at district level are being re-organized under District Education Officers separately for men and women assisted by Deputy District Education Officers (male and female) and sub divisional education officers. Similarly, the health department at district level is re-organized under district health officers assisted by deputy district health officers and coordinators.

Under Section 224 of the local government act 2012, the local government and rural development department will notify constitution of each local council and make transitional interim arrangements.

The agriculture department at district level has also been re-organized. Agriculture (extension) is strengthened by a district director, subject matter specialists, agriculture officers, plant protection officers, assistant horticulture officers and assistant agronomists. The livestock and dairy development (extension) also has a district director, senior veterinary officers and veterinary officers. On-farm water management has district directors, district officers and water management officers.

Soil conservation has district officers (soil conservation) and soil conservation assistants.

The public health engineering department and communication and works department are continuing with their previous organizational hierarchy at the sub-divisional, district and regional level.

Account-IV modality for transfer of funds to districts havs been operational with deputy commissioners as principal accounting officer for account-IV and chairman of the district development committee of their respective districts. The account-IV related to the funds utilized by the district government. In addition to oversight of the accounting aspects of the reorganization, the finance department is supposed to notify the deletion of existing posts and creation of replacements as per requirements of government departments, and the commissioner oversee transition, facilitate government departments, coordinate relocation of functions and ensure continuation of services in their respective divisions.

2.1.2 Administration of Tribal Areas

Khyber Pakhtunkhwa (KP) is one of Pakistan's four federal units, governed by an elected provincial government with the centrally appointed governor acting solely as the representative of the federal government. In British India, the area that is now Pakistan's KP was first administered by a chief commissioner as part of Punjab province. In 1901, KP was granted the status of a separate province and divided into Settled Areas ("Districts") and Tribal Areas ("Agencies"). Under the Governor General of India, the KP governor supervised the administration of both settled and tribal areas. Pakistan retained this system of administration, with the KP governor administering FATA as the agent first of the governor general and then the president. Article 247 of the constitution states: "Subject to the Constitution, the executive authority of the Federation shall extend to the Federally Administered Tribal Areas, and the executive authority of the province shall extend to the Provincially Administered Tribal Areas." KP's provincial governor exercises executive authority in FATA as the president's representative. The president enjoys discretionary powers in the 1973 constitution to "make regulations" with respect to "the peace and good governance" of FATA.

According to the government's official rules of business, the responsibility for the "overall administrative and political control of FATA" falls under the federal ministry of states and frontier Regions (SAFRON). While SAFRON, as a federal ministry, is answerable to the elected prime minister and national assembly, it is virtually irrelevant in policy implementation or execution in FATA and acts mainly as a conduit for routing federal funds. Ultimate executive authority over FATA rests with the president and is exercised through his agent, the provincial governor. A political agent (PA), a federal, and at times provincially recruited, bureaucrat heads the local administration of each FATA agency, backed by "khassadars" from different tribes. In this way, the administration controls a source of employment which it can use to deal with tribes or individuals.

Under the constitution, a law enacted by the parliament is not applicable to FATA unless the President of Pakistan issues special orders regarding its extension there. In the past laws have been extended to FATA without any amendments or changes commensurate with the prevailing conditions in FATA, even without setting up the relevant bodies required under the law. Moreover, proper arrangements have often not been made to implement the law, when extending it to FATA, to make it workable there.

2.1.3 Judicial Structures in FATA

2.1.3.1 Frontier Crimes Regulations (FCR 1901)

The Frontier Crimes Regulations 1901, popularly known as FCR is one of the major component of the administrative system of justice in Tribal Areas. FATA's judicial system is enshrined in the FCR (1901), a hybrid colonial-era legal framework that mixes traditional customs and norms with executive discretion. The British created this law to manage and control their Indian Empire's restive frontier belt. Originally drafted in 1872, the FCR was promulgated with amendments in 1901 and applied by Pakistan to NWFP (presently as KP) until 1963.

2.1.3.2 Revision of the Frontier Crimes Regulations – 2011

The 2011 amendments to the FCR brought the regulation in line with the Pakistan Penal Code (Act XLV of 1860) and the Code of Criminal Procedure, 1898 (Act No. V of 1898). The 2011 political reforms included numerous and extensive amendments to the Frontier Crimes Regulation. The legal concepts and overarching structure of the regulation, however, remained essentially untouched. While most critics and many FATA citizens argue that additional political reforms are needed, the 2011 amendments to the FCR did introduce new concepts, strengthened pre-existing substantive and procedural law, and made some gains in terms of the political and human rights of FATA citizens. Some of the more substantive reforms included in the amendments are:

- Protection of women, children below 16 and citizens above 65 from collective responsibility arrest or detention[8].
- Prohibition against arresting an entire tribe under the collective responsibility section[9].
- Fixed time limits for the disposal of cases.
- Provision for independent appeals process[10].
- Appellate authority power to review and revise decisions and orders[11].
- Strengthening the FATA Tribunal[12].
- Power to transfer cases to the assistant political agent[13].
- Concept of bail[14].

[8] Section 21(c)(3) and 22(d), Amended Frontier Crimes Regulation, 2011.
[9] Section 21, *ibid.* Following 2011 amendments, male members of a family must be arrested first, followed by the sub-tribe and then by other sections of the tribe.
[10] Section 4, 5 and 48, *ibid.* Appeals shall be heard by an appellate authority comprised of a commissioner and a dedicated additional commissioner to be notified by the Governor.
[11] Section 55(A)(4), *ibid*
[12] Section 55(A) and 55(AA)
[13] Section 5,

- Introduction of jail inspections.
- Reference to council of elders and *Qaumi Jirga*[15].
- Acceptance of local customs and traditions (*Rewaj*)[16].
- Fines on communities in the case of murder.
- Forfeiture of public salary for being involved in a crime[17].
- Arrest by authorities other than the political agent[18].
- Checks on arbitrary power to arrest[19].
- Punishment and compensation for false prosecutions[20].
- No deprivation of property rights without adequate compensation[21].
- Audit of political agent funds by the Auditor General of Pakistan[22].

2.1.3.3 FCR Jirga

Although the jirga is an informal institution but it has very formal effects on the Pukhtoon society in general and on tribal people in particular. It is one of the most time-honored institutions in the tribal world and part of the culture of the tribesmen, who are very proud and fond of their culture. The FCR preserves the Pashtun tribal structure of jirga (council of elders), to which the political agent can refer civil and criminal matters. The jirga ascertains guilt or innocence after hearing the parties to a dispute and passes verdicts on the basis of rewaj (customs). However, the Political Agent (PA) retains ultimate authority.

The FCR is based on the premise of cohabitation between the jirga and the political agent for the provision of speedy justice in accordance with tribal customs. Pakistan retained this system, with the political agent initiating cases, appointing the jirga, presiding over trials and awarding punishments without even the technical possibility of revision by a regular court of law. Most FATA residents supported the jirga as an efficient source of dispensing justice. In cases where neither the government nor the political agent has a stake, the process can be quicker and offer disputants more opportunity to air their grievance and negotiate than an ordinary court trial. But jirga verdicts often favor those with political or economic clout at the expense of the vulnerable segments of the population, particularly women, who are excluded from direct participation in the system and suffer when male members of their families are detained.

The names of the traditional legal instruments under which this tribal system operates are mostly oral and are passed down from one generation to other. The President of Pakistan is authorized to issue administrative orders under Article 247 of the Constitution.

As per Article 247 of the constitution, there are limitations on higher courts exercising their jurisdiction regarding disputes in FATA. This can only be done through special orders of the President of Pakistan. There is a need to explore solutions for providing justice and right of appeal to the project affected persons.

[14] With some restrictions and at the discretion of the political agent, the 2011 reforms granted the right to bail to FATA citizens. The FATA Tribunal or the appropriate appellate authority also has the power to revoke the right to bail. See Section 11(a), *ibid.*
[15] Section 12(a), *ibid.*
[16] Section 8, *ibid.*
[17] Section 26, *ibid.*
[18] Section 38 and 39, *ibid.*
[19] Section 40(A), *ibid.*
[20] Section 55(AAA), *ibid.*
[21] As per prevailing market value in accordance with the procedure laid down in the Land Acquisition Act 1894 (as followed in the rest of Pakistan). See Section 56, *ibid.*
[22] Though enacted, this amendment has not been implemented to date. As of February 19, 2012, no audit of political agent accounts has been reported having been performed by the Auditor General of Pakistan. See Section 58(2), *ibid.*

2.1.4 Administrative and Judicial Structures in F.R. Bannu

The administration of F.R. (Frontier Region) Bannu tribal area is the responsibility of the Deputy Commissioner Bannu district. The Deputy Commissioner Bannu is assisted by the district officer Frontier Constabulary Daryoba as assistant political agent for the Ahmadzais and the political tehsildar for the Utmanzais, Wazirs and Bhittanis. However, in 1976 a separate post of assistant political agent was sanctioned for the entire tribal area under the administrative control of the deputy commissioner, Bannu. The F.R. Bannu is in the federally administered tribal areas and all the financial liabilities for economic development and general administration are borne by the federal government. The Office of the Deputy Commissioner Bannu is actively supported by the Frontier Constabulary in addition to Khasadars engaged for political administration. The affairs of F.R. Bannu are largely regulated through the Jirga system. Besides FCR, most of the cases of Bannu F.R. areas are decided by the local laws (Riwaj) and Shariat.

2.1.4.1 Riwaj (Body of Traditional Law)

The most important body of customs, social and legal precepts in FATA and F.R. Bannu is riwaj. It means a body of customs which has over time assumed the status of usage, and frequently, the prevailing law. It is basically a body of social customs. Sometimes the term riwaj is used in contradiction with Shariah (Islamic Law). It is more in use than the Islamic law. Riwaj is a set of micro-social practices.

It is required of every Pukhtun to abide by riwaj, i.e. to observe the norms and values of the society. Although riwaj varies from tribe to tribe or from locality to locality, in respect of various matters, abiding by riwaj is considered obligatory.

Other prevailing judicial practice, both in FATA and F.R. Bannu is Jirga. Types of Jirga include:

- Sarkari or Governmental Jirga.
- Qaumi/ Ulusi or Local-Representative Jirga.
- Shakhsi or Third-Party Jirga.
- Loya or Grand Jirga.

2.1.4.2 F.R. Bannu and FATA in the Context of the FCR

Administratively, FATA is divided into seven political units namely Bajaur, Mohamand, Khayber Orakzai, Kurram, North and South Waziristan Agencies and six Frontier Regions (FRs) Peshawar, Kohat, Bannu and D.I. Khan.

The last one is further divided into F.R. D.I. Khan and F.R. Tank. Similarly F.R. Bannu had been divided into F.R. Bannu and F.R. Lakki Marwat. The FCR is equally applicable to F.R. Bannu as well as the FATA Area; however, its application is practiced more frequently in other parts of the FATA than the Frontier Regions.

2.1.5 Administrative and judicial Structures of Districts

The administrative units of Pakistan consist of five provinces, one federal capital territory, three autonomous territories and a group of federally administered tribal areas. Below this top tier, there are four more tiers of government, including 27 divisions, more than a hundred districts (zillahs), more than four hundred sub-districts (tehsils), and several thousand union councils.

Pakistan is a federal republic whose local government has been temporarily suspended following the expiration of the 17th amendment and the passing of the 18th amendment to the constitution, which transfers responsibility for local government from central to provincial government. Due to the delay in local government elections, the administration of each district is currently headed by an appointed district administrator. The local government system in Pakistan is a three-tier system comprising district (zila), tehsil and union councils.

2.1.5.1 Judicial System in Pakistan

The District Courts of Pakistan are courts that operate at the district level. They are controlled by the high courts. District courts exist in every district of each province, with civil and criminal jurisdiction. In each District Headquarters, there are numerous Additional District Sessions Judges who usually preside over the courts. A District Sessions Judge has executive and judicial power over the entire district under his jurisdiction. Sessions courts are also a trial court for heinous offences such as murder, rape (Zina), haraba offences (armed robbery where a specific amount of gold and cash is involved). It is also an appellate court for summary conviction offences and civil suits of lesser value. Each town and city now has a court of an Additional District Sessions Judge with equal authority over his jurisdiction. When it is hearing criminal cases it is called a sessions court and when it is hearing civil cases it becomes a District Court. Executive matters are brought before the relevant District Sessions Judge.

The High Court of each province has appellate jurisdiction over the lower courts. The Supreme Court has exclusive jurisdiction over disputes between and among provincial governments, and appellate jurisdiction over High Court decisions.

2.2 National Laws and Regulations

Pakistan's statute books contain a number of laws concerned with the regulations and control of the environmental and social aspects. However, the enactment of comprehensive legislation on the environment, in the form of an act of parliament, is a relatively new phenomenon. Most of the existing laws on environmental and social issues have been enforced over an extended period of time, and are context-specific. The laws relevant to the developmental projects are briefly reviewed below:

2.2.1 Pakistan Environmental Protection Act, 1997

The Pakistan Environmental Protection Act, 1997 ("the Act", or "PEPA") [23] is the principal legislative tool empowering the government to frame regulations for the protection of the environment. The 'environment' has been defined in the Act as: (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 interrelationships between any of the factors specified in sub-clauses 'a' to 'f'. The Act is applicable to a broad range of issues and extends to socioeconomic aspects, land acquisition, air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. The discharge or emission of any effluent, waste, air pollutant or noise in an amount, concentration or level in excess of the National Environmental Quality Standards (NEQS) specified by the Pakistan Environmental Protection Agency (PakEPA) has been prohibited under the Act and penalties have been prescribed for those contravening the provisions of the Act.

The powers of the federal and provincial Environmental Protection Agencies (EPAs), established under the Pakistan Environmental Protection Ordinance 1983[24], have also been considerably enhanced under this legislation and they have been given the power to conduct inquiries into possible breaches of environmental law either on their own initiative, or upon the registration of a complaint.

[23] The application of the Pakistan Environmental Protection Act (PEPA), of 1997, to FATA lacks proper homework to implement. It took the federal government almost 15 years to extend this law to those areas. However, experts believe that there are several provisions of this law, which could not be presently implemented in the FATA without making amendments to it. Under PEPA, several powers have been assigned to the relevant High Court, to Peshawar High Court in the case of Khyber Pakhtunkhwa Province. Interestingly, the jurisdiction of the superior courts, including the Supreme Court and the Peshawar High Court, has so far not been extended to FATA. Article 247 of the Constitution places a bar on exercising any jurisdiction by the superior courts in FATA.

[24] Superseded by the Pakistan Environmental Protection Act, 1997.

The requirement for environmental assessment is laid out in Section 12 (1) of the Act. Under this section, no project involving construction activities or any change in the physical environment can be undertaken unless an initial environmental examination (IEE) or an environmental impact assessment (EIA) is conducted, and approval is received from the federal or relevant provincial EPA. Section 12 (6) of the Act states that the provision is applicable only to such categories of projects as may be prescribed. The categories are defined in the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000.

2.2.1.1 Guidelines for Public Consultation

The purpose of a Public Consultation Plan (PCP) is to lay out a plan for the acquisition, organization, management and effective use of input from the general public regarding a project of this nature, public input is likely to be considerable, and possibly contradictory. Therefore, a well thought out plan is crucial to the success of the public consultation activities. Consultation is covered in Chapter 7 and a communications plan has been prepared for USAID.

Ideally, the public involvement program should commence at the screening stage of a proposal and then continue throughout the whole EIA process. This is represented in Figure 2-1below, produced by The World Bank to show how public involvement is incorporated into its procedures.

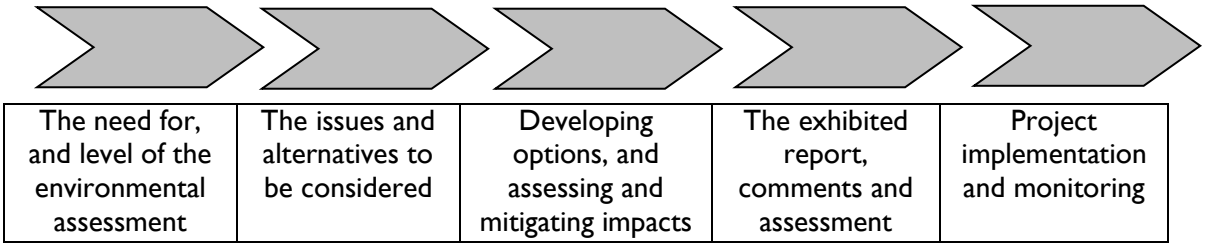


Figure 2-1: Incorporating public involvement into the stages of environmental assessment

2.2.1.2 Guidelines for Sensitive and Critical Areas

The objective of the guideline is to provide guidance to project proponents and other stakeholders in the environmental assessment process, so that projects are planned and sited in a way that protects the values of sensitive and critical areas.

These guidelines help proponents of projects:

- In identifying what are the officially notified protected areas in the project area. These may include critical ecosystems including wildlife reserves and forests, archaeological sites, monuments, buildings, antiquities, or cultural heritage sites.
- If any area within or within the vicinity of a project area is notified as protected area, then the approach detailed in the relevant Act should be adopted.

2.2.1.3 Checklist of Procedures for Environmental Assessment

In planning and siting a project the proponent needs to focus on being sensitive to the particular values of the relevant ecosystem. Prior to any Environmental Approval being granted by the Responsible Authority, the following steps should be undertaken:

- The proponent should identify whether the site for the proposed development is within the precincts of a protected ecosystem. For this the proponent should refer to list of notified protected ecosystems in Pakistan or relevant district e.g. District Bannu. If the proposed site is not located in a notified area, and there are no apparent ecological or cultural values associated with the site, no further action is required.

- If the proponent, or consultant identifies an ecological site that appears to be of importance, but the site is not listed, they should discuss the site with the relevant conservation authority.
- If the site falls within the boundaries of a protected ecosystem the relevant conservation authority in each province should be contacted for advice about the extent to which development may be allowed. Certain protected areas may have total prohibition of development while others may allow controlled development.
- The relevant conservation authority should inform the Responsible Authority of their assessment of the significance of the likely impacts of the proposed development early in the process in order for the Responsible Authority to determine the level of documentation required. The Provincial EPA's will then be in a position to review the level of reporting required in light of the advice from the conservation authorities.
- In the review of the Environmental Report, the Responsible Authority will liaise with the conservation authority to ensure that impacts and mitigation measures detailed in the Environmental Report are well based, and to frame Environmental Approval conditions which protect the values of the listed area.

2.2.2 Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000

The Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000 (the 'Regulations'), developed by the Pak-EPA under the powers conferred upon it by the Act, provide the necessary details on preparation, submission and review of the initial environmental examination (IEE) and the EIA. Categorization of projects for IEE and EIA is one of the main components of the Regulations. Projects are classified on the basis of expected degree of adverse environmental impacts. Project types listed in Schedule I are designated as potentially less damaging to the environment, and those listed in Schedule II as having potentially serious adverse effects. Schedule I projects require an IEE to be conducted, provided they are not located in environmentally sensitive areas. For the Schedule II projects, conducting an EIA is necessary.

The proposed project falls under the Schedule II of the Regulations.

Recognizing that the Pak EPA has delegated powers to provincial EPAs to enforce the provision of Environment Protection Act 1997, wherever required an EIA must be submitted to the provincial agencies in whose jurisdiction the project falls. The EIA for the KTDP will be submitted to KP EPA Department for implementing the project as the concerned agency.

As per Section 12 of Pakistan Environmental Protection Act 1997, 'No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an initial environmental examination. Accordingly, after filing of an application to KP EPA a no objection certificate (NOC) for KTDP was issued on 28th May 2005 by Director General EPA, NWFP (now KP) approving the EIA Report of the project. The validity of this NOC was for a period of three years which expired on 27th May 2008.

Prior to the 18th Amendment to the Constitution of Pakistan, the Federal EPA or the EPA of Khyber Pakhtunkhwa (KP) Province were authorized to issue environment related approvals for the FATA region. The legal authority of the KP EPA for granting approvals in FATA has not yet been documented clearly. Therefore, the NOC issuing authority for this EA has to be identified by the FATA Secretariat. Currently, an environmental office is being established within the FATA Secretariat. According to the information provided by KP EPA the monitoring for the implementation of this ESIA shall be taken over by the environment office at KP once it becomes operational. It was informally indicated by FATA Secretariat that KP EPA would be responsible for issuing NOC for the KTDC Project, inclusive for all its components either in NW Agency or Bannu and F.R. Bannu.

The approval (NOC) of an EIA and its accompanying EMP is valid for commencement of construction within three years from its issue. If construction commences within this period, the validity is extended for a further three years from the date of commencement of construction. However, if construction does not commence within the three year period the EIA and EMP shall be revised and resubmitted to the environmental authority for approval. In addition, where significant changes are made to a project during detailed design, these changes together with a report on their potential impacts must be submitted to the environmental authority for further review. If deemed necessary, the environmental authority may impose further conditions on the approval after this review.

2.2.3 National Environmental Quality Standards

The National Environmental Quality Standards (NEQS), promulgated under the PEPA 1997, specify the following standards:

- Maximum allowable concentration of pollutants in gaseous emissions from industrial sources;
- Maximum allowable concentration of pollutants in municipal and liquid industrial effluents discharged to inland waters, sewage treatment and sea (three separate set of numbers),
- Maximum allowable emissions from motor vehicles,
- Ambient air quality standards,
- Drinking water standards, and
- Noise standards.

The above NEQS's are presented in Appendices 9.3-1 to 9.3-7. These standards will be applicable to the proposed project.

2.2.4 Pertinent Acts, Ordinances and Policies

2.2.4.1 Land Acquisition Act, 1894

The Land Acquisition Act (LAA) of 1894 as amended from time to time has been the de-facto policy governing land acquisition and compensation in the country. The LAA is the most commonly used law for acquisition of land and other properties for development projects. It comprises 55 sections pertaining to area notifications and surveys, acquisition, compensation and apportionment awards and disputes resolution, penalties and exemptions. Additional detail is provided on this and other resettlement related laws and policies in the RPF prepared for the project.

Private property is protected in Pakistan through the Constitution of 1973, which rules that "every citizen shall have the right to acquire, hold and dispose property …. No property shall be compulsorily acquired or taken possession of save for a public purpose,[25] and save by the authority of law which provides for compensation therefor and either fixes the amount of compensation or specifies the principles on and the manner in which compensation is to be determined and given" (Constitution 1973; Article 23-24).

This power to expropriate private properties for public purposes vested in the government through the Constitution is implemented through the LAA. While it defines detailed procedures for the expropriation process, this 120 year old legislation does not fully address the economic, administrative, environmental or social realities of Pakistan in 2013. For example, it does not cover the resettlement and livrlihood restoration of physically and/or economically displaced people.

[25] Projects in the public purpose are according to the Constitution projects that have "the purpose of (i) providing education and medical aid to all … (e) (ii) providing housing and public facilities and services such as roads, water supply, sewerage, gas and electric power to all … (iii) providing maintenance to those who, on account of unemployment, sickness, infirmity or old age, are unable of maintain themselves" (Constitution 1973; Article 24).

While the LAA guides the land acquisition process in Pakistan, it needs to be noted that the Constitution of Pakistan rules that unless specifically enacted by the President, the laws of Pakistan (including the LAA) do not apply to the FATA (See Section 2.1.2), which includes the F.R. Bannu and North Waziristan (Constitution 1973; Article 246b). This means that all project land located in the Districts Bannu, Lakki Marwat and Karak (basically Component 3 plus minor parts of the access roads and the transmission line of Components 1 and 2) would be acquired through the process outlined in the LAA and other relevant legislation in Pakistan, while land located in the FATA (Components 1 and 2 with the exception of minor parts of the access roads and transmission line) would be acquired under the national framework in accordance with the land acquisition legislation applicable in the FATA.

Land acquisition in Districts Bannu, Lakki Marwat and Karak

The acquisition of land and easement for access roads, transmission lines, as well as canals and culturable command areas (CCA) in Districts Bannu, Lakki Marwat and Karak is governed under the national framework by the LAA and the Telegraph Act (1885).

The LAA defines "land" as land plus benefits arising from it plus all assets and resources attached to it and "person interested" as those who have rights and interests in this land (i.e. owners, sub-owners, tenants, mortgagees, leaseholders, easement holder etc.). The focus of the LAA is procedural rather than on substance and covers taking of land for public purposes as well as for private investors.

The expropriation process starts by informing the public about the intent to expropriate land for a specific purpose. The public announcement provides also the Land Acquisition Collector (LAC) with the right to access and survey all land of interest without any additional permission, while to access a house and/or enclosure he needs to inform the occupier at least 7 days in advance. Based on these rights the LAC conducts a preliminary land survey in order to identify the "interested persons". All damages caused by the survey need to be compensated immediately. Based on the survey results, a second public notice is issued, identifying the specific land plots to be expropriated and inviting all "interested persons" to voice objections within 30 days. After reviewing these objections, the LAC recommends actions to the Executive Revenue Officer of the Tehsil in question, which then decides to either enhance the documentation or to go ahead with the expropriation process.

In the next step, a "Declaration of Intended Acquisition" is published identifying the land plots to be expropriated as well as the reason for the expropriation. Based on this declaration, the LAC then demarcates the land to be expropriated, measures and valuates it, finalizes the identification of "interested people" and invites them through public notice to voice their claims/interests in the land and establish their claims based on the available information a draft updated cadaster drawing. After that, the LAC organizes a meeting to verify the various claims and finalize the information gathering process on size, nature and value of the plot with all improvements and assets on it as well as the apportionment of the overall compensation to the "interested people" based on their verified claims. The meeting closes the fact finding process and entitles the LAC to update the cadaster with the new information, issue an award note and take possession of the "land".

After the "land" had been formally taken, the "interested people" are invited to claim their share of the overall compensation. Any grievance against the expropriation process and/or the allocated compensation needs to be voiced through the legal system.

Compensation for "land", including all improvements (houses etc.) on it, is calculated as the average value declared in private acquisitions of similar lands nearby plus a markup of 15%. Informal improvements such as non-permitted houses are not compensated, while physically displaced people are provided with a transport allowance. In addition, damages on standing crops etc. are compensated at market value.

It needs to be noted that the LAA is a provincial law with different sets of standards and procedural steps most notable for the calculation and payment of compensations in each province. Beside of the normal procedure outlined above, the LAA also contains in article 17 an urgency provision that allows the immediate taking of land and of houses two days after the first notification has been issued.

Land acquisition for transmission lines falls under the Telegraph Act (1885) that covers, amongst other activities, the installation and maintenance of telegraph lines and poles and has been used ever since for transmission lines. The Act states that neither land nor easement is needed for the installation of poles/towers on private property and therefore no compensation is required. Similarly, while it is not permitted to construct houses underneath transmission lines no easement is acquired and consequently no compensation paid. In short, those affected by a transmission line are only compensated for damages on standing crops, buildings etc. during the construction period.

Land Acquisition and Land Use in North Waziristan and Frontier Region Bannu

As indicated above, the Frontier Region Bannu and North Waziristan are part of the FATA and are governed by a set of specific laws enacted by the President of Pakistan as well as written and unwritten customary laws. Until recent none of the formal laws applicable to the FATA contained any provision for expropriation of land, with the exception of land in the border region. Land can therefore only be acquired through the provisions of customary laws. Under customary law the tribes are the rightful owners of all lands and nobody has the right to take or use any land without the consent of the tribe that owns the land. In practice this means that administrative developers such as WAPDA task the political agent to negotiate a settlement with the Malik(s) of the affected tribe(s). A committee comprising the relevant Tehsildar, Malik(s) and Village Elders is then tasked to negotiate compensation rates for each of these entitlements. For national projects, once an agreement is reached, the Political Agent is tasked to disburse all entitlements in cash to the Malik(s), who is (are) then in charge of distributing it to the affected sub-tribes and households. As this general provision commonly created issues, projects financed by Multilateral Financial Institutions charge the Political Agent to disburse compensation for farmland and houses and allowances to each of the affected households and only disburse the remaining compensation for grazing and barren land as well as community infrastructure to the Malik(s).

On 27 August 2011, the President of Pakistan amended the Frontier Crimes Regulation (1901) through an Executive Order and added clause 56, which rules that now "no person shall be compulsorily deprived of his property unless he is paid adequate compensation with consensus rate or Government assessed value as in vogue in settled areas". This means that land and easement can be expropriated in the FATA as long as compensation is paid. Therefore, under the national framework all project land in the FATA (Components 1 and 2 with the exception of minor parts of the access roads and transmission line) can be expropriated as long as compensation is paid.

As the Telegraph Act has been enacted for the FATA, land for the transmission towers as well as easement for roads and the transmission corridor can be obtained through the Telegraph Act.

Land Acquisition Practice in Pakistan

Local governments and in particular the local Board of Revenues and the Land Acquisition Collector, both at Tehsil level, are provided through the LAA with discretionary powers with few checks and balances, provisions for public consultations, standardized methods of valuation and/or any form of proactive grievance mechanism in place. In the FATA, the Frontier Crimes Regulation provides the political agent with even more discretionary power as clause 56 provides no guidance on when to use negotiated settlements (compensation at the consensus rate) or compensate at the rate at least partly described in the LAA.

In turn, the absence of a modern land acquisition law has triggered significant delays, cost increases and protests as well as the desire to address and overcome this challenge. In 2002 a National Resettlement Policy was drafted to ensure an equitable, uniform and modern treatment of land

acquisition and resettlement all over Pakistan. The Draft Policy focused on key shortcomings of the LAA and suggested ways to a) compensate for the loss of (i) communal assets (structures and public infrastructure such as mosques, shrines, schools, graveyards etc.), (ii) communally administered access to assets (pasture, water rights, etc.), and (iii) incomes from assets and resources; b) assure transparency during the asset inventory and valuation process; c) assure livelihood restoration; d) integrate the affected people into resettlement planning and implementation through consultation processes; and, e) provide special attention to vulnerable groups. The Draft National Resettlement Policy was never submitted to the cabinet and/or parliament and is therefore not legally applicable to the resettlement needs of the project.

2.2.4.2 Wildlife (Protection, Reservation, Conservation and Management) Act, Ordinances and Rules-Act No. V of 1975

This law has been enacted to protect the all province's (NWFP) wildlife resources directly and other natural resources indirectly. It classifies wildlife by the 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.

This Act will be applicable to the construction as well as operation and maintenance (O&M) activities of the project.

2.2.4.3 Forest Act, 1927

The Act authorizes Provincial Forest Departments to establish forest reserves and protected forests. The Act prohibits any person to set fire in the forest, quarry stone, remove any forest produce or cause any damage to the forest by cutting trees or clearing up area for cultivation or any other purpose.

The project activities will have to be carried out in accordance with this Act. No activities will be carried out in any protected forests, and no unauthorized tree cutting will be carried out.

2.2.4.4 Canal and Drainage Act, 1873

The Canal and Drainage Act (1873) prohibits corruption or fouling of water in canals (defined to include channels, tube wells, reservoirs and watercourses), and obstruction of drainage.

This Act will be applicable to the construction and O&M works to be carried out during the proposed project.

2.2.4.5 Antiques Act, 1975 and EPA Antiques Procedures

The Antiquities Act of 1975 ensures the protection of cultural resources in Pakistan. This Act is designed to protect 'antiquities' from destruction, theft, negligence, unlawful excavation, trade and export. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, and national monuments. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area that may contain articles of archeological significance.

Under this Act, project proponents are obligated to:

- Ensure that no activity is undertaken in the proximity of a protected antiquity.
- If during the course of the project an archeological discovery is made, it should be protected and reported to the Department of Archeology, Government of Pakistan, for further action.

This Act will be applicable to the construction and O&M works to be carried out during the proposed project.

Preservation of archeological and historical heritage is obligatory under the Pakistan Antiquities Act 1975. All the artifacts, monuments, petrography and building of historical importance come under archeological heritage. Even old mosque, temples, churches and graveyards are covered under this Act.

The Antiquities Act 1975 "extends to the whole of Pakistan" and therefore applies for the project area including North Waziristan. It specifies that, in Pakistan, everything established before 1900 is considered "ancient" and that it applies to a wide area covering "historical, ethnographical, anthropological, military and scientific interests". In the event of a find of any movable antiquity, the project must inform the Director General of the Department of Archaeology and Museums within seven days and ask for guidance on what to do and who takes over the ownership of any newly discovered antiquity. If these provisions are not followed, the person who made the discovery and failed to inform the authorities can be imprisoned for up to three years.

The Director General is empowered to conduct archaeological surveys on all private and public land (§6), expropriate all lands that might contain any antiquity under the Land Acquisition Act of 1894 and place any antiquity including the land around it under protection. If it is a "protected immovable antiquity in danger of being destroyed, injured or fall into decay" the Provincial government shall expropriate the immovable antiquity including all land on which the antiquity is based, with the exception of religious sites and/or any antiquity that is managed by a custodian under the supervision of the Director General. No protected antiquity shall without the approval of the Director General be destroyed, broken, damaged, altered or otherwise harmed and no development scheme shall be implemented in a buffer zone of 200 feet around a protected immovable antiquity. This includes most activities expected during construction such as quarrying, excavating, blasting and movement of heavy vehicles. Any misconduct can result in imprisonment of up to 3 years. The act also rules that no excavation or exploration shall be conducted without a license and the consent of the owner of the land.

The Act also includes a list of all immovable antiquities under protection in the Bannu District: a) Akra (mounds at Akra near the village Bhart; b) Seri Khan Tarakai in the village Jani Khel Wazir; and, c) Ghundai near the village Bakka Khel Wazir.

2.2.4.6 Immovable Antiquities (Mining, quarrying and blasting in restricted areas) Rules 1979 (Notification SRO No 791 of 29th August 1979).

These rules further elaborate the provisions of Article 28 of the Antiquities Act and require the government to notify the public about any plans to protect any immovable antiquity in an area used for mining, quarrying and blasting amongst others 90 days before the final decision and consider in this the objections/suggestions made. It also provides for a process to conduct such work near immovable antiquities under the supervision of the Director General of Antiquities and Museums, if such work is amply justified.

2.2.4.7 Pakistan EPA EA Procedure Concerning Archaelogical Sites

The Antiquities Act of 1975 ensures the protection of cultural resources in Pakistan. The guideline procedure for Environment Assessment recommended by the Pakistan EPA reads as follows:
"If the proponent or the consultant identifies an archaeological site that appears to be of importance but the site is not listed they should discuss the site with the relevant conservation authority".
"The relevant conservation authority should inform the Responsible Authority of their assessment of the significance of the likely impact of the proposed development early in the process, in order for the Responsible Authority to determine the level of documentation required. The EPA will then be in a position to review the level of reporting required in the light of advice from the Archaeology Department". The Federal Department of Archaeology and Museum, Government of Pakistan is the sole custodian of all articles of archaeological finds and historical heritage.

2.2.4.8 Pakistan Penal Code, 1860

The Code deals with the offences where public or private property or human lives are affected due to intentional or accidental misconduct of an individual or organization. The Code also addresses control of noise, noxious emissions and disposal of effluents. Most of the environmental aspects of the Code have been superseded by the Pakistan Environmental Protection Act, 1997.

This Code of law will be applicable to the construction and O&M works to be carried out during the proposed project.

2.2.4.9 Pakistan Explosives Act, 1884

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

2.2.4.10 Telegraphy Act, 1910

The Act 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.

2.2.4.11 Factories Act, 1993 (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.

2.2.4.12 North West Frontier Province Protection of Trees and Brushwood 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.

2.2.4.13 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 Powerhouses and erecting electrical transmission lines.

2.2.4.14 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 requirements 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.

2.2.4.15 Labour Laws and Labour Policy 2010

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 project's construction contractors.

2.2.4.16 Employment of Child Act, 1977 and 1991

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 defines a child to mean a person who has not completed his/her fourteenth year of age. 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.

The project proponent, participating tribal heads, farmers and their contractors (for lining and construction of distributaries and watercourses) will be bound by the ECA to disallow any child labor at project sites or for project related activities.

2.2.4.17 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.

2.2.4.18 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 actions causing pollution to air, water or land.

2.2.4.19 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 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 items included in the Draft Resettlement Policy.

2.2.4.20 Other Laws in Brief

Following laws are also relevant for the legal framework and have been mentioned without giving detail:

- Hazara Forest Act 1936.
- Code of criminal Procedure 1898.
- The North West Frontier Province (NWFP) Forest Development Corporation Ordinance 1980
- The Provincial Administered Tribal Areas (Conservation and Exploitation of Certain Forests) Regulation 1980.
- The Forest (West Pakistan Amendment) Ordinance 1962.
- The West Pakistan Firewood and Charcoal (Restriction) Act 1964.
- The West Pakistan Fisheries Ordinance 1961 amended vide NWFP Fisheries (Amendment) Ordinance 1982.
- The NWFP Fisheries (Amendment) Act 1991.
- The NWFP Animal Contagious Diseases Act 1948.
- The West Pakistan Requisitioning of Immoveable Property (Temporary Powers) Act 1956.
- The West Pakistan Board of Revenue Act 1957.
- The West Pakistan Goats (Restriction) Ordinance 1959.
- The Sarhad Hydel Development Organization (Amendment) Act 1996.
- The NWFP Rivers Protection Ordinance 2001.

- The NWFP Power Crushers (Licensing) Ordinance 1980.
- The NWFP Forestry Commission Act.
- National Fund for Cultural Heritage 1994 (Act No 8 of 1994).
- Archaeological Excavation and Exploration Rules.
- Treasure Trove Act 1878 (Act No 6 of 1878 as modified in 1891.
- The Antiquities (Export Control) Act 1947 (Act 31 of 1947).
- Export of Antiquities Rules 1979.
- Dealing in Antiquities Rules 1989.
- Acquisition of Antiquities Rules 1989.
- Customs Act 1969 (Act No 4 of 1969 as modified in 1994).
- Prohibition for Movement of Antiquities between Specified Areas.

2.2.4.21 Water Rights in Irrigation Systems

There are two types of irrigation canals; (i) publicly owned canals which are developed and made by the government; (ii) civil or traditional canals, which are operational and under use by the people since centuries (in FATA as well as Khyber Pakhtunkhwa). According to the Canal Act of NWFP, all users of Public Canals must pay water fees, whereas no fee is levied by the government on civil canals. The water rights on civil canals are administered by tribes under their tribal system.

2.2.4.22 Gender and Inheritance Laws

In FATA, women are denied their basic rights in the name of either Pukhtunwali (Pukhtun Code of Conduct) or Islam or both, the right to property being the most important one of them. Landownership has been traditionally important not only as source of income, but is also a status symbol in settled and tribal areas. Owing to limited business, industry and employment opportunities in FATA, landownership has added significance in terms of status and power. In FATA, land revenue records are not documented. Individual land ownership in the tribe is oral but well known to succeeding generations. Ownership of shamilat (collective lands) is identified and acknowledged by the clans and tribes.

In tribal culture, a woman has no identity, except with a man. Tribesman does not allow a woman to own land independently or be known by the people on her own. Women are denied the right to inheritance, irrespective of the fact that Islam and Pakistani law recognize this right.

2.3 Relevant International Protocols and Agreements

The following paragraphs explain the international protocols and agreements relevant to the activities expected to be triggered during and after construction of the KTD Project. These have been selected taking into account the fact that the project site is located close to the border with Afghanistan.

2.3.1 Multilateral Environmental Agreements

Pakistan is signatory to several Multilateral Environmental Agreements (MEAs), as discussed below.

2.3.1.1 Basel Convention

Control of transboundary movements of hazardous wastes and their disposal, usually known as the Basel Convention, is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs). According to Section 14 (Handling of Hazardous Substances) of the Pakistan Environmental Protection Act - 1997 " no person shall generate, collect, consign, transport, treat, dispose of, 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."

2.3.1.2 Convention on Biological Diversity

The Convention on Biological Diversity started as a document drawn up by IUCN on the in situ conservation of biodiversity. The document was submitted to the UNEP Governing Council, which accepted the need for an international biodiversity convention and accepted responsibility for its drafting. The draft convention was broader than the IUCN document and covered conservation, wild species of commercial crops, and the transfer of technology, biotechnology and expertise to developing countries. Formal negotiations, involving representatives from 75 countries, started in November 1990 and a final version of the convention was signed in 1992 by 156 nations (including Pakistan) at the UN Conference on Environment and Development, the Earth Summit, in Rio de Janeiro. The convention aims to save animal and plant species from extinction and restore their habitats.

2.3.1.3 Convention on Wetlands (Ramsar)

World Wetlands Day marks the signing of the convention of wetlands on 2nd February 1997, in the Iranian city of Ramsar. The convention came into effect in 1975 and Pakistan became one its earliest signatories.

Wetlands of Pakistan include flood plain wetlands of major river systems and their extensive network of tributaries; saline and temporary wetlands of arid and semi-arid expanses inland; coastal system such as lagoons, backwaters and estuaries; mangrove swamps; marine wetlands; and coral associated with Astola Island in Balochistan.

The new identified sites provide sanctuary to 40 different species of migratory birds during the winter season. Besides providing habitat to the waterfowl, the wetlands also help in maintaining genetic and ecological biodiversity in the region.

2.3.1.4 Convention on International Trade in Endangered Species (CITES)

The Convention on International Trade in Endangered Species of Wild Fauna and Flora, in short the Washington Convention, is a legally binding international agreement dating from 1973 to protect endangered species of animals and plants. It is also known internationally as CITES Convention on International Trade in Endangered Species. Pakistan accessed the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) on 20th April 1976 that came into force on 19th July 1976 in the country. The National Council for Conservation of Wildlife (NCCW) is CITES Scientific and Management Authority in Pakistan.

2.3.1.5 UN Framework Convention on Climate Change

The Kyoto Protocol of the United Nations Framework Convention on Climate Change is a milestone towards global carbon mitigation efforts which resulted in the establishment of carbon markets. Pakistan ratified the Kyoto Protocol in 1997 and implemented it in 2005. It contributes towards carbon mitigation in the form of Clean Development Mechanism. This market based mechanism is instituted to facilitate the reduction of greenhouse gases through carbon trading.

2.3.1.6 Montreal Protocol

The Montreal Protocol on substances that deplete the Ozone Layer was signed in Montreal, Canada, in 1987. Pakistan signed and ratified the Protocol in 1992. The Ozone Cell was established under the Ministry of Environment in 1996 to oversee and ensure implementation of the Protocol. Pakistan is not an Ozone Depleting Substances (producing country but to meet its domestic needs imports a few substances (i.e. Chlorofluorocarbons, Carbon Tetrachloride, Hydrochlorofluorocarbons, Halon gas, Methyl Bromide etc).

2.3.1.7 UN Convention to Combat Desertification

The United Nations Convention to Combat Desertification is a Convention to combat desertification and mitigate the effects of drought through national action programs that

incorporate long-term strategies supported by international cooperation and partnership arrangements.

The Convention, the only convention stemming from a direct recommendation of the Rio Conference's Agenda 21, was adopted in Paris, France on 17 June 1994 and entered into force in December 1996. It is the first and only internationally legally binding framework set up to address the problem of desertification. The Convention is based on the principles of participation, partnership and decentralization, the backbone of Good Governance and Sustainable Development. It has 194 state Parties, making it truly global in reach. In 2013, Canada became the first country to announce its intention to withdraw from the convention.

2.3.1.8 Stockholm Convention on Persistent Organic Pollutants (POPs)

The Convention was adopted on 22 May 2001 at the Conference of Plenipotentiaries on the Stockholm Convention on Persistent Organic Pollutants, in Stockholm on 22-23 May 2001. In accordance with its article 24, the Convention was signed by all states and by regional economic integration organizations on 23 May 2001 at the Stockholm City Conference Centre/Folkets Hus, and at the United Nations Headquarters in New York from 24 May 2001 to 22 May 2002. Pakistan signed the convention on 6 December 2001 and ratified it on 17 April 2008.

2.3.1.9 Cartagena Protocol

This Protocol was adopted on 29 January 2000 by the Conference of the Parties to the Convention on Biological Diversity at the resumed session of its first extraordinary meeting held in Montreal from 24 to 29 January 2000. The Protocol was signed by states and by regional economic integration organizations in Nairobi at the United Nations Office from 15 to 26 May 2000, and at United Nations Headquarters in New York from 5 June 2000 to 4 June 2001, in accordance with its article 36. Pakistan signed the convention on 4 June 2001 and ratified it on 2 March 2009.

All the above MEAs impose requirements and restrictions of varying degrees upon the member countries, in order to meet the objectives of these agreements. However, the implementation mechanism for most of these MEAs is weak in Pakistan and an institutional setup is mostly nonexistent.

Table 2-2: Major International Environmental Treaties Ratified by Pakistan

Topic	Convention/Treaty	Year of	
		Treaty	Ratification by Pakistan
Indus Water Treaty	The Indus Water Treaty was 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	The United Nations Framework Convention on Climate Change has 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
	The 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 Union for	1997	2005

	reducing greenhouse gas emissions.		
	The 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	The 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
	The International Convention on Oil Pollution Preparedness, Response and Co-operation	1990	1995
	The Stockholm Convention on Persistent Organic Pollutants seeks to protect human health and the 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.	2001	2008
Biodiversity and the protection of plants and animals	The 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
	The Cartagena Protocol on Biosafety to the Convention on Biological Diversity addresses potential risks posed by living modified organisms resulting from modern biotechnology.	2000	2009
	The 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
	The 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
	The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	1973	1976
	The International Plant Protection Convention (1997	1951/	1954

	Revised Text) aims 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.	52	
	The Agreement for the Establishment of the Near East Plant Protection Organization, which promotes international co-operation with a view to implementing International Plant Protection Convention.	1993	2009
	The 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)
	The Convention on Wetlands of International Importance especially as Waterfowl Habitat and associated protocols and amendments aims to promote conservation and sustainable use of wetlands. The 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.	1971 (amended 1987)	1976 (amended 1994)
Cultural heritage	The 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

2.3.2 Pakistan Water Treaties

The EA should consider the water rights of riparians in the context of international water laws and treaties. (See also Section 2.5, OP 7.50.) Pakistan has a water treaty with India. Afghanistan has water treaties with Iran, Tajikistan, Uzbekistan, Turkmenistan and Kyrgyz. There is no water sharing agreement between Afghanistan and Pakistan, but there is an agreement dating from British times regarding demarcation of the border (Durand Line). The KTDP is close to the Durand Line.

2.4 USAID 22CFR 216

This EA is being prepared in accordance with 22 CFR 216, USAID's Environmental Procedures. These environmental procedures were prepared in accordance with sections 118(b) and 621 of the Foreign Assistance Act of 1961 to ensure that environmental factors and values are integrated into the USAID decision-making process. These procedures are consistent with Executive Order 12114, issued January 4, 1979, entitled Environmental Effects Abroad of Major Federal Actions, and the purposes of the National Environmental Policy Act of 1970. See Sections 1.2.4 and 1.2.5 for a brief discussion of scoping undertaken by MWH pursuant to Contract AID-391-C-13-00002. More detailed information on scoping is presented in Section 7.1.

An Initial Environmental Examination (IEE) was prepared for the KTDP in 2012 and a Threshold Decision made in accordance with 22 CFR 216.3, which resulted in the decision to require an EA in accordance with 22 CFR 216.2(d), which specifies the classes of actions that normally have a significant effect upon the environment. As a result of the decision to prepare an EA, the following provisions of 22CFR 216.6 are important to note:

- The purpose of an EA, according to 22CFR 216, is to provide USAID and host country decision-makers with a full discussion of significant environmental effects of a proposed action. It includes alternatives which would avoid or minimize adverse effects or enhance the quality of the environment so that the expected benefits of development objectives can be weighed against any adverse impacts upon the human environment or any irreversible or irretrievable commitment of resources.
- Collaboration in obtaining data, conducting analyses and considering alternatives is expected to enhance an awareness of development-associated environmental problems as well as assist in building institutional capability to deal nationally with such problems. USAID collaborates with affected countries in the development of an EA and consideration of the environmental consequences described in the EA.
- The Environmental Assessment is based upon the scoping statement. The Scoping Process conducted in early 2013 is referenced in Chapter 1. Additional information about consultation including the scoping and other consultations is provided in Chapter 7 and in Appendix 9.4.
- Consultation and review are required between USAID and the host government during preparation and on the results and significance of the EA, prior to USAID's authorization of the project. USAID_encourages the host government to make the EA available to the general public of the recipient country.
- In a situation where an analysis indicates that potential effects may extend beyond the national boundaries of a recipient country and adjacent foreign nations may be affected, USAID will urge the recipient country to consult with such countries in advance of project approval and to negotiate mutually acceptable accommodations.

In addition, USAID's Scope of Work requires preparation of these complementary studies:

- Resettlement Compensation and Land Acquisition Plan.
- Indigenous Peoples Plan (now called Vulnerable Peoples' Plan as discussed at 2.5).
- Cultural Heritage Preservation Plan.
- Instrumentation and Monitoring Plan (monitoring the Kurram Tangi dam hydro-meteorological, structural and seismic factors and data such as water quality, sedimentation, and downstream discharge).
- Emergency Preparedness Plan (consistent with World Bank Dam Safety Policy).

Moreover all pesticides must be checked against the Pakistan Pesticide Evaluation Report and Surface Use Action Plan (PERSUAP; Schroeder 2007, and 2013 Pakistan Programmatic Umbrella PERSUAP (PPERSUAP; Schroeder and Irshad, 2013) to determine restrictions on their use. The definition of pesticides in the PERSUAP and 2013 PPERSUAP is broad and includes: insecticides, miticideslaearicides, nematicides, molluscicides, fungicides, antimicrobials, bactericides, biocides, microbicides, antibiotics, herbicides, rodenticides, avicides, algicides, ovicides, disinfectants, sanitizers and anti-fouling agents. Even biological agents such as biopesticides, microbial pesticides, attractants/pheromones, repellents, defoliants, dessicants and insect growth regulators and plant growth regulators are included as pesticides.

USAID/Pakistan prohibits the procurement with USAID-provided funds of pesticides restricted by this PERSUAP. The Mission also prohibits the use of pesticides restricted by the PERSUAP and 2013 PPERSUAP in the implementation of USAID-funded activities. However, for activities outside the scope of USAID projects, the Mission does not, nor would it be possible to, restrict the procurement or use, or both, of any pesticide by recipients of USAID funds or participants in USAID-funded activities, so long as the funds used to procure such pesticides are not provided by USAID. For example, the Mission exercises no authority to restrict the use of pesticides on cotton crops by participants of a USAID-funded horticulture project, so long as the funds used to procure such pesticides are not provided by USAID.

2.5 Policies and Procedures of International Financing Institutions

The Scope of Work for the KTDP EA requires that international practices and the safeguard policies of potential international lenders, such as the World Bank and Asian Development Bank, be taken into account. The Scoping Document (April 2013) identified the relevance of various international requirements. The project team determined to use the World Bank policies as the yardstick for international practice, because there is variation among the World Bank, the Asian Development Bank and others, such as the International Finance Corporation (IFC).

2.5.1 World Bank Operational Policies

World Bank Operational Policies (OPs) considered relevant to the KTDP are discussed below.

2.5.1.1 Environmental Assessment (OP 4.01)

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:

- EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. 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. The Bank favors preventive measures over mitigatory or compensatory measures, whenever feasible.
- EA takes into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and transboundary and global environmental aspects (defined to include climate change, ozone-depleting substances, pollution of international waters, and adverse impacts on biodiversity). EA considers natural and social aspects in an integrated way. The Bank does not finance project activities that would contravene country obligations, as identified during the EA. EA is initiated as early as possible in project processing and is integrated closely with the economic, financial, institutional, social, and technical analyses of a proposed project.

The KTDP, given its size and complexity, is likely to have significant potential adverse environmental impacts that are sensitive, diverse, or unprecedented, which may affect an area broader than the sites or facilities subject to physical works. Thus, it meets the criteria for a Category A Project, as do most hydropower and irrigation projects dependent on large dams. For such projects that are highly risky or contentious or that involve serious and multidimensional environmental concerns, the Bank would normally require any Borrower to also engage an advisory panel of independent, internationally recognized environmental specialists to advise on all aspects of the project relevant to the EA. To meet Bank standards, this would likely need to be done.

The panel (which is different from the dam safety panel required under OP/BP 4.37, Safety of Dams) advises the borrower specifically on: (a) the terms of reference for the EA, (b) key issues and methods for preparing the EA, (c) recommendations and findings of the EA, (d) implementation of the EA's recommendations, and (e) development of environmental management capacity.

2.5.1.2 Natural Habitat (OP 4.04)

The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The Bank, therefore, supports the protection, maintenance, and rehabilitation of natural habitats and their functions. The Bank does not support projects that involve the significant conversion or degradation of critical natural habitat. In other (non-critical) natural habitats, the Bank does not support projects involving the significant conversion of natural habitats unless there are no feasible alternatives for the project and its siting,

and comprehensive analysis demonstrates that overall benefits from the project substantially outweigh the environmental costs. If the environmental assessment indicates that a project would significantly convert or degrade natural habitats, the project includes mitigation measures acceptable to the Bank. Such mitigation measures include, as appropriate, minimizing habitat loss (e.g., strategic habitat retention and post-development restoration) and establishing and maintaining an ecologically similar protected area.

2.5.1.3 Pest Management (OP 4.09)

This policy deals with the use of pesticides and provides guidelines related to Integrated Pest Management (IPM). Use of a pesticide is contingent on an assessment of associate risks (made in context of project's EA) taking into account proposed use and the intended users. The following criteria apply to the selection and use of pesticides: a) have negligible adverse health effects; b) effective against target species, c) minimal effect on non-target species and environment, d) takes into account need to prevent development of resistance in pests. The Bank does not finance formulated products that fall in WHO classes IA and IB, or formulations of products in Class II, if (a) the country lacks restrictions on their distribution and use; or (b) they are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly. The project will likely increase the need and opportunities for use of pest management, so this policy must be considered.

2.5.1.4 Indigenous People (OP 4.10)

For purposes of this policy, the term "Indigenous People" is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees.

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others.
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.
- Customary cultural, economic, social, or political institutions that are distinct from those of the dominant society and culture.
- An indigenous language, often different from the official language of the country or region.

In past World Bank projects in the FATA, this policy has not been triggered. Nevertheless, in recognition of the tribal status and the vulnerable situation of those affected, the project team has determined to prepare a Vulnerable Peoples' Plan.

2.5.1.5 Cultural Property (OP 4.11)

The World Bank's general policy regarding cultural properties is meant to assist in their protection and to avoid their elimination. The specific aspects of this Policy are given below:

- The Bank usually declines to finance projects that significantly damage non-replicable cultural property, and assists only those projects that are located or designed so as to prevent such damage.
- The Bank assists in the protection and enhancement of cultural properties encountered in Bank-financed projects, rather than leaving that protection to chance. In some cases, the project is best relocated in order that sites and structures can be preserved, studied, and restored intact in situ. In other cases, structures can be relocated, preserved, studied, and restored on alternate sites. Often, scientific study, selective salvage, and museum protection before destruction is all that are necessary. Mostly such projects should include the training and strengthening of institutions entrusted with safeguarding a nation's cultural patrimony. Such activities should be directly included in the scope of the project rather than being postponed for some possible future action, and the costs are to be internalized in computing overall project costs.

- Deviations from this policy may be justified only where expected project benefits are great, and the loss of or damage to cultural property is judged by competent authorities to be unavoidable, minor, or otherwise acceptable. Specific details on the justification should be discussed in project documents.
- This policy pertains to any project in which the Bank is involved, irrespective of whether the Bank is itself financing the part of the project that may affect a cultural property.

Religious shrines and other cultural resources are likely to be affected. Furthermore, in case of discovery of any cultural resources sites or artifacts during the project implementation, the work will be stopped at that site and the provisions for "late finds" will be followed. Additionally, the provincial and federal archeological departments will immediately be notified, and their advice sought before resumption of the construction activities on such sites.

2.5.1.6 Involuntary Resettlement (OP 4.12)

The WB's experience indicates that involuntary resettlement under development projects, if unmitigated, often gives rise to severe social, economic and environmental risks: production systems are dismantled; people face impoverishment when their productive assets or income sources are lost; people are relocated to environments where their productive skills may be less applicable and the competition for resources is greater; community institutions and social networks are weakened; kin groups are dispersed; and cultural identity, traditional authority, and the potential for mutual help are diminished or lost. This policy includes safeguards to address and mitigate these impoverishment risks.

The overall objectives of the Policy are given below:

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs.
- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to get share in the project benefits. Displaced persons should be meaningfully consulted and should have the opportunities to participate in planning and implementing resettlement programs.
- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, which one is higher.

In light of the scope of works at KTDP, land acquisition will be required and negative social impacts in the project areas are likely to occur.

2.5.1.7 Gender and Development OP 4.20

The objective of the Bank's gender and development policy is to assist member countries to reduce poverty and enhance economic growth, human well-being, and development effectiveness by addressing the gender disparities and inequalities that are barriers to development and by assisting member countries in formulating and implementing their gender and development goals. This is not a Bank "safeguard policy," so in that sense there is no formal determination of whether it is triggered. Nevertheless, given the situation in northwest Pakistan with regard to gender equality, it makes sense to consider gender in the development of the project.

2.5.1.8 Forestry (OP 4.36)

This operational policy deals with the health of forests and provides guidelines relating to the management of the forests and the welfare and rights of the people dependent upon forests. The objective of this Policy is to facilitate the potential of forests to reduce poverty in a sustainable manner, integrate forests effectively into sustainable economic development, and protect the vital local and global environmental services and values of forests. None of the project components

would be located inside forest; protection of the watershed, however, will require watershed management and this will indirectly entail management of forested areas.

2.5.1.9 Safety of Dams (OP 4.37)

The Policy seeks to ensure that appropriate measures are taken and sufficient resources provided for the safety of dams. This OP is highly relevant to the KTDP. OP 4.37 applies differently to small and large dams[26], small dams are normally less than 15 meters in height and large dams are 15 meters or more in height. Dams that are between 10 and 15 meters in height are treated as large dams if they present special design complexities, for example, an unusually large flood-handling requirement, location in a zone of high seismicity, foundations that are complex and difficult to prepare, or retention of toxic materials. Dams under 10 meters in height are treated as large dams if they are expected to become large dams during the operation of the facility. The policy has special provisions to deal with projects that rely upon existing dams.

For large dams, the Bank requires: a) reviews by an independent panel of experts (the Panel) of the investigation, design, and construction of the dam and the start of operations; b) preparation and implementation of detailed plans: a plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan, and an emergency preparedness plan; (c) prequalification of bidders during procurement and bid tendering, and d) periodic safety inspections of the dam after completion.

It will be critical, if WB support is sought, to ensure that a dam safety panel is put in place not only for the Kurram Tangi Dam and Weir III but also for the Kaitu Weir, as this will become a potentially existing dam related to the Kurram Tangi Dam, if a donor other than the WB funds the Kaitu Weir. The role and functions of the dam safety panel are provided in detail in the policy.

2.5.1.10 Projects on International Waterways (OP 7.50)

This OP defines the procedure to be followed for projects that the WB finances which are located on any water body that forms a boundary between, or flows through two or more states.

This policy applies to the projects related to; (a) hydroelectric, irrigation, flood control, navigation, drainage, water and sewerage, industrial, and similar projects that involve the use or potential pollution of international waterways including any river, canal, lake, or similar body of water that forms a boundary between, or any river or body of surface water that flows through, two or more states, and (b) detailed design and engineering studies of projects, including those to be carried out by the Bank as executing agency or in any other capacity.

Since the rivers associated with the project arise in Afghanistan and involve catchment areas within Afghanistan, this policy will apply. The Bank requires the beneficiary state, if it has not already done so, formally to notify the other riparians of the proposed project. If the prospective borrower indicates to the Bank that it does not wish to give notification, normally the Bank itself does so. If the borrower also objects to the Bank's doing so, the Bank discontinues processing of the project. The Bank ascertains whether the riparians have entered into agreements or arrangements or have established any institutional framework for the international waterway concerned. In the latter case, the Bank ascertains the scope of the institution's activities and functions and the status of its involvement in the proposed project, bearing in mind the possible need for notifying the institution. Following notification, if the other riparians raise objections to the proposed project, the Bank in appropriate cases may appoint one or more independent experts to examine the issues.

2.5.1.11 World Bank Access to Information (A1 Policy)

The World Bank Policy on Access to Information ("AI Policy") sets out the institution's policy on public access to information. The new World Bank Policy on Access to Information became effective

[26] The definition of "large dams" is based on the criteria used to compile the list of large dams in the World Register of Dams, published by the International Commission on Large Dams.

July 1, 2013. Certain documents are prepared or commissioned by a member country/borrower that are made available to the public as a condition for doing business with the Bank. The country/borrower provides such documents to the Bank with the understanding that the Bank will make them available to the public. For example, safeguards assessments and plans related to environment, resettlement and
indigenous peoples (see OP/BP 4.01, Environmental Assessments, OP/BP 4.10, Indigenous Peoples, and OP 4.12, Involuntary and OP/BP 4.12 Involuntary Resettlement).

2.5.1.12 Environmental Health and Safety Guidelines

The International Finance Corporation's (IFC) Environmental Health and Safety (EHS) were developed in 2007. They are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). They provide guidance for projects in defining target performance levels for atmospheric emissions and ambient air quality, energy conservation, waste and ambient water quality, water conservation, hazardous materials management, waste management, ambient noise, and contaminated land. The EHS Guidelines (2007) include performance levels that can generally be achieved in new facilities using reasonable-cost available control technologies.

In applying the General EHS Guidelines to projects, due consideration should always be given to the hazards and risks associated with the project, the host country requirements, and site-specific environmental and social conditions. When host country requirements are less stringent than the guidance contained in the General EHS Guidelines, the IFC levels should be used, providing they are applicable to the site-specific project conditions.

2.5.2 Asian Development Bank Environmental and Social Assessment Guidelines

The Asian Development Bank (ADB) safeguard policy framework (2009) consists of three Safeguard Policy Statements: Environment, Involuntary Resettlement; and Indigenous Peoples). These are accompanied by sections in an Operations Manual. All three safeguard policies involve a structured process of impact assessment, planning, and mitigation to address the adverse effects of projects throughout the project cycle, similar to that of the World Bank The safeguard policies require that (i) impacts are identified and assessed early in the project cycle; (ii) plans to avoid, minimize, mitigate, or compensate for the potential adverse impacts are developed and implemented; and (iii) affected persons are informed and consulted during project preparation and implementation.

2.5.2.1 Environment

This safeguard policy lays down the procedures and guidelines for conducting EIA of the projects including the aspects to be considered in EIA, environmental planning and management, habitats, health and safety, public consultation and information disclosure procedures. It also provides environmental screening guidelines for classifying the projects into various categories. Similar to OP 4.01 of the World Bank, project alternatives analysis and an EMP are required.

2.5.2.2 Involuntary Resettlement

This policy spells out the ADB requirements when involuntary resettlement is triggered (when full/partial or permanent or temporary physical displacement is occurred). Full compensation, assistance and benefits for the displaced persons should be considered in the project planning and design. It is similar to that of the World Bank.

2.5.2.3 Indigenous Peoples

This policy contributes to the Bank's mission of poverty reduction and sustainable development by ensuring that the development process fully respects the dignity, human rights, economies, and cultures of Indigenous Peoples. For all projects that are proposed for Bank financing and affect Indigenous Peoples the Bank requires the borrower to engage in a process of free, prior, and informed consultation. Such Bank-financed projects include measures to (a) avoid potentially adverse

effects on the Indigenous Peoples' communities; or (b) when avoidance is not feasible, minimize, mitigate, or compensate for such effects.

In previous projects in the FATA, the ADB has determined that the peoples are indigenous. This is a different practice from that of the World Bank in previous projects.

Different from the Indigenous People's Policy of the World Bank, the ADB requires the consent of affected Indigenous Peoples communities to the following project activities: (i) commercial development of the cultural resources and knowledge of Indigenous Peoples; (ii) physical displacement from traditional or customary lands; and (iii) commercial development of natural resources within customary lands under use that would impact the livelihoods or the cultural, ceremonial, or spiritual uses that define the identity and community of Indigenous Peoples. The consent of affected Indigenous Peoples communities refers to a collective expression by the affected Indigenous Peoples communities, through individuals and/or their recognized representatives, of broad community support for such project activities.

3 PROJECT DESCRIPTION

3.1 Purpose and Need

The KTDP will provide both power and irrigation benefits by developing the Kurram and Kaitu River systems. The KTDP will affect populations in five districts/areas in Northwest Pakistan:

- North Waziristan.
- Frontier Region Bannu (F.R. Bannu).
- Bannu District.
- Karak District.
- Lakki Marwat District.

The first two districts are located in the Federally Administered Tribal Area (FATA);, the last three are in settled areas of the Khyber Pakhtunkhwa Province (KP). In terms of the KTDP program, Components 1 and 2 (with the exception of minor parts of the access roads and transmission line) lie in the FATA, while, Component 3 (plus minor parts of the access roads and the transmission line of Component 1) are located in the Bannu, Karak and Lakki Marwat Districts. These five Districts have a total population of around two million people.

The project will bring much needed economic development and will create job opportunities in the region. Pre-requisites to reducing poverty and developing sustainable commercial and industrial activities are a reliable water supply and electricity. The project has been studied for many years and enjoys full support from various FATA, KP and Federal Government agencies, including WAPDA, the lead agency responsible for its construction and operation.

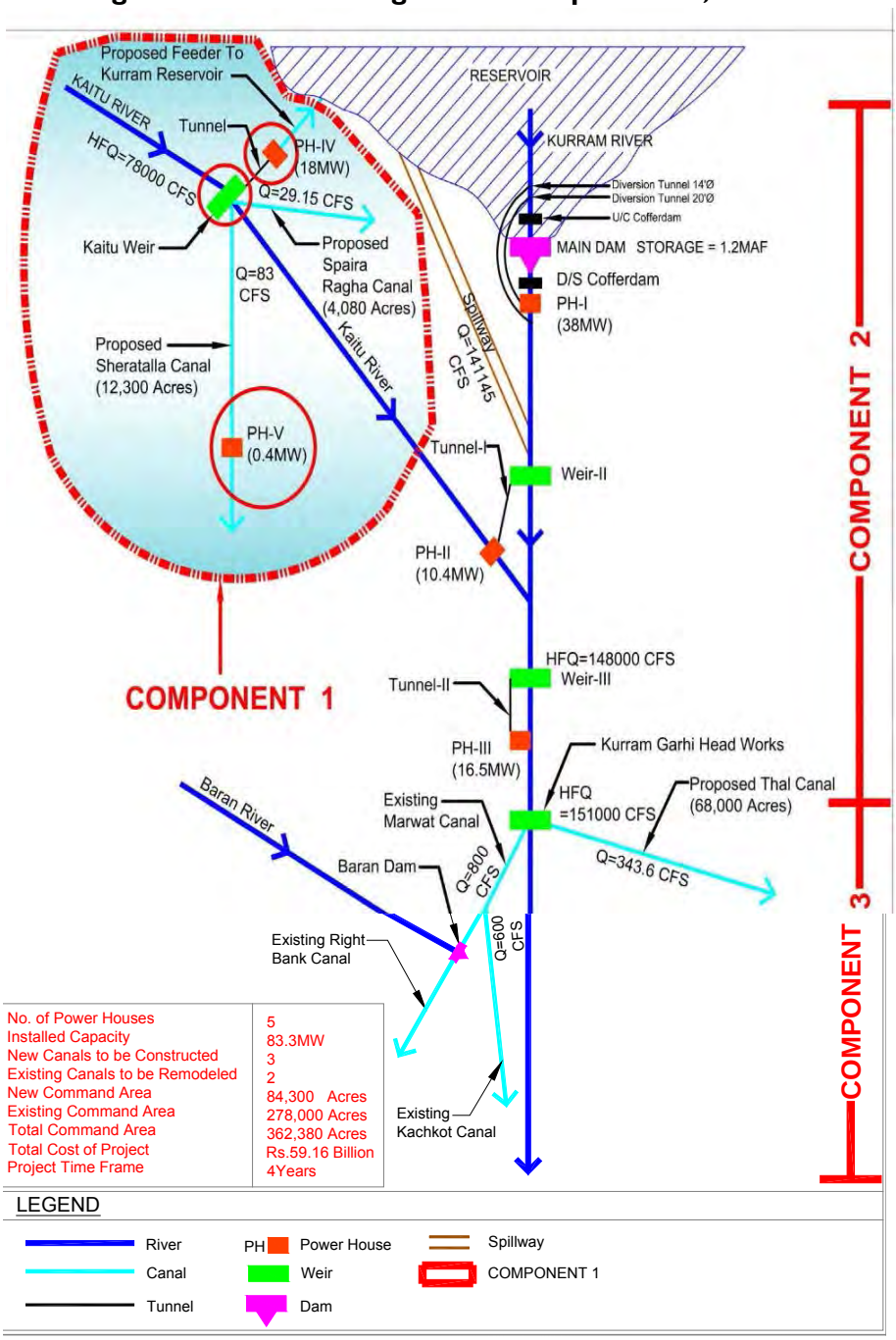
The catchment areas spread across the international border between Pakistan and Afghanistan. Maps 1-1 and 1-2 show the location map of the project and its layout. Map 3-1 shows the entire Project Area of Influence and Maps 3-2 through 3-4 show the catchment areas of the Kaitu and Kurram Rivers. Figure 3-1 below presents an overall diagram of the various Project Components.

The project description presented in this chapter is based on the material presented in the Tender Documents (PES *et al*., 2011b) and the 2004 feasibility study (KTDC, 2004). Alternatives analyzed in prior studies are presented in Chapter 6, along with additional alternative options that were developed as part of the technical due diligence review performed under the current assignment. For ease of planning and execution, WAPDA divided the project into three major components, described briefly below (and in more detail in the sections that follow).

- Component 1 comprises the Kaitu Weir and associated structures, the irrigation command areas on the Sheratalla and Spaira Ragha plains, as well as two powerhouses (IV and V) and a transmission line from Powerhouse IV to the Domail substation near Bannu.
- Component 2 comprises the Kurram Tangi reservoir and dam, a saddle dam on the southeast arm of the reservoir, three powerhouses (I, II and III) with transmission interconnections to the main transmission line built in Component 1.
- Component 3 comprises remodeling of the existing Kurram Garhi Headworks, the construction of the new Thal Canal and its command area, and the rehabilitation and upgrade of the existing Marwat and Civil Canals and their command areas.

It is anticipated that Component 1 will be constructed first, beginning in 2014. Components 2 and 3 will follow as soon as additional funding becomes available.

Figure 3-1: Overall Diagram of Components 1, 2 and 3



3.2 Component 1: Kaitu Weir, Power and Irrigation

Component 1 involves construction of the Kaitu Weir, Sheratalla Canal System, Spaira Ragha Canal System, the feeder tunnel, pump stations, Powerhouse IV, Powerhouse V and other ancillary works such as roads and transmission lines. The tertiary canals and the development of the Command areas will be done by the Irrigation Department. A transmission network will be developed and constructed by other entities operating in the project area. The key features of Component 1 are shown in Maps 3-5 through 3-10.

3.2.1 Kaitu Weir

A weir will be constructed in the Kaitu River about 400 feet upstream of the Mir Ali -Thal Road Bridge, or about 17.5 miles upstream of the confluence of the Kaitu and Kurram Rivers. The weir forms a pool (Kaitu Pool) that facilitates the diversion of water (1) to irrigation canals on the right bank and (2) to the Kurram Tangi Reservoir via Powerhouse IV.. The main characteristics as of the Kaitu weir are shown in Table 3-1 below.

Table 3-1: Kaitu Weir Characteristics

Crest Elevation	2,353 ft msl
Crest Length	302 ft
Height above river bed	18 ft
Water Pool Surface Area	45.2 acres
Length of Pool	0.5 mi
Design Flood	78,000 cfs
Stilling Basin Length	80 ft

The Kaitu Weir, and all other structures within Component 1 are classified as non-critical structures, based on the ICOLD (2002) definition of critical and non-critical structures. Detailed seismotectonic studies for the dam site were carried out and are detailed in the Feasibility Report (KTDC, 2004). The studies included acquisition of satellite imagery, its interpretation and identification of tectonic structures, site studies, and calculation of design ground acceleration. A 475-year return period earthquake and operating basis earthquake have been recommended as the design criteria in the feasibility report. The seismic design criteria were further reviewed as part of the EA studies; the results are presented in Section 4.2.2.5 and Chapter 6 and the detailed Seismic Analysis Supplemental Report.

3.2.2 Sheratalla and Spaira Ragha Irrigation Canals

From the Kaitu Reservoir, there will be two separate off-takes: one each for the Sheratalla and Spaira Ragha iIrrigation canals as summarized in Table 3-2. The proposed Sheratalla Canal will irrigate a Command Area of 12,300 acres, while the proposed Spaira Ragha Canal will irrigate 4,080 acres.

Table 3-2: Characteristics of Sheratalla and Spaira Ragha Irrigation Canals

	Sheratalla Canal	**Spaira Ragha Canal**
Off-take Point	Right Bank	Left Bank
Irrigated Command Area	12,300 acres	4,080 acres
Design Discharge	83 cfs	29 cfs
Total Canal Length	16 miles	8 miles

(Main/Minor/Distributary)		
Main Canal Bottom Width	4.5 ft (typ.)	4 ft (typ.)
Main Canal Right of Way including Longitudinal Drain	47 ft (typ.)	43 ft (typ.)

The proposed Spaira Ragha Canal System, located on the left bank of the Kaitu River, will comprise concrete lined gravity and lift channels provided with regulating structures, cross drainage structures, bridges, culverts, escape structures and outlets, summarized in Table 3-3. This canal system divides into two canals, one of which will have a 55-foot lift and a pumping station capable of lifting 10 cfs, located at RD 10+780. The pumping station will use electricity produced from Powerhouse V to feed water to the lift minor of the Spaira Ragha Canal. The pumping station will comprise a pump house, five electric pumping sets and ancillary electrical and mechanical works.

Table 3-3: List of Key Structures on the Spaira Ragha Canal System

Structures	Quantity
Catch Water Drains	50
Head Regulator / Cross Regulator at RD 37+330 of Main Canal	1 (for Minor 1)
Bridges and Culverts	10
Cross Drainage Structures	20 Culverts and 6 Syphons
Escape Structure at RD 7+626 of Main Canal	1
Fall	1on Minor 1 at RD 1+000
Tail Clusters	3
Outlets	7
Pump House at RD 10+780 of Main Canal for Lift Minor	1

The proposed Sheratalla Canal System on right bank will comprise eight distributaries, seven minors and sub-minors, regulating structures including head regulators, cross drainage structures, bridges, escape structures and outlets, as shown in Table 3-4.

Table 3-4: List of Key Structures on the Sheratalla Canal System

Structures	Quantity
Catch Water Drains	534
Head Regulator / Cross Regulator	15
Bridges and Culverts	AR Bridges - 4 and VR Bridges - 3
Cross Drainage Structures	48 Culverts, 7 Syphons and 6 Super Passages
Escape Structure at RD 7+626 of Main Canal	1
Falls	114
Outlets and Tail Clusters	47

The canals will have differing sizes at various segments but will have a trapezoidal shape and concrete lining throughout. The construction of the primary and secondary canals will be done by WAPDA while the tertiary canals will be constructed by the Irrigation Department.

3.2.3 Powerhouse IV

There will be a third off-take from the Kaitu Reservoir to provide water for a powerhouse located in the Kurram River watershed as shown in Map 3-8. A sediment excluder is provided at the beginning of the waterway. This 60-ft wide and 120-ft long concrete structure allows the suspended sediment to settle out before entering the feeder channel. Water then travels through a 950-ft long

feeder channel leading to a 14-ft diameter feeder tunnel excavated under the high mountain located in the left bank of the Kaitu River. The 6,100-ft long tunnel is followed by a 15,000-ft long headrace channel and a 900-ft steel penstock culminating in Powerhouse IV. A short tailrace channel will discharge water from the powerhouse to the Kurram Tangi Reservoir.

Thus, Powerhouse IV and associated waterways divert Kaitu River flow in excess of irrigation requirements at the Spaira Ragha and Sheratalla systems and the downstream minimum release for storage in Kurram Tangi Dam and generate a maximum of 18 MW of hydropower. The main characteristics of the sediment excluder, waterways and powerhouse are shown in Table 3-5 below.

Table 3-5: Powerhouse IV Characteristics

Sediment Excluder	122 ft x 60 ft
Feeder Channel	950 ft
Tunnel	6100 ft long, 14 ft diameter
Head Race Channel	15,000 ft
Penstock	900 ft long,
Number of Units	2
Length and width	141 ft by 105 ft
Total Installed Capacity	18 MW
Turbine Type	Vertical Francis
Design Discharge	635 cfs
Normal Tailwater Elevation	2,125 ft
Switchyard Size	160 ft x 360 ft
Length of Transmission Line	11 miles @ 132 kV

The proposed generator rated voltage for Powerhouse IV is 11 kV. Segregated phase bus ducts are proposed for connecting the generators to their respective 11/132-kV step-up transformers, and the high voltage side of the step-up transformers is connected to 132-kV conventional outdoor switchyard. A state-of-the-art computer based control system will be provided in the powerhouse control room. A new 30-mile long 132-kV transmission line will connect the Powerhouse IV switchyard to the existing substation at Domail, as shown in Map 3-10.

3.2.4 Powerhouse V

A small powerhouse will be constructed along the Sheratalla Canal (shown on Map 3-9) as an energy recovery project. Water will be conveyed to the surface-type powerhouse via a waterways system consisting of a feeder tunnel, headrace channel and two parallel penstocks. The main characteristics of this powerhouse are shown in Table 3-6.

Table 3-6: Powerhouse V Characteristics	
Design Discharge	50 cfs
Gross Head	112 ft
Installed Capacity	0.4 MW
Number of Units	2
Turbine Type	Horizontal Shaft Cross Flow
Length of Feeder Tunnel	1,300 ft, 7 ft diameter (horse-shoe shape)
Length of Headrace Channel	125 ft
Length of Steel Penstocks	2 x 850 ft long, 2 ft diameter
Length of Tailrace Channel	525 ft
Length of Transmission Line Powerhouse V to Kaitu Weir Kaitu Weir to Spaira Ragha Canal Pumping Station	 24,175 ft @ 11kV 4,100 ft @ 11kV

The proposed generator rated voltage for Powerhouse V is 400 V. Segregated phase bus ducts are proposed for connecting the generators to their respective 400V/11-kV step-up transformers, and the high voltage side of the step-up transformers is connected to an 11-kV conventional outdoor switchyard. A new 11-kV transmission line will connect the Powerhouse V switchyard to the Spaira Ragha Canal Pumping Station at via Kaitu Weir. The transmission line will have poles every 200 ft.

3.2.5 Construction Phase

3.2.5.1 Land Acquisition

WAPDA shall complete the land acquisition prior to the start of construction. The footprint – overall and by affected land type – is shown in Table 3-7 below. Most of the land is dedicated for the establishment of the various CCAs. More details on land acquisition and the associated potential socioeconomic impacts can be found in the Resettlement Policy Framework for the entire project and the Resettlement Action Plan for Component 1.

Table 3-7: Affected Land and Land Use for Component 1

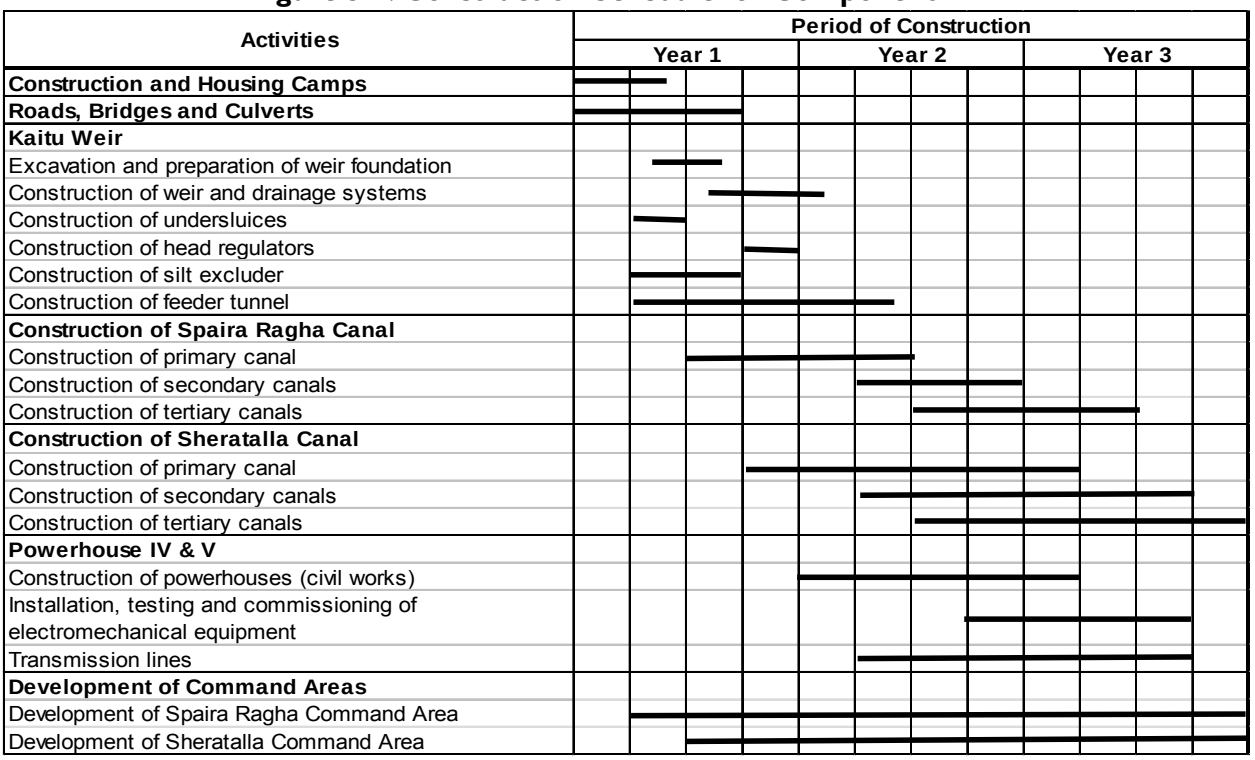
Component	Package	Affected land and land use (acres)				
		Total	Agricultural	Residential	Water	Worsho
1.1	Kaitu weir with other permanent facilities	3.5	0.0	0.0	3.2	0.3
1.1	Kaitu reservoir	45.2	16.5	0.0	27.2	1.6
1.1	Kaitu weir construction camp, quarry etc. (temporary facility)	10.0	2.0	0.0	0.0	8.0
	Kaitu Weir, reservoir, camps, quarries etc.	58.7	18.5	0.0	30.3	9.9
1.2	15 km of new road from Spinwam to Spaira Ragha	129.0	12.3	1.2	2.7	112.7
1.2	Access road to Powerhouse IV	1.1	0.5	0.0	0.0	0.5
1.2	Mains and secondary canals of the Spaira Ragha Plains	78.7	33.6	0.1	0.5	44.4

1.2	Mains and secondary canals of the Sheratalla Plains	319.2	79.5	2.5	8.3	229.0
1.2	Access road to Powerhouse 5	2.3	0.0	0.0	0.0	2.3
1.2	Powerhouse IV at the Kurram + Transfer canal and tunnel	24.0	0.0	1.0	0.5	22.3
1.2	Pumphouse for lift canal, housing, support staff and security staff.	0.6	0.6	0.0	0.0	0.0
1.2	Powerhouse V and pumping station	0.1	0.0	0.0	0.0	0.1
	Canals, roads, powerhouses, tunnel etc.	554.9	126.6	4.8	12.0	411.4
1.3	Transmission lines from Powerhouse IV to Bannu to the existing grid near Bannu	302.4	67.8	3.3	28.0	203.3
1.3	Transmission line from grid to pumphouse for lift canal	4.8	0.5	0.2	0.0	4.1
1.3	Transmission lines from Powerhouse V	28.4	5.7	0.0	0.0	22.7
	Transmission lines	335.6	74.0	3.6	28.0	230.1
1.4	Overall area of CCA in the Spaira Ragha plains	4,302	2,668	4	42	1,588
1.4	Overall area of the CCA in the Sheratalla Plains	18,427	5,983	309	573	11,561
	CCA	22,729	8,651	313	616	13,149
	Component 1 Total	**23,679**	**8,870**	**321**	**686**	**13,801**

3.2.5.2 Construction Schedule

Figure 3-2 below shows the proposed schedule to build the key features of Component 1.

Figure 3-2: Construction Schedule for Component 1



3.2.5.3 Access Roads

The Mir Ali-Thal road and the bridges along the road will be upgraded to hande the design loads required for the heaviest piece of equipment used in the Project. The Spinwam Bridge, especially, will be inspected for soundness. If its design loading is found to be insufficient to carry heavy-load construction vehicles, the existing ford downstream could be modified with the addition of a concrete slab crossing.

The Bannu-Thal road will be used as a main access road to link with the Mir Ali-Thal road and to provide transportation from Bannu to all the proposed facilities within Component I. Prior to the start of construction, the construction contractor will further assess and upgrade (as needed) the Bannu-Thal road and bridges along the road to make them suitable for handling the design loads required for the heaviest piece of equipment used in the Project.

3.2.5.4 Construction Techniques

Kaitu Weir. The weir is to be constructed of roller-compacted concrete (RCC). A cofferdam will be constructed to isolate the right half of the channel, allowing the construction of the undersluice portion of the weir. When that portion is complete, the cofferdam will be removed and placed in the left half of the channel, diverting the water through the undersluice section. The remaining portion of the weir will then be constructed, including the head regulators and the offtake for the diversion tunnel. The entire construction is expected to require 13 months.

Powerhouses IV and V. Construction of both powerhouses and the installation of electro-mechanical equipment is expected to be completed in two years. Construction of the diversion tunnel for both powerhouses is expected to be by conventional excavation.

Sheratalla Canal System. The construction of the Sheratalla Canal system is scheduled to start about three months after the beginning of the construction of Kaitu Weir and will last for about 21 months. The canal bed will be excavated by backhoe and graded to the specified slope. A gravel foundation will be laid down and concrete poured and smoothed to the specified contours.

Spaira Ragha Canal System. The construction process for the Spaira Ragha Canal System is essentially identical to that for the Sheratalla system, except that the duration of construction is expected to be a few months shorter. The pump house and accessory structures will require a building construction crew of about fifty workers.

3.2.5.5 Construction Camps

Since Component 1 is now scheduled to be constructed first, independent of the other two components, the location of the construction camp facilities specific to Component 1 has yet to be defined. The existing Tender Documents (PES *et* al., 2011b) require the construction contractor to decide on the most appropriate locations.

WAPDA recently mentioned the possibility of using an old army base located on the left bank of the Kaitu River, upstream of the proposed Kaitu Weir site. This base could be used as the Headquarters for the construction contractor but it will most likely not be large enough for a full construction camp.

For both canals, it is can be assumed that the construction crews will live in tents along the right-of-way, and will be provided with food, water, fuel and other amenities at the central camp near the Weir. For the tunnel, powerhouse, and ancillary structures of Powerhouses IV and V, site accommodations for construction crews of about 100 workers and supervisors will be required.

3.2.5.6 Labor Force

The labor force for the Weir construction is expected to be about 400. Among this number about six percent will be management and supervisory staff, 20 percent skilled workers (electricians, plumbers, machinists, mechanics, etc.), 40 percent semi-skilled workers (drivers, cement layers, excavators), and the remaining 30 percent unskilled laborers and support staff (cooks, gardeners, nonmilitary guards, domestic staff).

3.2.5.7 Construction Material

Table 3-8 lists the quantities of the major construction material needed during the construction of Component 1. Crushing and screening plant will have to be established to produce coarse and fine aggregates required for concrete works. Batching plants will have to be established at each of the sub projects within Component 1. Reinforcement steel and cement will have to be procured from sources identified prior to the start of the construction. The construction material will come from outside Component 1 but some may be provided from Bannu.

Table 3-8: Construction Material Quantities for Component 1

Excavation	53 million ft^3
Filling	176 million ft^3
Concrete	6.5 million ft^3
Steel Reinforcement	7.3 million lbs
Cement	900,000 bags

3.2.5.8 Other Construction Aspects

The energy source for the camp has yet to be determined, but probably will consist of a diesel or petrol generator, since local electricity supplies are insufficient to support the additional demand.

3.2.6 Operation Phase

The Kaitu Weir will be operated to provide water to the Sheratalla and Spaira Ragha canals, after the release of enough flow to ensure the ecological conditions of the downstream channel and the irrigation and domestic water needs of the Datta Khel population complex. The combined design release to the two canals will be 116.5 cfs. Additional incoming flows above these amounts, up to 1,200 cfs, will be discharged through the diversion tunnel and powerhouse IV to the Kurram River.

No information is yet available on the operation of the new Sheratalla and Spaira Ragha canals and the organization of Command Areas and potentially the creation of Water Users Associations.

3.3 Component 2: Kurram Tangi Dam and Related Structures

The basic purpose of the proposed Kurram Tangi Dam is the storage of water for irrigation and power generation. At present, up to 50 percent of the flows from the Kurram River are underutilized, as there is a lack of storage capacity within the river basin. By constructing the proposed Kurram Tangi Dam, flows from the Kurram River will be regulated through the dam and reservoir and water will be released according to the irrigation requirements and downstream user demands, while the excess water will be stored for use during low flow periods. The Kurram Tangi Dam will also store excess water from the Kaitu River basin that will be diverted via a diversion tunnel. A main powerhouse, with an installed capacity of 38 MW, is proposed at the foot of dam, and two additional powerhouses with capacities of 10.4 and 16.5 MW are proposed between the Kurram Tangi Dam and Kurram Garhi Headworks.

The principal features of this component will be a Concrete Faced Rockfill Dam (CFRD) and a large reservoir as shown on Map 3-11 and described in Table 3-9 and Table 3-10.

3.3.1 Main Dam

A CFRD was selected as the preferred dam type for the main dam. A CFRD, as the name suggests, is a rockfill (or an earth/rockfill) dam with a concrete face slab over the upstream slope. The face slab is between 0.25 and 0.6 m thick, with vertical and horizontal joints to accommodate deformation which occurs during construction and when the water load is applied. The face slab is joined with a reinforced concrete plinth beam / toe slab cast on sound, low permeability rock. The toe slab provides foundation support to the concrete face slab and also controls seepage through the foundation. The concrete face acts as the main impervious barrier for this dam type, whereas the main body of the dam, made of rockfill zones, provides the required overall stability. Outer slopes for upstream and downstream are defined as 1.5H:1V to suit the available rockfill material. Instrumentation is provided within and on the dam to measure vertical and horizontal movement of dam. The main features of the Kurram Tangi Dam are given in Table 3-9.

Table 3-9: Kurram Tangi Dam Characteristics

Type	CFRD
Crest Elevation	2,142 ft msl
Riverbed Elevation	1,820 ft msl
Crest Width	45 ft
Maximum Height above Riverbed	322 ft
Crest Length	1,035 ft
Slope – Upstream Face (H:V)	1.5H:1V

Slope – Downstream Face (H:V)	1.5H:1V

As shown above, the dam will have a height of 322 ft above river bed. It is therefore classified as a large dam under ICOLD definitions. Its final design will meet all ICOLD standards for safety and reliability.

3.3.2 Main Dam Roadways

Improvements to existing roads and construction of new roads will be required for construction of the main dam to allow for heavy vehicles and increased traffic during the construction phase. The roadway from Bannu to Mir Ali to Spinwam will require improvements. The distance along existing road from Bannu to Mir Ali is 21 miles and from Mir Ali to Spinwam is 28 miles. The carriageway from Bannu to Mir Ali to Spinwam is 20 ft wide paved track with shoulders of 5 ft on each side. The total width of the carriageway is 30 ft. Generally the condition of the bridges and the road is not in good condition. Most of the bridges are designed for 12 ton loading, which meets the requirement. However, improvement of the existing road is needed in some reaches.

The construction of a new access road from Spinwam to the main dam will be needed. This new proposed road will take off from the Mir Ali-Thal Road at Spinwam near Kaitu River Bridge and follow the route along the proposed Spaira Ragha irrigation canal and subsequently the periphery of the reservoir. It will be 9 miles in length, of which about 4 miles will be in the Spaira Ragha Plain without involving rock excavation and 5 miles will require rock excavation. It does not involve any bridge construction. The elevation varies from 2,115 to 2,345 ft. The proposed road width is 30 ft with 20 ft paved and 5 ft shoulders on either side. The maximum gradient will be less than 10 percent.

3.3.3 Kurram Tangi Reservoir

The proposed Kurram Tangi Reservoir will be used mainly to meet irrigation needs of the existing Civil Canals, Marwat Canal and the new Command area in Thal Plain. Water from the reservoir will also be used to generate electrical power and released back to the Kurram River. These releases will reach Kurram Garhi Headworks, at River Mile 56, after passing through the main powerhouse (Powerhouse I) and the two powerhouses located in between the Kurram Tangi Dam and Kurram Garhi Headworks (Powerhouses II and III). At the Kurram Garhi Headworks water will be diverted to the respective canals as per their requirements and quotas. The reservoir characteristics are summarized in Table 3-10.

Table 3-10: Kurram Tangi Reservoir Characteristics

Catchment Area	2,464 sq. mile
Full Reservoir Level	2,127 ft msl
Full Reservoir Capacity	1.2 million acre feet (MAF)
Live storage	0.900 MAF
Dead storage	0.300 MAF
Gross storage	1.208 MAF
Reservoir Length	8 miles
Average Reservoir Depth	117 ft
Reservoir Area of Kurram Tangi Dam	10,939 acres
Average Annual Inflow at Dam Site	908,000 acre-feet
Filling of dead storage	125 years
Filling of 50% of live storage	Further 50 years

Filling of the reservoir will submerge part of the existing road from the Mir Ali-Thal Road near Shewa Post; therefore the construction of a new roadway will be required. The length of the new road will be 6 miles with a 30 ft carriage way and a 20 ft paved surface, and will involve the construction of two bridges.

3.3.4 Kurram Tangi Spillway

The spillway is proposed to be located on the right bank of the Kurram River at River Mile 67. The main features of the spillway were established during the feasibility study. The spillway and its various components include piers, a bridge, guide walls, chute, and stilling basin. The spillway and its various components were designed to safely pass the Probable Maximum Flood (PMF). The spillway capacity at Kurram Tangi Dam is being fixed so that the flood surcharge due to the PMF including wave-run-up would be lower than the top of the dam. The spillway is capable of passing the PMF, with normal flood surcharge 5.8 ft above normal reservoir level. A gated spillway with a discharge capacity of 141,145 cfs is provided. The spillway will be operated to maintain the reservoir level at El. 2,127 ft msl. The spillway is 200 ft wide, having four bays, and the energy will be dissipated through a 300 ft long by 200 ft wide spillway with chute blocks.

Table 3-11: Kurram Tangi Spillway Characteristics

Number, Size of Radial Gates	Four Gates 44.75 ft x 40ft
Width	200 ft
Crest Elevation	2,097 ft msl
Discharge Capacity at Full Reservoir Level	141,145 cfs
Peak flows (PMF)	187,000 cfs
Surcharge Level during PMF	2,133 ft msl
Invert Elevation of Stilling Basin	1780 ft msl
Size of Stilling Basin	200 x 300 ft
Tailrace Channel Invert Elevation	1810 ft msl

3.3.5 Diversion Tunnels

Two diversion tunnels, one of 20 ft diameter and the other of 14 ft diameter, will be constructed on the right bank of the Kurram River between the dam and the spillway. The 20 ft diameter tunnel will be used later as power tunnel for the main powerhouse, located at the foot of dam. The length of the power tunnel, including the intake portal, is 1,013 ft and it has a slope of 0.005. The tunnel has a maximum discharge capacity of 24,500 cfs with a flow velocity of 78 ft/sec. The power tunnel will be provided with a Y branch to accommodate the penstock that will lead to Powerhouse 1. The 20-ft-diameter power tunnel will have a trash rack and stop log rack provided at the intake. The length of the trash rack and stop logs will be extended above the dead storage level of 2001.6 ft. A grouted riprap stilling basin (USBR Type II stilling basin) will be provided to dissipate the velocity head of outflow as it leaves the pipe.

The 14-ft-diameter tunnel will be used as a low-level outlet for providing irrigation water during the initial few years after construction of dam, as during these years, the river flows may be just close to irrigation requirements. Following this period, the 14-ft-diameter tunnel will be plugged with a bulk head gate. In addition, this tunnel would be used for flushing of sediments.

3.3.6 Weirs II and III

As shown in Map 3-11, there will be two weirs along the Kurram River downstream of the Kurram Tangi dam to create small reservoirs for power generation. Weir II will be located approximately 8,000 ft downstream of the main dam at River Mile 65.5, used to divert water to Powerhouse II, and will be 418 ft long and 20 ft high. For control of seepage and uplift pressures, a slurry trench cutoff tied to the bedrock has been provided under the structure. Additionally relief wells at 25 ft spacing have also been provided through a 5 x 7 ft gallery located in the structure. Weir II has been designed as standard ogee shape with crest at El. 1808 ft. Undersluices with a channel width of 30 ft with sluice gates have been provided on right bank. The floor level has been kept 2 ft above the river bed level. The flow in tunnel will be diverted by sluice gates through a 20ft x 2 ft rectangular orifice.

Weir III will also be located along Kurram River, about 30,000 ft downstream of the main dam at River Mile 61. Weir III will be 1,190 ft long and 75 ft high. Weir III will be a Roller Compacted Concrete (RCC) structure with a maximum height of 75 ft above the river bed level. The downstream face of the weir has been provided with a cascade type of chute for dissipation of energy. The chute will terminate in a stilling basin 62.0 ft long. Two low level conduits of 12.0 ft diameter, which will initially be used for river diversion, have been provided in the weir for the sluicing of sediments. These conduits will have vertical gates at upstream, operated from the crest of the weir. The main characteristics of these two weirs and reservoirs are presented in Table 3-12.

Table 3-12: Weirs II and III Characteristics

	Weir II	Weir III
Crest Elevation	1,808 ft msl	1,700 ft msl
Type	free overflow	Cascade type free overflow
Design Flood	78,000 cfs	148,000 cfs
Length	418 ft	1,190 ft
Stilling Basin Length	105 ft	62 ft
Tunnel Diameter	16 ft	16 ft
Forebay Size	61 x 78 x 34 ft	NA
Surge Tank Size	NA	21 ft diameter
Penstock Diameter	12.5 ft	12.5 ft
Surface Area of Weir Impoundment	10.1 acres	730 acres
Average Depth of Weir Impoundment	NA	57 ft
Length of Weir Impoundment	0.3 miles	3.5 miles

3.3.7 Powerhouses I, II, and III

Three powerhouses are proposed in Component 2, as shown in Map 3-11.

Powerhouse 1, the main powerhouse, will be located at the toe of the dam on the right bank of Kurram River, at River Mile 67, and have an installed capacity of 38.0 MW. The size of the powerhouse, which will basically be a semi-surface powerhouse, was determined after dimensioning the spiral case, draft tube and generator dimensions. The total length and width of the powerhouse including the loading bay and control building have been determined to be 180 ft long and 111 ft

wide, having galleries on the upstream and downstream sides for positioning the electrical and mechanical equipment.

As shown on Map 3-13, powerhouse II will be located 2.1 miles downstream of the dam, or roughly 0.17 miles from the confluence of Kaitu and Kurram Rivers, and will have an installed capacity of 10.4 MW. It will be constructed downstream of the main dam to utilize the natural slope of Kurram River by bypassing a bend in it. For this purpose, a diversion weir will be constructed on the river around 8,000 ft downstream of the main dam, from which a 16 ft wide, 5,400 ft long horseshoe shaped tunnel will convey water to the powerhouse located just upstream of confluence of Kaitu and Kurram Rivers (confluence located at River Mile 64). The tunnel will be connected to penstock through a forebay for conveying water to the powerhouse. The proposed length and width of the powerhouse are 142 ft long and 105 ft wide.

As shown on Map 3-14, powerhouse III will be located 4.8 miles downstream of Powerhouse II, at River Mile 60, and have an installed capacity of 16.5 MW. Powerhouse III will be constructed on right bank of Kurram River. The size of the power station, which would basically be a semi-surface powerhouse, was determined after dimensioning the spiral case, draft tube and generator dimensions. A 16 ft wide, 3,250 ft long horse shoe shaped tunnel will convey water to the powerhouse. The total length and width of the powerhouse including the loading bay have been determined as 145 ft long and 105 ft wide, having a downstream gallery for disposition of the electrical equipment. The powerhouse building will be a reinforced concrete structure. The powerhouse has also been provided with an under-drainage system to take care of seepage and uplift pressures. This under-drainage system will comprise horizontal and vertical drains. It is also proposed to conduct consolidation grouting of foundations before erecting the structure.

As shown on Map 3-10, the three powerhouses will be connected to the new transmission line to the existing substation at Domail that will be built as part of Component 1.

The main characteristics of these three powerhouses are presented in Table 3-13.

Table 3-13: Powerhouses I, II and III Characteristics

	Powerhouse I	**Powerhouse II**	**Powerhouse III**
Tunnel	Not applicable	5,400 ft long 16 ft wide horseshoe	3,250 ft long, 16 ft diameter
Number of Units	3	2	2
Dimensions	180 ft x 111 ft	142 ft x 105 ft	145 ft x 105 ft
Installed Capacity	38.0 MW	10.4 MW	16.5 MW
Turbines	Vertical Francis	Vertical Francis	Vertical Francis
Design Discharge	450 cfs	820 cfs	927 cfs
Normal Tailwater	1,809 ft	1,713 ft	1,583 ft
Tailwater for PMF	1,838 ft	1,723 ft	1,593 ft
Generator	Suspended Type	Suspended Type	Suspended Type
Switchyard Size	200 ft x 360 ft	160 ft x 360 ft	160 ft x 360 ft

Road improvements include construction of a new access road for Powerhouse II on the right bank of the river. This road will take off from a new access road from the dam Site at RD 48+500 and follow an existing track to Powerhouse II site. It involves rock cutting but does not involve any bridges Its length will be 5 miles and its width 30 ft.

A new access road for Powerhouse III will also be needed. The road involves construction of a bridge. The road will be constructed on the right bank of the river for access to the intake tunnel and powerhouse. The total length will be 2 miles.

The existing road from the dam site to Powerhouse III, on the left bank of the river, will be improved. It is about 10 miles long. Upgrades will include construction of one bridge, 12 culverts, and 12 causeways.

3.3.8 Construction Phase

3.3.8.1 Land Acquisition

WAPDA shall complete the land acquisition prior to the start of construction. Table 3-14 below informs about the overall footprint as well as how much of each type of land will be affected. Most of the land is dedicated for the establishment of the reservoir and resettlement sites. More details on land acquisition and the associated potential socioeconomic impacts can be found in the Resettlement Policy Framework for the entire project.

Table 3-14: Affected Land and Land Use for Component 2

Component	Package	Affected land and land use (acres)				
		Total	Agricultural	Residential	Water	Worsho
2	Kurram Tangi Dam and Reservoir	11,444	1,589	326	1,500	8,029
2	Kurram Tangi construction & security camps	10.1	2.6	0.0	0.0	7.5
2	Powerhouse 1, weir and appurtenant structure	8.3	0.1	0.0	1.0	7.2
2	Powerhouse 2, weir and appurtenant structure	11.6	2.1	0.0	1.5	8.0
2	New access road to Powerhouse 2	56.1	1.1	0.0	0.0	55.0
2	Powerhouse 3, weir and appurtenant structure	7.6	0.0	0.0	3.8	3.8
2	New bridge and access road	0.0	0.0	0.0	0.0	0.0
2	New alignment of Mir Ali-Spinwam-Thal road	60.4	0.0	2.5	1.9	56.0
2	Additional land take for enhancement of Bannu-Shewa road	16.0	4.0	2.0	0.0	10.0
2	Resettlement sites	2,577.6	483.3	161.1	0.0	1,933.2
	Component 2 Total	**14,191**	**2,082**	**492**	**1,508**	**10,109**

3.3.8.2 Construction Schedule

Figure 3-3 below shows the proposed schedule to build the key features of Component 2.

Figure 3-3: Construction Schedule for Component 2

Item No.	Activities	Period of Construction			
		Year 1	Year 2	Year 3	Year 4
1	**Construction and Housing Camps**				
2	**Roads, Bridges and Culverts**				
3	**Main Dam**				
3.1	**Diversion works**				
3.2	**Main Dam**				
3.2.1	Construction of U/S cofferdam				
3.2.2	Dewatering of dam foundation				
3.2.4	Preparation of dam foundation				
3.2.5	Main dam placement and compaction				
3.2.6	Laying down the concrete Pad				
3.2.7	Anchoring				
3.2.8	Consolidation and grouting @ 10' C/C				
3.2.9	Curtain grouting				
3.2.10	Laying of u/s concrete slab				
3.2.11	Construction of parapet wall				
3.2.12	Instrumentation				
3.2.13	Instrumentation house				
3.3	**Spillway and Other Structures**				
3.3.1	Construction of d/s cofferdam				
3.3.2	Excavation of spillway approach channel and weir				
3.3.3	Excavation of chute and stilling basin				
3.3.4	Construction of spillway weir				
3.3.5	Construction of chute and stilling basin				
3.3.6	Spillway gate installation				
3.3.7	Spillway deck				
3.3.8	Excavation of switchyard and placement of material in embankment				
3.3.9	Excavation of material in front of tunnel's stilling basin and placement in embankment				
4	**Powerhouse I**				
4.1	Construction of powerhouse (civil works)				
4.2	Installation of penstock trifurcation				
4.3	Installation, testing and commissioning of electromechanical equipment				
4.4	Transmission lines				
5	**Powerhouse II**				
5.1	Excavation and preparation of weir foundation				
5.2	Construction of weir and drainage systems				
5.3	Construction of undersluices				
5.4	Construction of tunnel				
5.5	Construction of forebay				
5.6	Construction of powerhouse (civil works)				
5.7	Installation of penstock				
5.8	Installation, testing and commissioning of electromechanical equipment				
5.9	Transmission lines				
5.10	Construction of embankment				
6	**Powerhouse III**				
6.1	Excavation and preparation of weir foundation				
6.2	Construction of weir and drainage systems				
6.3	Construction of tunnel				
6.4	Construction of surge chamber				
6.5	Construction of powerhouse (civil works)				
6.6	Installation of penstock				
6.7	Installation, testing and commissioning of electromechanical equipment				
6.8	Transmission lines				

3.3.8.3 Construction Techniques

River Diversion during Construction. Diversion of Kurram River will be accomplished through two circular concrete lined tunnels in the right bank, of 16 and 20 foot diameters. Following construction, the 20 ft diameter tunnel will be converted into a power tunnel for Powerhouse I while the 16 ft diameter tunnel will be plugged with a bulkhead gate. Tunneling will be performed from both ends, by conventional blasting and rock removal means. The excavation volume required for construction of the tunnels will include approximately 165,000 cy of overburden material (requiring about 1.5 acres of storage area, assuming a stockpile height of 30 yards) and approximately 290,000 cy of rock material (requiring about 3 acres of storage area, assuming a stockpile height of 30 yards). The rock material will be stockpiled for use in the dam, at a site to be

selected. When the downstream portal is complete, the stilling basin will be constructed. As the tunnels near completion the gate structures will be constructed. The preparation of the tunnels is expected to consume six months, during which time the abutments will be prepared. During this time, the upstream cofferdam will be partially constructed, leaving space for the river to pass.

When the diversion tunnels are complete, the river will be diverted. This is planned to take place during the period between November and January, when the flow is the lowest. The upstream cofferdam is expected to be 65 feet above the river bed and require a volume of about 112,900 cubic feet of fill. The downstream cofferdam is expected to be 70 feet above the river bed. The cofferdams are provided to control the 30 year return flood during construction. The characteristics of the upstream and downstream cofferdams are summarized in Table 3-15 and Table 3-16, respectively.

Table 3-15: Upstream Cofferdam Characteristics

Type	Rockfill
Length of Coffer Dam	900 ft
Design Flood	34,500 cusec
Embankment Slope	1V:1.5H
Crest Elevation	1890 ft msl
Freeboard (Above maximum Water Level)	5 ft

Table 3-16: Downstream Cofferdam Characteristics

Type	Rockfill and Cellular
Embankment Slope	1V:1.5H
Crest Elevation	1850 ft msl
Freeboard (Above maximum Water Level)	5 ft

Dam Foundation Work. With the river diverted, the first task will be to pump out the work area between the cofferdams. Once this has been accomplished, the foundation of the dam will be prepared, starting with the removal of approximately 13,000 yd^3 of alluvium. This is expected to require about six weeks. In another six weeks, the slab will be concreted and grouted. The next activity, completion of the toe slab, is expected to consume about 14 months.

Dam Fill Placement. The filling of the CFRD will be derived from the tunnel excavations, the spillway excavation, and the removal of the right bank of the river where it bends to the right downstream of the dam. A small quantity of fill will be obtained from creation of a bench for the switchyard, which will be on the left bank shoulder.

About 300 feet of the left bank peninsula immediately downstream of the spillway stilling basin will be removed and stored for use in the dam. In addition a section of the right bank, downstream of the stilling basin will also be removed and placed in the dam. This section will be armored in order to prevent erosion in the event of spilling. This material, and that from the switchyard, will be used only when needed.

During the filling of the dam, the spillway crest and gates will be completed, so that by the end of Month 33 the spillway will be operational. Powerhouse I, at the toe of the dam, will be constructed independently of the other structures, as it is not on the critical path. Powerhouse I is scheduled to

begin in Month 14 and be completed in Month 39. It is expected to be ready for testing and commissioning by the end of Month 42. Impounding will depend on the available flow and downstream irrigation water requirements, but it could start any time after the end of Month 46.

Powerhouse I. Powerhouse I will be located at the main dam. It will be constructed in the dry due to the provisions made for the main dam. See above for discussion of river diversion and dam construction provisions.

Weir and Powerhouse II. At the weir site, the river occupies a single channel near the right bank on the outside of a bend. The width of the whole channel at this point is about 640 feet, allowing space for construction of the weir against the left bank. A cofferdam will create a work space in that area, leaving the river to flow through the remainder of the channel. When the weir is complete the remaining space will be closed by an embankment, allowing the river to flow through the undersluices.

Water from the weir will be conveyed by a horseshoe-shaped tunnel 16 feet wide and about 5,400 feet long, excavated by conventional means. It will end in a 400-foot open aqueduct conveying the flow over a nullah to a concrete forebay. A 14-foot diameter penstock will convey the water to the above-ground powerhouse, located on the Kaitu River, about 500 feet upstream of its junction with the Kurram. The powerhouse will be constructed of reinforced concrete. A tailrace channel about 500 feet long will discharge the water into the river.

Weir and Powerhouse III. The weir for Powerhouse III is much larger than the other weirs in the system. At the presumed site, the river flood plain is about 700 feet wide. The flow in the spring would be restricted to the right bank, in a channel about 50 feet wide. The remainder of the flood plain appears consist of a sand bar, the part against the left bank being devoted to agriculture.

The circular power tunnel will be 3,250 feet long and 16 feet in diameter. The resulting 24,200 cubic yards of excavated material will be spoiled from adits along the route. The land along the tunnel is largely uninhabited, but in the neighborhood of the powerhouse there is irrigated cropland.

3.3.8.4 Existing and New Access Roads

As discussed above, improvements to existing roads and construction of new roads will be required for construction and operation of Component II. Improvements specific to the main dam and powerhouses are discussed in Section 3.3.2 and 3.3.7 respectively.

Additionally, a structure will be constructed before the start of dam construction for transportation of light equipment, men, and material from the left to right bank or vice versa. A temporary steel structure is suggested for the purpose and may be constructed by the main dam contractor during his mobilization.

3.3.8.5 Construction Camps

It is anticipated that about 200 Engineers, Geologists and other professionals will be working for the construction supervision of the project. Due to the short duration of the project and its isolated location, it was considered uneconomical to provide residential accommodation at site with all amenities available at Bannu; therefore only two colonies with residential and office accommodation have been proposed; one at a site in the Spaira Ragha Plain with reasonable amenities and the other at Bannu with all amenities available in the city. The colony proposed in the Spaira Ragha Plain is at a convenient distance of 8 km from the dam site.

A camp will also be needed for the contractor's personnel. The camp will be constructed by the contractor to his requirements and it is anticipated that the labor force will be about 1,100 persons at peak, for which appropriate provisions shall be made. Provision for construction of works shall include a medical dispensary, water supply and sewerage system, access roads, electricity and

illumination, shops, hard furnishing of offices and accommodations. Land shall be leased or acquired, as appropriate, for camp construction.

3.3.8.6 Construction Materials

Availability of construction materials in the vicinity of the dam site was a major consideration in locating and selecting the type of dam at Kurram Tangi. The type of dam is also influenced by the type and quantities of materials available from the proposed excavations at the dam site and borrow areas, which mainly include sandstone and river alluvium, consisting of sand and gravels.

It is estimated that the sufficient rockfill material for the main dam will be available from the required excavations for the spillway, powerhouse, diversion works and main dam foundation. Additional sandstone is also available in sufficient quantity in the vicinity of the dam site to meet any shortfall, and any excess excavated material from the Component 2 may be diverted for filling borrow areas for Component 1. The fine filter material (sand) and the coarse filter material (fine gravels) for the main dam will be obtained from the river alluvium, which will need proper processing and crushing.

Studies carried out to date indicate that concrete aggregate material requirements can be met from river gravels and terrace gravels with appropriate processing. Therefore, a crushing and screening plant will be established to produce coarse and fine aggregates required for concrete works. Mining of river gravels will be restricted to the reservoir bed, as this process can be very damaging to riverine ecological conditions. Batching plants will also need to be established at each of the sub-components within Component 2. Reinforcement steel and cement will have to be procured from the sources identified prior to the start of the construction. There are no cement factories in the project area that are suitable for supplying the full quantities of cement required for the project. Steel and bricks are also available in the vicinity of Bannu as well as from Peshawar and Rawalpindi. Available river water is suitable for use in construction. The quantities of the major construction materials needed during the construction of Component 2 are listed in Table 3-17.

Table 3-17: Construction Material Quantities for Component 2

Excavation	250 million ft^3
Filling	4.5 million ft^3
Concrete	20 million ft^3
Steel Reinforcement	20,000 tons
Cement	4 million bags

3.3.9 Operation Phase

The Kurram Tangi Reservoir will be operated to provide water to the downstream irrigation canals. Reservoir operation was simulated for planned irrigation target releases using historical/simulated river flow values, gross storage of 1,200,000 AF, and dead storage of 300,000 AF. Over the study period (1971-2001) analyzed in prior studies, seven years would have water shortages, with an average shortage during shortage years of 10,900 AF/year, and an average over all shortage of 2,500 AF/year.

The flows of the Kurram and Kaitu Rivers are stored in varying amounts at multiple sites: Kurram Tangi Dam, Weir III Reservoir, Kurram Garhi Head Works, and Baran Dam. Water is to be released to different canals to ensure that planned crop water requirements are met for the Civil Canals, Marwat Canal and the proposed Thal canal. For highest system efficiency an extensive telemetry system is required to record and transmit the instantaneous flows at the various sites. The discharge/flow information will be transmitted to a central processing/control room at some suitable

place (Kurram Tangi Dam or Kurram Garhi Headworks). The following operational guidelines are proposed:

- Release all storage available at Baran Dam to Marwat canal subject to target demand. Balance requirements of Marwat canal are met from Kurram Garhi Headworks.
- The local runoff generated below the Weir III Reservoir and part of spill at the Weir III Reservoir may be detained at Kurram Garhi Headworks. Such storage would be released on a priority basis to Baran Dam or to the irrigation canals.
- The spills at the Weir III Reservoir would be used as diversion to Baran Dam subject to availability of the storage space in the Baran Dam, or released to the irrigation canals.
- Water stored at the Weir III Reservoir is released earliest for further diversion to Baran Dam and/or to irrigation canals.
- Canal target diversions not met from above sources are released from the Kurram Tangi Dam.
- The minimum Environmental Flow Releases for Kurram Tangi Dam, Weir II and Weir III shall be written into the dam/weir operating procedures once they have been finalized. Section 5.3.3.6 discusses flow releases in more detail.
- Discharge in excess of 1,500 cfs at Kurram Tangi Dam may be released through the low level outlet during March and August to November each year for sediment flushing at the dam.

3.4 Component 3: New Thal Canal and Command Area

Component 3 includes the new Thal Canal and rehabilitation and upgrade of the existing Civil and Marwat Canals to improve the water conveyance performance of the present systems. The tertiary canals and the development of Command areas for the Thal canals will be done by the Irrigation Department. Transmission and distribution (rural electrification) will be done by other entities operating in the project area. The key features of Component 3 are shown in Map 3-15.

3.4.1 Thal Canal

The existing Kurram Garhi Headworks, constructed during 1959-1969, regulates flow to the existing Civil Canals. A new head regulator will be constructed at the Kurram Garhi Headworks to service the new Thal Canal. The head regulator will have one bay with vertical lift gate. Thal Canal will off-take from the left bank of Kurram Garhi Headworks, at EL 1,428 ft msl, and lead to a tunnel. A tunnel will run underneath the hill range for 3,100 ft before it transitions back into a trapezoidal channel at RD 4+500. The canal takes its course through undulating hills, crosses various streams and ends in the Karak District, as shown in Map 3-16. The main characteristics of the Thal Canal are shown in Table 3-18. The canal system will have 19 distributaries, 4 minors, 2 sub-minors totaling in length about 73 miles.

Table 3-18: Thal Canal Characteristics

Off-take point	Left bank of the KG Headworks
Total Tunnel Length (two segments)	3,100 ft
Irrigated Command Area	69,000 acres
Designed Discharge	350 cfs
Length of Main Canal	48 miles
Main Canal Bottom Width	8 ft (typ.)
Main Canal Right of Way including Longitudinal Drain	54 ft (typ.)

Total Length of Distributaries, Minors and Sub-minors	73 miles
Distributary Bottom Width	4 ft (typ.)
Distributary Right of Way including Longitudinal Drain	37 ft (typ.)

The Thal Canal will have concrete lined gravity channels provided with new regulating structures, cross drainage structures, bridges, culverts, escape structures and outlets, as shown in Table 3-19.

Table 3-19: List of Key Structures on the Thal Canal System

Structures	Quantity
Head Regulator at Main Canal	17 on Main Canal, 5 on Distributaries
Tunnels	2 on Main Canal
Aqueduct	16 on Main Canal, 11 on Distributaries
AR Bridge	1 on Main Canal, 7 on Distributaries
VR Bridge	14 on Main Canal, 68 on Distributaries
Foot Bridge	5 on Distributaries
Watershed Crossing	67 on Main Canal, 15 on Distributaries
Fall	1 on Main Canal, 248 on Distributaries
Escape Cluster	1 on Main Canal
Tail	3 on Distributaries
Tail Outlets	17 on Distributaries
Outlets	130 on Distributaries

3.4.2 Rehabilitation and Upgrade of the Civil and Marwat Canals

The Project will also upgrade about 200 miles of old canals, collectively called Civil Canals, built by landowners, with a command area of approximately 107,000 acres, and the Marwat Canal, with a command area of 170,000 acres. The Civil Canals have been the means of irrigation in Bannu area for a long time. These channels were originally laid down, probably sometime in the first half of the 20th century, by the landowners and promoted by the local community. As such, these channels were constructed with an indigenous design approach and gradually expanded the irrigation to a large area over the decades. With the construction of Kurram Garhi Headworks in 1959 to regulate the Kurram River flows, these canals were given a sound base for further development. However, the Kurram Garhi Headworks lack seasonal regulation capability. Due to the fluctuations in river flow, realizing a sustainable agriculture has been hard. In 1962 Baran Dam and Marwat Canal system were added. Usefulness of the Baran Dam was badly affected by silting up of the reservoir within a relatively short span of 30-years with loss of 70% of its capacity.

The existing Civil Canals have neither proper alignments nor bed grades. The canals flow generally along the course of depressions and nullahs. Present cross sections of the canals cannot cope with the discharges being conveyed and as such, there are overflows of the canals, as there is no freeboard.

Except at the main feeder and canal heads, there are no regulators on any distributary or minor. The outlets have no controlling structure but function freely at user's discretion. The channels run with disproportional withdrawal resulting in inequitable distribution. Over-withdrawal in upper reaches of the canal results in colossal wastage of irrigation water which gives rise to water-logging and salinity conditions and also results in acute shortages of water in the lower reaches, thus reducing the intensity and crop yields.

The upgrade of the Marwat and Civil canals, along with the construction of the Kurram Tangi Dam for the seasonal regulation of the Kurram River flows (see Component 2) has been identified as a solution for the development of a sustainable agriculture in the region. Table 3-20 shows the main characteristics of the Marwat and Civil Canal upgrades.

Table 3-20: Civil Canals Characteristics

	Marwat Canal	Civil Canals
Length	50 miles (approximately)	200 miles (approximately)
Off-take point	Right bank of the KG Headworks	Right bank of Baran Dam (Right Bank Canal), Downstream of Marwat Canal (Kachkot Canal)
Irrigated Command Area	170,000 acres	107,000 acres
Designed Discharge	800 cfs	600 cfs (Kachkot Canal)

The canals will have differing sizes at various segments but will have a trapezoidal shape and will have a concrete lining throughout. The construction, or upgrade, of the primary and secondary canals will be done by WAPDA while the tertiary canals will be constructed by the Irrigation Department.

3.4.3 Construction Phase

3.4.3.1 Land Acquisition

WAPDA shall complete the land acquisition prior to the start of construction. Table 3-21 below informs about the overall footprint as well as how much of each type of land will be affected. Most of the land is dedicated for the establishment of the various CCAs. More details on land acquisition and the associated potential socioeconomic impacts can be found in the Resettlement Policy Framework for the entire project.

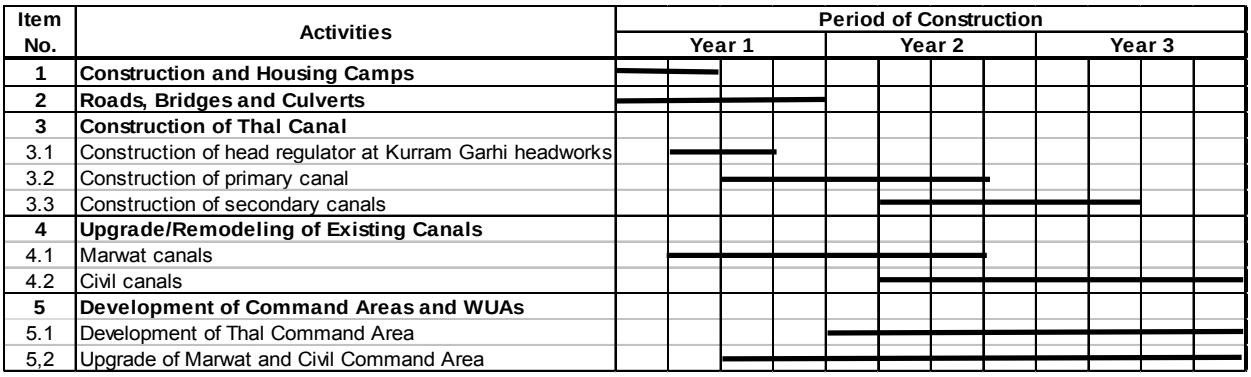
Table 3-21: Affected Land and Land Use for Component 3

Component	Package	Affected land and land use (acres)				
		Total	Agricultural	Residential	Water	Worsho
3	Canal to Thal CCA Including Distributaries	879.5	589.4	23.8	85.5	180.7
3	CCA Thal (Buildings in Thal CCA not affected)	143,803	107,276	7,600	22,910	6,017
	Component 3 Total	**144,683**	**107,866**	**7,624**	**22,996**	**6,198**
	Grand Total	**182,553**	**118,818**	**8,437**	**25,190**	**30,108**

3.4.3.2 Construction Schedule

Figure 3-4 below shows the proposed schedule to build the key features of Component 3.

Figure 3-4: Construction Schedule for Component 3



3.4.3.3 Construction Materials

Table 3-22 lists the quantity of the major construction material needed during the construction of Component 3. Some excavated material will have to be temporarily stored at the stock piles, and other will be transported to the crushing and screening plants for producing the required crushed aggregates. Reinforcement steel and cement will have to be procured from sources identified prior to the start of the construction.

Table 3-22: Construction Material Quantities for Component 3

Excavation	125 million ft^3
Filling	160 million ft^3
Concrete	17 million ft^3
Steel Reinforcement	36 million lbs
Cement	4 million bags

3.4.4 Operation Phase

No information is yet available on the operation of the new Thal canals and the organization of Command Areas and potentially the creation of Water Users Associations.

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4 BASELINE – AFFECTED ENVIRONMENTAL AND SOCIOECONOMIC SITUATION

4.1 Methodology and Approach

4.1.1 General Considerations and Data Sources

The remoteness of the project area, coupled with its risky security situation, has posed challenges to the collection of current data as described in Section 1.3.3. In particular it was necessary to limit the use of maps and GPS in the field. In the descriptions below, where possible, an attempt is made to evaluate the quality of the data obtained, while indicating their source. Teams of data gatherers were sent to the project region to survey, through questionnaires and direct observation, the human and social characteristics.

IDC collected both primary and secondary data on the physical environment and economic data in the jurisdictions affected by all three components of the project, i.e. North Waziristan, F.R. Bannu, District Bannu and Lakki Marwat as well as part of Karak district. Primary data were collected during two rounds of field surveys conducted in July and August 2013. Checklists prepared by NESPAK for the different aspects of the environmental baseline were used for the data collection. Activities included interviews/discussions with key informants, physical observation, walk throughs in the project area, and mapping and photography of selected features in the field. Secondary data were gathered during consultative meetings with officials of the concerned departments. In addition data was also extracted from previous studies.

All the land use for the project has been developed on Satellite Imagery of 0.5m spatial resolution was used to determine land use in the project AOI as described in more detail in Section 1.3.4.1. No Ground Control Point for determination of ortho-rectification of satellite imagery could be fixed in the field owing to the remoteness of the area and uncertain law and order situation. This information was then developed as GIS layers. Most land use maps were prepared at a scale of 1:5,000. Those for the Kurram Tangi dam were prepared at a scale of 1:1,000.

An infrared band of Pléiades Satellite Imagery (*0.5m spatial resolution*) was purchased for all of Components 1 and 3, and for the proposed reservoir area in Component 2 to investigate and estimate the cropped area and existing canal command area (Section 1.3.4.2.)

Catchment boundaries were demarcated at different locations within the project area using Shuttle Radar Topographic Mission (SRTM) and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) topographic datasets of 90m and 30m spatial resolution respectively (Section 1.3.4.3).

All the relevant drawings from Tender Documents and Feasibility drawings were overlaid on satellite imagery. As described in Section 1.3.4.4, difficulties were encountered in transforming these AutoCAD drawings into GIS.

4.1.2 The Study Area

The Area of Influence (AOI) is defined as those areas affected by the Project, as shown on Map 4-9. This is generally the area of direct influence and does not include, for example, all transport and access roads on which equipment, materials and goods will travel. It also does not encompass the watersheds or represent the area in which potential cumulative impacts may occur. (See Section 5.5 for potential cumulative impact issues).

The watersheds of the Kurram and Kaitu Rivers, as shown in Map 4-5 (Project Catchment Area), are also considered part of the Study Area, because activities in the watershed will affect the operation of the project and thus should be subject to mitigative measures and watershed management. In addition, according to the World Bank (OP 7.50), effects on international waterways must be

considered, including a notification process to upstream and downstream nations. In general, consideration of transboundary effects is required by international safeguard procedures.

4.2 Land Resources

4.2.1 Topography and Drainage

The dominant drainage feature in Component 1 is the Kaitu River prior to its confluence with the Kurram River, while the Kurram River dominates in Components 2 and 3. The descriptions below are largely derived from interpretation of Google Earth imagery and of soil maps of Bannu SCARP (Map 4-1) (Atlas Survey and Research Organization Planning Division WAPDA, 1981), Spaira Ragha Plain, Sheratalla Plain and the Thal Command Area (respectively Maps 4-1, 4-3 and 4-4; Soil Survey of Pakistan, 1973) by NESPAK. Slope maps of the Kaitu River catchment (Map 4-7) and Kurram River catchment were produced from satellite imagery (Map 4-5; Map 4-6).

4.2.1.1 Component 1

The watershed of the Kaitu River comprises a mountainous area of approximately 2,000 mi^2, of which 1790 mi^2, or 90 percent, lies in Afghanistan, where it is known as the Shamal (also referred to as the Shamil or Samal) (Map 4-6). The Kaitu River watershed is mountainous with steep valleys, containing ephemeral streams (nullahs). Ridges are mostly 500 to 1,000 feet above the valleys. The elevation of the catchment boundary varies between 5,000 ft msl in the south and southeast to as much as 15,000 ft msl in the northeast, north, west, and far southwest. Vegetation cover is a mix of arid, bare mountain rock surfaces, coniferous, thorns/deciduous trees of varying density and scrub forests. Slopes down to the river are commonly steep, with flash floods common in its various tributaries and the Kaitu River itself after heavy rainfall events.

The Kaitu River arises in the Koh-e-Sufaid Mountains of Afghanistan, its basin adjoining that of Kurram River on the south and west, in the Afghanistan province of Chakmanni. Its sources are at a somewhat higher elevation than those of the Kurram River, lying at about 14,500 ft msl. The Kaitu River flows past Khost, the provincial capital, at about River Mile (RM) 53.5. With the union of several rivers, at Harunkhel, the Kaitu nearly doubles in size. About 13 miles upstream of the Pakistan-Afghan border, the Kaitu flows eastward through the province of Khost and turns sharply southwards close to Harunkhel about eight miles from the border. In the vicinity of Zarakhel in Afghanistan, the Kaitu River forms a dog-leg and flows in a southwesterly direction across the border into Pakistan at about RM 30 at an elevation of about 2,800 ft msl. The site of the proposed Kaitu Weir is at RM 17.5 where the river bed is at an approximate elevation of 2,320 ft msl. The Kaitu River follows a sinuous course to the southwest for about a further six miles downstream of the Kaitu Weir, and then turns and flows to the northeast before joining the Kurram at an elevation of about 1,700 ft msl (Map 4-5).

Within Pakistan, the Kaitu River comprises multiple braided channels, with areas of gravel and cobble between the channels, in a floodplain varying from 200 to about 1,200-feet-wide. In both Pakistan and Afghanistan, there are many villages along the river banks, whose inhabitants grow irrigated crops on the floodplain and on river islands.

The slopes of the Kaitu River are similar to those of the Kurram River. The detailed bed slopes of the river are shown on Map 4-7. From Khost to Harunkhel the Kaitu descends 487 feet in 12 miles, resulting in a slope of 0.76 percent. From Harunkhel to the border it descends another 348 feet, a slope of 0.57 percent. From the border to the proposed Kaitu Weir site a distance of approximately 12.5 miles, the Kaitu River descends another 557 feet, at an average slope of 0.67 percent. In the 17.5 miles from the proposed Kaitu Weir site to its junction with Kurram River, it descends another 649 feet, at an average slope of 0.07 percent (Map 4-5; Map 4-7).

The Spaira Ragha Canal lies in an area of alluvial outwash dunes, consisting mainly of weathered sand stone with minor weathered shale. The area to the north of Spaira Ragha canal, where the diversion

tunnel feeding the Kurram Tangi Reservoir will be sited is similar in nature although there are some natural terraces on hills. Elevations are about 2,300 ft msl to 2,400 ft msl.

The Sheratalla Canal and its associated Powerhouse lie within the Sheratalla Plains on the right bank of Kaitu River downstream of the Kaitu Weir. The Sheratalla Plains comprise alluvial fans, piedmont plains, nullah beds and low hills, forming an undulating topography. The command area consists of eroded but sparse sand dunes with some natural vegetation. Average elevations are 2,100 ft msl to 2,500 ft msl.

4.2.1.2 Component 2

The Kurram River originates at approximately 14,000 feet in the Koh-e-Sufaid Mountains in southeastern Afghanistan, flowing to the southwest before turning to the east near Ahmad Khel. It flows eastward for approximately 20 miles and enters Pakistan near the border post of Kharlachi (approximately RM 123 from the junction with the Indus River) in the Kurram Agency at an elevation of 5,121 ft msl. In this reach most of its tributaries are received on the left bank and are relatively small. At RM 102 it bends sharply south, near the left bank town of Sadda. In this reach, the braided channels of the river occupy a floodplain about 200 to 1,000-feet-wide. There are numerous towns along the river, mostly at the junctions of tributaries, and roads connect these towns on both banks of the river. The braided channels of the river separate islands that are cultivated.

The Kurram River forms a large dog-leg turning sharply to the southwest a further 30 miles downstream and then abruptly to the southeast at RM 71, where it enters the broad valley that will contain the Kurram Tangi Reservoir. The river bed elevation at the entrance to the valley is about 1980 ft msl (Map 4-5). Here the flood plain is about 2000 to 3000 feet wide and the river is highly braided, creating large islands that are densely cultivated, as are both banks.

At RM 67, Kurram River enters a range of ridges oriented roughly northeast-southwest. At the entrance to these hills is the proposed Kurram Tangi Dam site. As Kurram River continues through these ridges, the river undulates, producing the sites for Powerhouses II and III. A little over a mile upstream of RM 62 the Kurram River turns sharply southwest. At RM 62 it receives a major right bank tributary, the Kaitu River (described above), near the town of Zarwam, and turns sharply southeast again. For about four miles further downstream, the river flows southeast, parallel to the ridges, and then bends southwest to the Kurram Garhi Headworks, at RM 56.

At the proposed Kurram Tangi Dam site the Kurram River drainage basin/ catchment area is about 2,464 sq. miles. At the Kurram Garhi Headworks site the Kurram River drainage basin is nearly twice that at 4,632 sq. miles of which the northern two thirds is mountainous and sparsely populated, with most settlements located along the river.

In the 85 river miles between the Kurram River entrance into Pakistan at the Karlachi border post and the Kurram Garhi Headworks, the Kurram River descends from 5,121 ft msl to 1,455 ft msl with an average slope of 0.82 percent or 43 feet per RM (8.2 meters per kilometer) (Map 4-5). In general, the upper reaches of the river have somewhat steeper slopes than the lower ones, but the differences are not extreme. In the 13 miles from Gozar to the border the river descends 856 feet, or 65.8 feet per RM (1.24 percent), 11 miles downstream of the proposed Kurram Tangi Dam site it descends 444 feet, or 40.4 feet per RM (0.76 percent) (Map 4-5). From about RM 100 to the proposed Kurram Tangi Dam site slopes gradually decrease from 0.82 percent to 0.63 percent (Map 4-5). Over the first eight miles downstream of the Kurram Tangi Dam site average slopes are 052 percent. They then average 0.44 percent over the six and a half miles to the Kurram Garhi Headworks.

The topography of the watershed is similar to that of the Kaitu, with steep valleys and hill slopes. Heavy erosion of these hills has resulted in the river bed being composed of gravels and small

boulders, separating braided channels. The upper elevations of the basin are largely forested, but within the Project Area the slopes have been heavily deforested and the resulting rangeland overgrazed by livestock.

4.2.1.3 Component 3

In Component 3, the Kurram River flows in a southeasterly direction from the Kurram Garhi Headworks at RM 56 past the city of Bannu to join the Indus River near Mianwali. River bed elevations decrease from 1,455 ft msl at the Headworks to about 639 ft msl at the confluence with the Indus.

About 17 miles downstream of the Headworks, Adhami Nallah and Jour Nallah feed into the Kurram River from the north near Ghoriwala about two miles north of Sarai Naurang (Map 4-1).

In the 56 river miles between the Kurram Garhi Headworks and the confluence with the Indus, the slope decreases from 0.51 percent immediately downstream of the Headworks to 0.1 percent at the confluence (Map 4-6). In the first 6 miles average slopes are 0.5 percent, and then 0.34 percent over the next three miles. For roughly a further three miles slopes average 0.34 percent. From this point, approximately two km upstream of Jando Khel, average slopes range from 0.16 percent to 0.11 percent to 0.14 percent at the confluence with Jour Nallah (Map 4-6). Immediately downstream of this confluence, average slopes are 0.05 percent over several miles. They then increase slightly to about 0.1 percent until the confluence with the Indus (Map 4-6).

The Baran River, which flows roughly parallel and to the west of the Kurram River and joins the Gambilla River about 5.5 miles due west of Sarai Naurang. Approximately nine miles downstream, the Chal Nallah feeds into the Gambilla River two to three miles northeast of Sarai Gambilla (Map 4-1). The Kachkot canal starts from north of Bannu and ends north of Lakki Marwat. In addition the Civil and Marwat Canals irrigate the Bannu Basin (Map 4-1).

The Thal canal command area lies downstream and southeast of the Kurram Garhi Head works in this component. It dominantly comprises barren land with eroded sand dunes in the north-east with sparse presence of shrubs and vegetation cover. Topographically, the Component 3 area is dominantly composed of flat, fertile land. Average elevations in the Bannu plains and Lakki Marwat region decrease from about 1200 ft to 639 ft msl, at the point of confluence of the Kurram River with the River Indus near Mianwali. The area forms an oval shaped valley enclosed by an almost continuous rim of low mountains. Apart from a few areas of saline land in the southern reaches of Lakki Marwat, the area comprises sparsely vegetated shallow alluvium. Most of the area is cultivated through a network of sub-canals.

4.2.2 Geology, Geotechnical Issues and Seismicity

The descriptions of geology and geotechnical information are largely derived from KTDP Feasibility Report (KTDC, 2004), KTDP Detailed Engineering Design Report (PES at al, 2011a), and KTDP Tender Documents (PES et al, 2011b). MWH studied analyzed the geotechnical aspects of the project (MWH, 2013a) and carried out a seismic analysis (MWH, 2013b) for the entire project area which is discussed after the geology and geotechnical sections.

4.2.2.1 Regional Geology

The area within 100 km of site, which includes the catchment area of the Kurram Tangi Dam and the Kaitu Weir, is underlain by both sedimentary and metamorphic rocks. The sedimentary rocks are fluvial to marine in nature. These include sandstone, siltstone, shale, limestone, and marl. These range in age from upper Paleozoic to Recent. The metamorphic rocks belong to the lower Paleozoic era and are exposed in the northern area of the region.

The project area under study is a part of the Kohat Plateau and is located on the western limb of the Bannu Basin. The area is underlain by stratified sedimentary formations of marine and fluviatile origin

of Eocene to Pliocene age. The marine facies are mostly comprised of the Eocene age Panoba shales and Kohat limestone formations. The fluviatile facies consist of sandstone, shale and conglomerates of the Rawalpindi and Siwalik formations, which range in age from lower Miocene to Middle Pliocene.

4.2.2.2 Component I

Kaitu Weir. The area is dominantly underlain by sandstone with shale and gritty sandstone interbeds. The proposed weir and its appurtenant structures will be placed on the massive sandstone on the left abutment; however a few shale and gritty sandstone beds have also been found alternating with sandstone beds. The right abutment area is covered with overburden material of different composition. The area close to and sloping towards the river generally consists of scree, sandy gravels and cobbles, whereas further away from the river, overburden consisting of sand, gravels and cobbles is available in compacted form which is in contact with sandstone, alternating with shale and gritty sandstone. The river valley section is filled with loose sand, gravels and occasional boulders. The surface geological mapping of the covered area does not show any structural deformation.

Three investigation boreholes, two in the valley and one on the right abutment were drilled during the previous studies. The boreholes indicate that sandstone bedrock is covered by about 20 ft of overburden in the river valley and on the right abutment. The permeability as recorded during drilling through lugeon test is generally low. It is inferred from these results that the engineering properties of the available sandstone rock are suitable for foundation.

Kaitu Weir serves as a means to divert irrigation water to the Sheratalla and Spaira Ragha Plains, and to divert surplus flow from Kaitu River into Kurram Tangi Reservoir**.** The brief description of physiography and geological conditions of the command areas of the Sheratalla Plain and Spaira Ragha Plains presented in the following paragraphs are based on the satellite image interpretation studies.

Sheratalla Plain. The Sheratalla Plain is formed by alluvium washed from the local sandstone and shale hills. Alluvial fans, a piedmont plain, nullah beds and low hills constitute this plain. Some 60 percent of the area is littered with gravels, cobbles and boulders. The nullah beds are completely covered by varying thicknesses of cobbles, gravels and boulders. The major part of the piedmont plain surface is free of stones and is covered by fine grained materials.

Spaira Ragha Plain. Spaira Ragha area is a weathered rock plain consisting mainly of weathered sandstone. The area also includes a piedmont plain made up of alluvial fans and weathered shale material. The soil in the main part of the terrace, i.e. weathered sand plain, are up to two meters deep in the main valley. The soil depth reduces from the valley center to the nearby hills. Clay content increases towards the valley center. Sandstone is exposed at the lowest part of the Spaira Ragha and the weathered. Areas underlain by shale are frequently severely eroded into deep gullies at places.

Geotechnical investigations have not been carried out for the Sheratalla and Spaira Ragha canals and there is no geological information available along the canal routes.

Kaitu Feeder Tunnel. A major part of the tunnel passes under the overburden material consisting of sand and gravels. Alternating sandstone and shale beds are present in the inlet area. It is anticipated from the geology of the area that alternating beds of sandstone and shale will be present under the overburden. The sandstone is moderately hard to hard whereas shale is soft to moderately hard. Joints are not well defined. No prominent shears or other major discontinuities were mapped in the area.

Two investigation boreholes were drilled along the tunnel during previous studies and are shown on the geologic section drawing. The borehole logs indicate that shale is encountered at a shallow depth under the overburden. The surface geological map of the Kaitu Weir site indicates that the left abutment of the proposed weir site (also the intake portal of the Kaitu feeder tunnel) is made up of massive sandstone beds with few shale and gritty sandstone beds. One of the investigated Kaitu Feeder Tunnel sections indicates that the tunnel will be constructed mostly in shale. Because of comparatively soft character of shale necessary protective supports and measures will be required during excavation as well as in the design of the tunnel. The permeability values noted in the test results are generally low.

Powerhouse – IV. The powerhouse area is covered with overburden, its thickness varies from eight to 28 ft. Overburden consists of gravels and boulders embedded in silty sandy matrix, clay content increases towards the periphery of the Kaitu Weir pool. Under the overburden, there is a presence of shale which has swell potential and slakes slowly when exposed to atmosphere. Silty sandstone grits are observed at a few places.

An investigation borehole on the Kaitu feeder tunnel outlet portal has been considered to be representative of the condition encountered in the powerhouse location. The foundation rock (shale) is reasonably sound to sustain the expected load of the powerhouse structure.

Powerhouse – V. The powerhouse area is covered with overburden varying from eight to 28 ft in thickness. The overburden consists of gravels and boulders embedded in clayey-silty matrix, Alternating beds of sandstone and shale underlay the overburden. The foundation rocks are reasonably sound to sustain the expected load of the structure.

4.2.2.3 Component 2

Kurram Tangi Dam Site. The Kurram Tangi Dam site is located at a place where a relatively wide valley ends in a narrow gorge as the Kurram River cuts through a series of parallel sub-vertical ridges. The gorge is eroded into well-bedded Siwalik Sandstone, which forms the dominant lithology of the dam foundation and spillway, interbedded with lesser amounts of shale and conglomerate. Similar rock types are found downstream at the sites of the weirs and powerhouses. At the proposed dam site, the valley is quite narrow and bedrock is not expected to be very deep. The abutment slopes are irregular with small gullies almost parallel to the dam axis.

There are thick sandstone beds outcropping on both the abutments. There are numerous outcrops and the most significant overburden deposits are limited to nullah and associated alluvial slopes. The narrow river channel is mostly filled with alluvial material consisting of sandy gravels, cobbles and occasional boulders. Some shale beds have been noted on the upstream and downstream side of the major sandstone beds.

The exposed rocks are generally weathered. The weathering cover is estimated to vary from 10 ft to 15 ft There are minor local faults and shear zones. Joints are closely spaced and well developed, particularly in hard sandstone. It is noted that a massive sandstone bed is present all along the dam alignment. This sandstone is generally of good quality and fresh under a thin layer of weathering. Two investigation boreholes were drilled to 202 and 252 ft deep, respectively, during the pre-feasibility study and six boreholes spanning from 100 to 300 ft deep were drilled during the feasibility study along the dam axis and the nullah bed to find engineering properties of sub-surface strata and the depth of the bedrock under the overburden. The rock is concluded to be moderately strong to strong.

Spillway. The proposed spillway is located on the right abutment. The crest of the spillway has almost the same alignment as that of dam axis, and is founded on the same sandstone ridge. A massive sandstone is exposed in the greater part of the spillway area. The exposed sandstone rock which will form the foundation is fairly indurated, moderately strong to strong having variable

particle size and cementing material. Joints are generally sparsely spaced due to massive nature of the sandstone.

The thick massive sandstone bed is available under the spillway crest as well as under the greater part of the chute. However, some part of chute together with stilling basin will be founded on siltstone/shale beds with interlayered sandstone. Two investigation boreholes were drilled in the vicinity of the chute area. The water pressure test results show very low permeability.
Provision of drainage galleries, relief wells, and drainage mesh seems to be sufficient to control the uplift pressures and seepage control.

Reservoir Area. Surface geological mapping of the reservoir area could not be carried out due to restricted access to the area. As a result, assessments of landslide hazards, mass movement, or location of significant tectonic structures (faults and shear zones) could not be performed. It is known that the region is tectonically affected; hence a number of minor faults may be present in the area. A major fault known as Kurram Fault passes through the northern part of the reservoir which is about 17 km upstream from the dam site. Such hazards may have the potential to affect river flow (e.g. blockage), or impact water seepage from the reservoir. The presence of active faults in the reservoir area could have an influence on potential reservoir triggered seismicity. Slope stability studies have not been conducted at the dam site in the area immediately upstream of the dam; however a preliminary level Reservoir Geological map has been prepared with the help of satellite Google image in order to identify the physiography and lithological units of the reservoir area during the present study. The identified lithological units are marked on the satellite image with the help of physical features interpretation and the available geological literature of the regional and local dam site geology.

The reservoir area is generally underlain by the Panoba Shale, which is overlain by the Habih Rahai limestone. This in turn is overlain by the Kamlial formation of the Rawalpindi Group which is the dominant rock unit at the dam site and in the reservoir area. The Kamlial Formation consists of sandstone and shale. The sandstone is mostly massive, fine to medium grained, moderately hard to hard, sparsely jointed, associated with thin alternate beds of shale / siltstone. The shale is thinly bedded, soft to medium hard, moderately jointed, interbedded with thickly bedded to massive sandstone. Alluvial riverbed and terrace deposits are widespread in the reservoir area. These consist of loose to medium dense, sandy silty gravels and cobbles with few boulders, gravel and cobbles are rounded to sub rounded.

It is strongly recommended to carry out geological mapping of the reservoir area along with the Neo-tectonic Studies upstream and downstream of the dam site in order to study the behavior of the reservoir after impounding.

Diversion and Power Tunnels. The two tunnels are closely spaced and the overall geology would be same for both. The major part of both the tunnels will pass through the massive sandstone bed. The sandstone is generally moderately hard to hard and the beds are dipping in the downstream direction at angle of 70° to 75°. The shale beds which will be encountered are softer and weaker.

Generally, the rock conditions along the tunnel alignment are good and there appear to be no problems for tunnel excavation; however, soft rock zones will need proper support and treatment. No seepage is expected during excavation as the ground water table was not been encountered during drilling.

Powerhouse I. At the Powerhouse I site, similar conditions prevail: up to five feet of overburden consists of loose and highly weathered sandstone and the underlying bedrock is hard to very hard, moderately weathered sandstone. The permeability, as determined from tests in the borehole, is low.

Weir II, Tunnel and Powerhouse II. The river channel bed of the Kurram River at the proposed site for Weir II is filled with alluvial material mostly consisting of sandy gravel, cobbles and occasional boulders. Sandstone bedrock is exposed on the right abutment of the weir. The left abutment slopes are covered with overburden material that consists mostly of loose to semi consolidated sandy gravel and few boulders. Sandstone bedrock is present at the Weir II site beneath 24-32 feet of unconsolidated alluvium. Boreholes along the tunnel alignment indicate that it will pass through alternate beds of sandstone and shale. The powerhouse will be located on sandstone, underlain by thin beds of shale. The foundation rock appears to possess suitable strength for the powerhouse, with little permeability, but consolidation grouting will be performed.

The geology maps show that alternating beds of sandstone and shale are exposed along the tunnel. At places, the beds are quite thin. No prominent structural discontinuities or structural abnormalities were noted in the surface mapping.

It is noted that a 100 ft length which, has insufficient cover, will need appropriate additional support and appropriate excavation methods. Due to presence of non-homogenous strata special care, support and treatment will be required during excavation.

Powerhouse II is located on a thick sandstone bed that is underlain by thin beds of shale. A borehole was drilled at the powerhouse site. It is inferred that the foundation rock is sound and is a suitable foundation for the proposed powerhouse.

Weir, Tunnel and Powerhouse III. Most of the river channel along the Weir III axis is covered with overburden material and that sandstone beds are exposed on both abutments. The surface geological mapping does not show any structural anomaly in the area.

Alternating beds of sandstone and shale are exposed along the entire alignment of the tunnel. The sandstone is dominant rock type. Shale beds are also well exposed but they are thinly bedded. The beds strike across the tunnel alignment and dip steeply towards the inlet portal. No significant structural discontinuities or anomalies have been mapped.

The proposed powerhouse is located on an exposed sandstone bed which is shown on the surface geological map. The joints are generally moderately to widely spaced in the vicinity of the powerhouse location. No significant abnormality or geological structure has been noted in the geological mapping at the powerhouse location.

4.2.2.4 Component 3

Component 3 structures will be centered on the Kurram Garhi Weir and its canals, including the new Thal Canal to the east. Based on the regional geological map, it appears as if the Kurram Garhi Weir is sited in an area underlain by sandstone. Beyond the investigations performed for the Kurram Garhi Weir, no geological exploration has been done for the new structures proposed under the Component 3.

Thal Canal System. The brief description of physiography and geological conditions of the command areas of the Thal Canal presented in the following paragraphs are based on the satellite image interpretation studies. About 90 percent of the soils are developed in the piedmont plain and about 10 percent in the river plain. Sandy loam and Sandy clay loam is the major textural class. Clays and loamy sands, however, form significant part of the landscape. Another landscape unit of the command area constitutes of the alluvium from Kurram River. This is brown to dark brown in color and dominantly silty clay in texture. Some silty clay loams are also found.

Remodeling of Existing Marwat and Civil Canal System. Geotechnical investigations have not been carried out for any portion along any of the Component 3 canals; therefore geotechnical assessment without sub-surface information could not be made.

4.2.2.5 Seismicity Issues

Regional Tectonics and Stratigraphy. The collision tectonics in the Himalayas and geodynamic history of the region are represented by the Indus and Shyoke sutures which are distinct features resulting from the convergence of the Indian and Eurasian Plates. In northern Pakistan, another prominent tectonic feature is the Kohistan Island Arc, a zone sandwiched between the two plates. In the west and northwest, near the Afghan border, collision involving the crystalline basement of the Indian Plate is substantially different from the collision between the Indian Plate and the Eurasian Plate. Unlike the Himalayas, thrusts related with collision have involved a transitional sub-oceanic crust rather than the crystalline basement (Asif et al., 2003).

In contrast to the Indian Plate-Kohistan collision zone in northern Pakistan, where the uplift has been so severe that the suture zone exposed the base of the Kohistan crust in contact with the basement gneisses of the Indian Plate, the Waziristan-Kurram suture zone between Indian Plate and Afghanistan preserves a more or less complete stratigraphic record of collision.

The Kohat Plateau is located towards the north and northeast of the project site. The northern boundary of the Kohat Plateau is marked by the Main Boundary Thrust , a long thrust running from Parachinar in the west to Murree in the east. Further east, it takes a sharp bend along the Hazara-Kashmir syntaxis and then extends all along the Himalayas up to Aasam. The southern boundary of the Kohat Plateau is marked by the Karak Thrust.

Immediately west of Bannu, the Pliocene-Pleistocene Ahmadzai conglomerates are deformed, involved in a monocline developed east of a major upright fault structure, the Kurram fault. This N-S fault runs parallel to the Chaman fault which represents the transform boundary between the Indian and Eurasian Plates on the western side of Pakistan.

East of the Bannu basin, the Salt Range and its Trans-Indus ranges are present; the boundary between these ranges is represented by the strike-slip Kalabagh fault. The trans-Indus ranges, the Bhittani range, Surghar range, and the Khisor range are bounded by thrust faults.

It is clear that the project is located in a tectonically active region due to proximity of the collisional boundary of the Indian and the Eurasian plates. As the plate movement is still going on, stress develops in the shallow crust and is released in the form of earthquakes.

Significant Historic Earthquakes. The catalogue of historical earthquakes for this region is rather sparse and probably highly incomplete. The historical data are few and concentrated mainly on the centers of the colonial administration.

Before the establishment of seismological observatories, which began at the beginning of 20th century, intensity data collected from the historical records was the only source of earthquake information. Historical earthquake data includes a general account of damage/ loss to life and property.

The Kangra earthquake occurred on April 4, 1905 in the north-west Himalaya. The earthquake was located in northern India and was one of the first devastating earthquakes of the 20th century. The Punjab Government estimated that more than 20,000 of its ≈ 375,000 epicentral population were killed, and that 100,000 buildings were destroyed by the earthquake (Ambraseys and Bilham, 2000). The economic costs of recovering from the earthquake were estimated at 2.9 million (1905) rupees (Ambraseys and Bilham, 2000). Although this earthquake is not the only severe event known in the western Himalaya, it has the largest death toll and is the first to have occurred since the development of instrumental seismology. Gutenberg and Richter published a magnitude of Ms = 8 for the 1905 event. Subsequent estimates for the magnitude of the event range from M = 8.6 to Ms = 7.5 (this study used a M_w=8.5) (Ambraseys and Bilham, 2000).

The 1935 Quetta earthquake occurred on May 30, 1945, in Quetta, Pakistan. It is estimated that there were 30,000 fatalities (USGS, 2013). Ambraseys and Bilham (2009) calculated the magnitude of the event to be M_S=7.7. The towns of Quetta and Mastung were totally destroyed along with 100 villages (Ambraseys and Bilham, 2009). It is believed that this rupture was associated with the zone of faults that lie along the east edge of the Chiltan range with extends to the south passing the towns of Mastung and Kalat. The mechanism was most-likely a left lateral strike-slip event (Ambraseys and Bilham, 2009).

Review of Prior Studies. The Feasibility Study (KTDC, 2004) only included a deterministic approach to develop the seismic parameters for the dam and appurtenant structures. The resulting Design Basis Earthquake (equivalent to the Maximum Credible Earthquake or MCE) of 0.20g was recommended for the design of the dam. In light of the active tectonic environment and proximity to the transform boundary of the Indian and Eurasian tectonic plates, the previous seismic hazard evaluation is considered to have underestimated the seismic design parameters.

During previous studies, selection of the seismic design parameters used methodologies and guidelines that are not in keeping with current practices for seismic hazard evaluations on dam projects, such as the industry standard guideline published by the International Congress on Large Dams (ICOLD, 2010). The seismic hazard evaluation should account for more realistic earthquake source modeling and also use a probabilistic approach.

On the basis of review of the previous studies, it was decided that a re-evaluation of the seismic hazard analysis be carried out, to include:

- Effects of seismic potential of the Kurram and Karak Faults in the deterministic analysis.
- A probabilistic analysis based on recorded seismicity and maximum magnitude potential of the faults and/or areal seismic sources to evaluate the Operating Basis Earthquake (OBE) and Safety Evaluation Event (SEE)/Maximum Design Event (MDE) in accordance with ICOLD Guidelines.

The failure of the Kurram Tangi Dam, if an MCE were to occur, could pose a great environmental hazard. Therefore, a realistic evaluation of seismic hazard is imperative in mitigating the effects to the dam and appurtenant structures.

Seismic Design Criteria. ICOLD guidelines for Large Dams were followed to provide guidance on the SEE, OBE and the Design Earthquake for the dam and appurtenant structures.

- Safety Evaluation Earthquake. Because the dam is a high hazard structure, with large potential consequences in terms of life and property should it fail catastrophically, it is recommended that the SEE be defined as the 10,000 year return period event. This guidance is based on ICOLD (2010). It is further recommended by ICOLD that the SEE should be used as the design event for all components of the dam necessary for retaining or controlling water and for those critical for dam safety.
- Operating Basis Earthquake. Following the ICOLD guidelines, the OBE represents the level of ground motion at the dam site for which only minor damage is acceptable. It is recommended that the OBE be defined as the 145 year event as calculated from the Probabilistic Seismic Hazard Analysis.
- 475 Year Return Event or Local Building Code. Finally, it is recommended that the design basis for appurtenant structures, excluding those that are critical for dam safety, be the 475 year return period event. It is further recommended that the local seismic building code be followed if it is greater than the 475 year event.

Evaluation of Design Criteria. By separating all components into critical or non-critical structures the design criteria can be evaluated. The definition of a critical structure and non-critical structure are as defined in ICOLD, 2002.

- **Critical structures**: a critical structure is one whose seismic failure is the loss of function or damage which could lead to failure of the main dam and/or other important appurtenant structures. Failure may result in uncontrolled releases of water from the reservoir, and/or generate unacceptable downstream hazard. The design should provide a structure able to safely withstand the MDE, it means a structure able to operate and make releases to protect the dam against failure.
- **Non-critical structures**: a non-critical structure or "non-safety related" structure is one in which failure or damage would not lead to failure of and /or damage to the main dam, nor would it inhibit the making of required releases to protect the dam. The design should provide a structure able to operate after the OBE.

ICOLD guidelines recommend that if the safety of a dam is critically dependent on operability of an associated structure, then the structure should be designed to resist the SEE.

A state of the art seismic hazard assessment was performed using probabilistic and deterministic approaches to provide a comparison to the previously developed Design Basis Earthquake (Peak Ground Acceleration PGA = 0.20g). The newly developed values follow the state of the practice in performing seismic hazard analyses, include updated relationships and follow ICOLD guidelines (ICOLD, 2010). The results are presented for each feature of the project, not only the dam site as calculated during the feasibility stage. The values are presented in the table below.

Table 4-1: List of Project Features and Recommended Design Criteria

Feature	Recommended Design Criteria	Ground Motion (PGA, horizontal)[3] (g)			Critical Structure
		SEE	475	OBE	
Main Dam	SEE, 475 & OBE	0.80	0.18	0.09	Yes
Spillway –Gated Structure This includes the ability to access the gate controls and operate the spillway gates after an earthquake	SEE, 475 & OBE	0.80	0.18	0.09	Yes
Protective Dike for Spillway	OBE	-	-	0.09	No
Diversion Tunnels[1]	SEE, 475 & OBE	0.80	0.19	0.09	Yes
Kaitu Weir (18 feet high)	475 & OBE	-	0.19	0.09	No
Weir II (26 feet high)	475 & OBE	-	0.18	0.09	No
Weir III (75 feet high)[2]	SEE, 475 & OBE	0.70	0.17	0.09	Yes
Powerhouses	475 & OBE	-	0.19	0.09	No
Powerhouse Appurtenant Structures	475 & OBE	-	0.19	0.09	No
a. Tunnel (not including portals)	475 & OBE	-	0.19	0.09	No
b. Penstock	475 & OBE	-	0.19	0.09	No
Emergency power sources and control panels	SEE, 475 & OBE	0.80	0.19	0.09	Yes

Notes: 1. Potential failure of the valves, gates, and associated structural elements could result in uncontrolled release of the reservoir. 2. Failure may generate unacceptable downstream hazard. 3. If the feature listed has several locations the ground motion values are presented for the highest PGA, the structure (i.e. Main Dam or Weir) that is closest to the identified feature should be used.
SEE: Safety Evaluation Earthquake, 475: 475 Year Return Period Event, OBE: Operating Basis Earthquake (as defined by ICOLD)

The PGA developed for the feasibility level design (0.20g) is significantly lower than the PGA developed following current ICOLD guidelines (0.80g). One of the main differences in the current seismic hazard analysis compared to the previous analysis is that updated attenuation relationships were used in the calculations. In addition the Kurram and Karak faults, located less than 10km from the project site, were considered to be active.

The design values calculated in the current site specific hazard analysis were developed to provide a comparison to the feasibility level design values. It is assumed that the 0.60g increase in PGA will require modifications that most-likely will have a major impact on the dam design. These modifications could negatively impact the cost and schedule.

4.2.3 Soils

4.2.3.1 Introduction

This section assesses and evaluates the irrigable lands in the command areas based upon available data sources. The soil data are interpreted and evaluated in terms of land capability classes for irrigated production.Soils with salinity and water logging problems are also identified.

Baseline Data . The largest part of the baseline information regarding the Command Areas of Component 1 and Thal (Component 3) has been extracted from the Feasibility Report (KTDC, 2004), which is based mainly on the Reconnaissance Soil Survey Report, Bannu Basin (Soil Survey of Pakistan, 1973). Specific studies about the soils in Component 2 are not available. Specific soil studies are also not available for the Civil Canals and Marwat Command Areas. The soils of the Bannu SCARP area (WAPDA, 1981) are considered a good proxy for the soils in the Civil Canals and Marwat command areas.

It is assumed that relevant properties of the soils in the project area have not changed in the period between 2004 and 2013. This is a reasonable assumption because there have not been considerable development efforts which could have affected the soils.

The suitability of the soils in the command areas for irrigated agriculture is also assessed, according to the land capability classification under project conditions.

The classification is similar in structure to the system of the U.S Bureau of Reclamation (U.S.D.I, 1953) with some modifications made to suit local conditions. Six land classes are designated (I to VI), while subclasses, which represent hazards/limitations are shown by small letters used as suffix with the class numerals. Four classes, I through IV, are for arable lands, class V, a provisional class, is for lands presently unfit but with potential for agriculture after improvement. Class VI land is agriculturally unproductive because it does not meet the minimum requirements of cultivable lands.

Soils are rated under project conditions, when irrigation, increased input use, improved crop varieties and cultural practices are practiced. The ratings are based on field observations, interviews with progressive farmers and results of the Agricultural Research Stations.

IDC collected soil data during field visits to 23 sites shown on Map 4-8. The soil data are observations of a few samples in small areas. Therefore, it is impossible to generalize and extrapolate these data because the extent to which these sites are representative of the soils in the various components is unknown. Owing to the security situation it was not possible to physically sample and test soil properties. Therefore studies of actual soil conditions focused on determining the type of soils, suitability and problems (e.g. salinity, drainage) by visual observation and interviews with residents of the sites. It can be concluded that the baseline data collected in 2013 have not contributed much to the already existing knowledge of the soils. Relevant results of the baseline study will be discussed by respective components.

It can be foreseen that in the various project phases and components different potential impacts of project infrastructures (weir, tunnel, Powerhouses, roads) related to soil and land conditions (slopes, climate, vegetation) will emerge such as erosion, landslides, soil contamination, water logging, salinization and soil compaction. These potential impacts and mitigation measures are the subject of Chapter 5.

Erosion potential in the Area of Influence. High resolution satellite imagery was used for the interpretation and analysis of erosion in the KTDP AOI. Three categories of erosion have been defined based on intensity and severity and in function of the geological, geomorphological and climatological conditions in the AOI and in its vicinity. Three categories have been defined: more significant, moderate significant and less significant. Erosion in the AOI based on this categorization is shown in Map 4-9.

Soil erosion is a component of the desertification in the Kurram River watershed. The proximate physical cause of the soil erosion is the reduction of plant cover. As forests occupy only a few (1.4) percent of the area most of the soil erosion is in the rangeland (70 percent). Currently the major degrading factor is the overexploitation of rangeland for fuel wood and second comes overgrazing. Their combination is particularly destructive. Even in protected forests, and also on most of rainfed cropland, accelerated man-made erosion is widespread.

Soil erosion is irreversibly advanced on most mountain slopes, thus half of the Kurram River watershed is ecologically dead. Gravelly fans and terraces, in the upper catchment in areas of temperate climate, are less susceptible to erosion, and erosion damage is reversible.

The AOI has a relatively plain landform compared to the upper catchment areas of Kurram and Kaitu Rivers. To the west, the areas adjacent to Janikhel up to Khairokhel lie along the foot hills of north-south oriented mountains, which are adversely affected by flash floods especially during the monsoon season which prevails from June to September. Hence, these areas are prone to moderate to more significant erosion hazards caused by flash floods and sheet flows.

In the northeast of the AOI near Sadakhel, there are a many nullahs. Owing to the non-cohesive nature of the top soil, water is the principal agent of erosion in this area; particularly along river banks which are prone to more significant erosional hazard.

Erosion leads to enhanced sedimentation which has a number of downstream potential impacts such as shortening of lifetime of the reservoirs, dams, irrigation channels and other water control structures. Current sediment load is 50 – 500 ton/hectare which is very high compared to the internationally accepted 10-20 ton/hectare.

Soil Erodibility. Soil characteristics including depths, texture, structure, percentage of organic matter, and rate of infiltration can markedly affect erodibility of soil. In general terms, the lower the proportion of fine sand, silt and clay and higher the organic matter content, more developed the soil structure, and higher the infiltration, the less erodible the soil will be. All the mountain soils in the watershed are characterized by shallow depth over bedrock, swelling clayey texture with a low amount of fine sand, silt and organic matter and unstable structure. They have low infiltration and high surface run-off due to surface sealing as a result of heavy trampling by livestock and as such they fall within the highly erodible soil group, particularly if they are without vegetation cover which provides them with binding force. On the contrary, the soils of the gravelly fan and terraces, piedmont plains, river plains and terraces, are less erodible. An estimated qualitative analysis of erodibility of the soils by landforms in Kurram river watershed is given in Table 4-2.

Rainfall Erosivity. The magnitude of surface soil erosion is directly related to the type and intensity of rainfall. The Kurram River watershed in all its length and breadth, receives monsoon rains of high intensity rainfall. All the land systems (landforms) therefore, are subject to rainfall

erosivity to various degrees depending upon their topographic forms and the plant or crop cover they support at the time of rainfall. The mountain systems with steeper slopes and without vegetation cover have higher erosivity as compared to gentler sloping landforms. The qualitative analysis of erosivity of various land forms occurring in the watershed is presented in Table 4-2.

Bank-Cutting / Erosion. Severe bank-cutting/ erosion by the rivers in the watershed is a serious problem to agriculture land and habitations along the rivers. As a result of cutting the trees and other woody vegetation in the upper watersheds of the rivers and streams, the mountain slopes have been rendered barren. Consequently, the rainwater is not absorbed into the soil, resulting in loss of water as runoff or flash floods down in the rivers and streams. Since flow of water is not sustained, it causes under mining and scourge of banks during high peak flow periods.

Landslides. The main factors resulting in landslides in the Kurram River watershed are structure and incline of mountain slopes; rock type and number and density of natural fracture planes.

The majority of landslides in the watershed area are initiated on slopes between 30 to 45 degrees. Small shallow slides tend to occur more frequently on un-vegetated slopes, while much larger, deeper slides tend to occur independent of the vegetation cover. The existence of forests may increase the interval between slides, but in the long run may not prevent them if the terrain is inherently unstable. The ability to resist erosion hazard caused by the rainfall is largely dependent on the percentage cover and vigor of vegetation at ground level, viz. the shrubs, grasses, forbs and litter

4.2.3.2 Component 1

The Canal Command Areas of this Component are Spaira Ragha and Sheratalla.

Soils: General Nature and Texture Classes

Spaira Ragha Canal Command Area: The Spaira Ragha Command area has a gross acreage of about 5,245 acre. The Spaira Ragha area consists mainly of weathered sandstone, partly of piedmont plain including some alluvial fans and weathered shale. This weathered shale is severely eroded in places and has taken the shape of deep gullies. The texture ranges from loamy sand to silty clay in the Spaira Ragha Plain. Near the foothills on comparatively more sloping parts, the soil texture is mainly loamy sand. These loamy sands are deeply homogenized places, up to four feet deep. The soil texture in hillsides increases in clay content from the hillsides to the valley. In the northern part of the piedmont part of the plain soils are generally loamy in texture (KTDC, 2004). A breakdown of the different textures is presented in Table 4-3 and their distribution is shown on Map 4-1.

The structure of the soils varies from massive (sand) to weak (sandy loam and moderate (clay loams and silty clays) sub-angular blocky. The soils are non-saline and non-sodic. The color of soils is dark reddish brown. The soils are homogeneous, porous, permeable, somewhat excessively drained, moderately to strongly calcareous, and have a pH value of about 8.

Table 4-2: Qualitative Analysis of Erosivity by Landform and Soils in the Lower Kurram Watershed

Sr. No	Landform	Soils	Rainfall Erosivity	Soil Erosivity	River Bank Cutting
Arable Soils (Irrigated)					
1	Old piedmont plains, level	V. deep silt loams / clay loams	Moderate	Moderate	High
2	Subrecent piedmont basins	V. deep silty clays	Low	Low	High
3	Old river plains, level	V. deep silty clays	Low	Low	High
4	Subrecent slightly concave basins / channel infills	V. deep silty clays and silty clay loams	V. Low	V. Low	High
5	Level plains	V. deep silt loams / clay loams	Low	Low	High
Arable Soils (Rainfed)					
6	Old piedmont plains, nearly level	V. deep well drained sandy clay loams	Moderate	Moderate	High
7	Gently undulating plains	V. deep sandy loams and sandy clay loams	Moderate	Moderate	High
8	Level plains	V. deep silty clays and sandy clays	Low	Low	High
9	Subrecent sandy plains, undulating	V. deep sands / loamy sands	Low	Low	High
10	Subrecent slightly concave basins	silty clays and silty clay loams			High
11	Level plains	V. deep silt loams , saline (gypsic)	Low	Low	High
Non-Arable Soils					
12	Steeply dissected mountain slopes (SIWALIKS)	V. patchy v. shallow gravelly loams sandy loams over bed rock	High	High	High
13	Gravelly hills	Shallow gravelly loams / sandy loams, excessively drained	High	High	High
14	Gravelly piedmont slopes	Deep gravelly loams / sandy loams somewhat excessively drained	Moderate	Low	High
GL	Gullied land	Variegated soils	High	High	High
DL	Dune land	Deep shifting sand	Low	Low	High
ML	Marsh land	Open water muddy periphery	Low	Low	Low
RB	River bed	Sandy / gravely / stony	Low	Low	High
UL	Urban land				

Source: Table 5.2.10 (1), KTDC (2004)

Table 4-3: Soil Textural Classification-Spaira Ragha Command Area

Mapping Symbol	Soil Textural Class	Acreage	Percentage
C	Deep Loamy sands	1,510	28.8
MC	Sandy loams with loamy sand surface	1,548	29.5
MF	Deep Sandy clay loams/Clay loams	811	15.5
F	Moderately deep Clays/Silty clays	312	5.9
Gf	Gravelly fans consisting of shallow loamy soils over bed rock with 30 percent surface slope	189	3.6
Lh	Low hills/Exposed bed rocks	875	16.7
	Gross Command Area (GCA)	**5,245**	**100**

Note: Culturable Command Area (CCA): 4,080 Acre (PES et al, 2011a, Ch.1, Introduction)

Sheratalla Canal Command Area. The Sheratalla Canal command area (GCA is about 15,840 acres) is formed in alluvium derived from the local hills, comprising mainly sandstone and some shales. The piedmont plains, alluvial fans/gravelly terraces, nullah beds and low hills constitute the canal command area. Some 60 percent of the entire area is littered with gravels, cobbles and boulders. These piedmont plains are mainly formed in porous, permeable and well-drained soils. The texture of the soils varies from loam/silt loam to sandy loam in the command area. The texture of soils along with their main characteristics is described in Table 4-4 and their distribution is shown on Map 4-3.

The content of nitrogen and organic matter is low. A small part of the area (mapping symbol: Map) has slightly saline to strongly saline soils (ECe[27] value between 4 to 32 dS/m at 25°C). All the soils are moderately to strongly calcareous (KTDC, 2004).

Table 4-4: Soil Textural Classification-Sheratalla Command Area

Mapping Symbol	Soil Texture Class	Acreage	Percentage
M	Deep to very deep loamy soils with loam to sandy loam surface.	6,379	40.3
MG	Deep loamy soils with 15 to 50 percent gravel and cobbles littered on the surface.	3,941	24.9
MGg2	Moderately deep loamy soils containing 30 percent gravel in the profile and also littered on the surface	2,228	14.1
Ma	Deep loamy salt affected soils having ECe value ranging between 4 to 32 dS/m at 25°C in patches	51	0.3
MGg3t	Gravelly fan comprised of shallow loamy soils with more than 50 percent gravel littered on the surface and as well as in the profile, with surface slope of 6 to 30%	2,967	18.7
LH	Low Hills	274	1.7
	Gross Command Area	**15,840**	**100.0**

EXPLANATIONS

[27] ECe: electrical conductivity of saturated soil paste

M= Loamy soils, G= Gravel littered on the surface, g2= 15 to 30 percent gravel by volume in the soil profile, g3=More than 50 percent gravel by volume in the soil profile, a= salt affected soils, t= Limitation of surface slope.
Note: Culturable Command Area: 12,300 acre (PES et al, 2011a, Ch.1, introduction)

The IDC field team visited five sites for soil identification in Component 1. It must be noted that these sites are concentrated in the surroundings of Spinwam and Datta Khel and are not representative of the soils of the command areas of Spaira Ragha and Sheratalla. The five sites have shallow soils of sandy and clayey texture. Consultation with primary and secondary key informants confirms that most of the area in Component 1 is suitable agricultural land. Irrigation is the basic condition needed to make this land productive.

Land Capability Classification. The land capability classification has been made under project conditions when adequate irrigation water is made available and improved crop varieties including cultural practices are provided. Soil limitations that would affect the adaptation to certain crops are related to soil texture (sandy, sandy loam with loamy sand surface, clayey nature).

Spaira Ragha Command Area. Taking into account the above mentioned limitations, the soils of Spaira Ragha have been grouped into four land capability classes under project conditions (KTDC, 2004). Their statistics are presented in Table 4-5.

Table 4-5: Land Capability Classes under Irrigation (Project Conditions)-Spaira Ragha Command Area

Mapping Symbol	Land Capability Class	Acreage	Percentage
I	Very Good Agricultural land	811	15.5
IIIs-1	Moderate Agricultural land	312	5.9
IIIs-2	Moderate Agricultural land	1,548	29.5
IVs-3	Marginal Agricultural land	1,510	28.8
VI	Unproductive Agricultural land (built-up areas, roads)	189	3.6
VI	Unproductive Agricultural land (hills, gravelly fans)	875	16.7
Gross Area		**5,245**	**100**

EXPLANATIONS
S-1 = Clayey texture, S-2 = loamy sand texture, S-3 = Sandy texture
Source: Table 3.20, Annexure 2, KTDC, 2004

The distribution of land capability classes under project conditions is presented on Map 4-10.

Sheratalla Canal Command Area. A land capability classification has been made under Project conditions when salt-affected soils of the command area are reclaimed, surface gravel is scrapped, irrigation water has been provided and improved crop varieties and cultural practices are introduced. Four land classes have been identified in the canal command area under project conditions. These are presented in Table 4-6.

Table 4-6: Land Capability Classification under Irrigation (Project Conditions) – Sheratalla Command Area

Mapping Symbol	Land Capability Class	Acreage	Percentage
I	Very Good Agricultural land	10,371	65.5
III g2	Moderate Agricultural land	2,228	14.1
VI Gg3t	Unproductive Agricultural land (gravelly fans)	2,967	18.7

VI h	Unproductive Agricultural land (low hills)	274	1.7
Gross Area		**15,840**	**100**

EXPLANATIONS
I to VI land capability classes
G=15 to 50 percent gravel littered on the surface; g2=15 to 30 percent gravel by volume encountered in the soil profile, g3=30 to 50 percent gravel by volume encountered in the soil profile; t = limitation of surface slope and h= limitation of low hills
Source: Table 3.14, Annexure 2, KTDC, 2004

The distribution of the land capability classes under irrigated (with project) conditions is shown on Map 4-11.

4.2.3.3 Component 2

Specific studies about the soils in Component 2, particularly of the reservoir area are not available. The IDC field team visited 4 sites. The IDC report mentions that shallow loamy textured soils are dominant in the cultivated areas. It is reported that no water logged, sodic or saline areas are present in Component 2. Since there is no command area in Component 2, a description of soils, soil texture classification and soil capability classification are not relevant for this component.

4.2.3.4 Component 3

Soils: General Nature and Texture Classes

Thal Canal Command Area. Predominantly the soils of the area have been developed in the piedmont alluvium with minor admixture of river material. The soils are moderately well to excessively drained, deeply homogenized and calcareous. The soils are dominantly non-saline and non-sodic and their pH value ranges between 8.0 and 8.4. About 6.0 percent of the gross area has moderately to strongly saline soils. According to the Feasibility report of 2004, salinity/sodicity is found in the flood plain deposits near the banks of the Kurram River and along Kashu Nullah where saline sediments have been deposited. The content of organic matter is generally less than one percent in all the soil types (KTDC, 2004).

Soil texture ranges from loamy sand to silty clay. Soil texture classification of Thal command area is extracted from soil associations (distinguished in Soil Survey of Pakistan, 1973) and is presented in Table 4-7. The soil distribution is shown on Map 4-4.

Table 4-7: Soils Textural Classification-Thal Canal Command Area

Mapping Symbol	Soil Textural Class	Acreage	Percentage
C	Loamy sand	9,350	11.2
MC	Sandy loam	19,250	23
M	Silt loam	6,620	7.9
MF	Sandy clay loam	16,160	19.3
MF	Clay loam	750	0.9
MF	Silty clay loam	2,170	2.6
F	Silty clay	13,700	16.4
	Miscellaneous areas	15,600	18.7
Gross Command Area		**83,600**	**100.0**

Note: CCA = 68,000 acre (KTDC 2004)

Bannu SCARP Area. Specific soil studies are not available for the Civil Canals and Marwat command areas. The soils of the Bannu SCARP area (WAPDA, 1981) are considered a good proxy for the soils in the Civil Canals command area and for the Marwat command area.

The Bannu SCARP soils comprise the flood plain deposits of the Kurram and Tochi rivers which largely include the Civil and Marwat Canal Command Areas. The alluvium is of highly mixed nature and expected to have a different mineralogical makeup to piedmont deposits. The soils are excessively to well drained and are moderately to strongly calcareous. These soils exhibit varied shades of brown/dark brown to grayish color. The content of organic matter is low.

Soil Textural classification ranges from coarse to fine, and moderately fine texture is dominant. The structure varies from massive to weak and moderate sub-angular blocky. The breakdown of different textures is presented in Table 4-8. The distribution of different soil textural classes is shown on Map 4-1.

Table 4-8: Soil Textural Classification-Bannu Scarp Area (As a Proxy for Component 3)

Mapping Symbol	Soil Textural Class	Acreage	Percentage
C	Loamy sand/Sand	5,700	3.0
MC	Sandy loam	1,900	1.0
M	Loam/Silt loam	28,500	15.0
MF	Silty clay loam/clay loam	140,600	74.0
F	Silty clay/clay	1,900	1.0
Misc. Area	Agriculturally Unproductive land	11,400	6.0
Gross Bannu SCARP Area		**190,000**	**100.0**

According to the surface salinity survey, about 68 percent (129,200 acres) of the area is non- saline, non-sodic soils. The remaining 30 percent (57,000 acres) is salt-affected. Of this 10, 5 and 15 percent of the area is strongly, moderately, and slightly saline, respectively. About 15 percent of the total saline area would require initial leaching and amelioration. The distribution of the different surface salinity classes is shown on Map 4-13.

The 14 sites studied in Component 3 have predominantly deep soils of clayey texture. The field data and consultations confirm that most of the area in Component 3 is productive agricultural land under irrigation. It was observed that there are some places, for example Gandi Khan Khel, Sarai Naurang and Ghani Khel, that have problems such as scarcity of surface water, salinity and a lack of drainage. The data also suggest that salinity and drainage problems (three in 14 sites or 20 percent of the sites) are more or less in the same order of magnitude as the 30 percent salt-affected soils mentioned in WAPDA (1981).

Land Capability Classification-Thal Command Area. The main limitations affecting the choice and production of crops for irrigated agriculture under optimal conditions are related to soil texture (sandy) and clayey nature.

Keeping in view the above limitations, the soils have been grouped into five land capability classes under project conditions. The statistics of land capability classes are extracted from the component land capability association/soil association and are summarized in Table 4-9.

Table 4-9: Land Capability Classification-Thal Canal Command Area

Mapping Symbol	Land Capability Class	Acreage	Percentage
I	Very Good Agricultural land	23,530	28.1
IIs-1	Good Agriculture land	15,870	19.0
IIs-2	Good Agriculture land	19,250	23.0
IVs-3	Marginal Agriculture land	9,350	11.2

	Culturable Command Area (CCA)	68,000	81.3
VI	Agriculturally Unproductive land	15600	18.7
Gross Command Area		**83600**	**100.0**

EXPLANATION
S-1 = Clay texture, S-2 = loamy sand texture, S-3 = Sandy texture
Source: Table 3.6, Annexure 2, KTDC (2004).

The distribution of land capability classes in the Thal command area is presented on Map 4-12.

Land Capability Classification- Bannu SCARP Area. The soils of Bannu SCARP area have been evaluated in land capability considering the ultimate development conditions when improved agronomic practices are introduced and salt-affected soils are reclaimed. Soil limitations that would affect crop suitability and production are related to soil texture (clayey and sandy textures).

Keeping in view the above limitations, the soils have been grouped into five land capability classes. These are presented in Table 4-10.

Table 4-10: Land Capability classification under Project Conditions

Mapping Symbol	Land Capability Class	Acreage	Percentage
I	Very Good Agricultural land	28,500	15.0
IIs-1	Good Agricultural land	142,500	75.0
IIs-2	Good Agricultural land	1,900	1.0
IVs-3	Marginal Agricultural land	5,700	3.0
VI	Agriculturally Unproductive land	11400	6.0
Gross Area		**190,000**	**100.0**

EXPLANATION
S-1 = Clay texture, S-2 = sandy loam texture, S-3 = Sandy texture
The distribution of above land capability classes is presented on Map 4-14.

4.2.4 Land Use

The land use generally depends upon the availability of moisture including soil, hydrological and climatic conditions of the area. The study of land use through field investigations was not possible due to security problems and hostile conditions in the area; therefore land use information/data are extracted from the 2004 Feasibility Report. It is assumed that land use has hardly changed due to lack of drivers or considerable development efforts in the period between 2004 and 2013.

4.2.4.1 Sources of Information

IDC collected land use data during field visits to 23 sites shown on Map 4-15. The land use data are observations of small areas. As the extent to which land use in these sites is representative of the land use in the various components is unknown, it is impossible to generalize and extrapolate these data. Owing to the security situation, use of maps and GPS was severely limited. Therefore land use conditions were assessed by visual observation and interviews with residents of the sites. The collected baseline data in 2013 are superficial, not complete, missing context and sometimes contradictory (irrigated vs. barani). They are not sufficient to draw conclusions about changes in the land use that could have occurred since 2004. Relevant results of the baseline study are incorporated into the description of the land use of the respective Components.

A second source of information is recent satellite imagery (See Sections 1.3.4.1 and 4.1), which has been interpreted in order to define the existing land use situation in the area. This is the most reliable method for assessing the actual land use. Fourteen classes of land use were identified and developed as GIS layers. These are summarized in Table 4-11.

Table 4-11: Land Use Classification in the Project AOI			
Land Use Class	**Area (Acres)**	**Area (Km²)**	**Area (mile²)**
Airport	247.97	1.0035	0.3875
Barren[28]/Hill	277624.40	1123.5106	433.7899
Built-up	38661.14	156.4567	60.4083
Cultivated	510421.59	2065.6111	797.5369
Flood Plain	29179.98	118.0877	45.5939
Forest	2767.40	11.1993	4.3241
Graveyard	205.54	0.8318	0.3212
Helipad	0.48	0.0019	0.0007
Nullah	61759.64	249.9334	96.4998
Open	48056.91	194.4802	75.0892
Orchard	2434.71	9.8529	3.8042
Plantation	12579.91	50.9093	19.6562
Vegetation	18756.37	75.9046	29.3069
Waterbody	1799.30	7.2815	2.8114
TOTAL	**1004495.32**	**4065.0646**	**1569.5302**

A third source of information is the Feasibility report (KTDC, 2004) which has been consulted, particularly for the canal command areas.

4.2.4.2 Component 1

Catchment area of the Kaitu River. The catchment area of the Kaitu River lies partly in Afghanistan and Pakistan. The catchment area is generally barren, very undulating with higher elevations composed of bare rock surface. There is no forestry or rangeland management. Agricultural land use is both rainfed and irrigated. Rainfed land, depending upon low and erratic rainfall, is generally cropped with low yielding wheat in the Rabi season. Intensive development of irrigated agriculture is limited to the narrow valley area along the Kaitu River. Other types of land present in the area are waste land, current fallow land, low hills, gravelly terraces, nullahs, scattered vegetation and settlements on either side of the Kaitu River.

The Kaitu River Catchment area is shown on Map 4-16. Land use statistics at catchment level are provided in Table 4-12 below.

Table 4-12: Kaitu River Catchment Land Use Patterns (GIS Interpretation)		
Land Use Category	**Area (Acres)**	**Area (Square Miles) (1 sq. mi = 640 acre)**
Barren/ Hill	103,0784	1,611
Built up	22,963	36
Cultivated (Cropped/ Agriculture)	117,625	184
Nullah	25,088	39
Forest	47,782	75
Glacier	1,600	3
Grand Total	1,245,824	1,947
Catchment in Pakistan	108,800	170
Catchment in Afghanistan	1,136,960	1,777

[28] Barren means land that is unused or undeveloped. It may be being used as pasture

Note: In Box 4.1 & 4.2, Chapter 4, KTDC (2004) indicates that the total catchment area of Kaitu River is 1,994 sq. mi. in which 1,790 sq. mi. is in Afghanistan and 204 sq. mi. in Pakistan (172 sq. mi. up to Kaitu weir and 32 sq. mi. between Kaitu weir and confluence of the Kaitu and Kurram Rivers). The differences are negligible.

Within Component 1, four areas could be distinguished in which the project interventions could potentially have impacts on land use:

- Spaira Ragha plain/command area.
- Sheratalla plain/ command area.
- Affected irrigated riparian area downstream of the Kaitu Weir.
- Affected irrigated area riparian upstream of the Kaitu Weir.

The land use of the riparian areas will be described in section 4.2.5 (Agriculture and Irrigation baseline).

The command areas in Component 1 and riparian areas are shown on Map 4-17.

Spaira Ragha Canal Command Area. The cultivated area according to GIS interpretation (2013) is 2,668 acres while barren/ hill area is about 1,588 acres. The land use statistics of the Spaira Ragha Command Area are given in Table 4-13. The difference in cultivated area between the GIS analysis and KTDC (2004) is significant, in the order of 100 percent. However it should be noted, owing to security concerns ground truthing of GIS information was not possible. Determination of the reasons for the difference is not possible without ground truthing.

Table 4-13: Existing Land use of the Spaira Ragha Command Area

Based On GIS Interpretation 2013			KTDC, 2004
Land use Category	**Acreage**	**Percentage of CCA**	**Percentage of CCA**
Cultivated land	2,668	62	33
Barren/ Hill	1,588	37	
Built up	3.75		
Nullah	42	1	
Culturable Command Area	**4,302**	**100**	

Source: Map 4-24.

Note: KTDC (2004) mentions a cultivated land area of 1,343 acre in a CCA of 4,020 acres.

The cultivated land is mainly used for growing of wheat during the winter season (Rabi). Crop yields are generally poor.

Sheratalla Plain. Based on the 2013 GIS analysis, cultivated land in Sheratalla plain covers about 11,479 acres and built up land 320 acres. The breakdown of land use categories is presented in Table 4-14. The difference in cultivated area between the GIS analysis and KTDC (2004) is significant, more than 100 percent. However it should be noted, owing to security concerns ground truthing of GIS information was not possible. Determination of the reasons for the difference is not possible without ground truthing.

Table 4-14: Land use of the Sheratalla Command Area

Based on GIS Interpretation 2013			KTDC 2004
Land use Category	**Acreage**	**Percentage**	**Percentage**
Cultivated land	11,479	62	17
Built up	320	3	
Barren/ Hill	5,982	32	
Nullah	573	3	
Open (not used for any purpose)	72		
Gross Command Area	**18,426**	**100**	

Source: Map 4-25
Note: Table 3-30 in KTDC (2004) mentions a cultivated land area of 2,712 acres in a GCA of 15,840 acres.

The cultivated land is mainly rainfed, remains out of production in the summer season and water is conserved for winter crops. Wheat is the common winter crop. Since 2002-2003 six dug wells (depth to groundwater: about 80 ft) have been constructed for irrigation but their localization and other data (irrigated acreage) are not known.

The data collected in the five sites studied in Component 1in 2013 confirm that these sites have suitable agricultural land. Irrigation is the basic condition to make this land productive. However, a considerable part of the visited sites and surrounding lands (about one third) is too gravelly to be used as cultivated land. Further downstream along the Kaitu River, irrigation is practiced using river water for agriculture in Datta Khel. The cultivated area in this area is approximately 477 acres according to Map 4-18.

4.2.4.3 Component 2

Catchment Area. The Kurram River catchment is bounded to the North by the Koh-e-Sufaid water divide between Pakistan and Afghanistan, to the east by Khyber Agency, Kohat District and Isa Khel, to the south by D.I. Khan District and South Waziristan and to the west by Durand line between the Pakistan and Afghanistan.

The elevation of the catchment boundary varies between 5,000 ft in the south and southeast to as much as 15,000 ft in the northeast, north, west, and southwest. The Kurram River carries perennial flows from snowmelt of Koh-e-Sufaid, which forms the northern and western catchment boundary. The catchment area has a steep slope towards the river. Combined with high intensity rainfall this causes flash floods in various tributaries and the main river.

The catchment or watershed area is generally mountainous and barren. Gentle slopes with thick soil cover have been terraced for arable farming and tree plantation (gravelly terraces) below the steep mountain slopes. The crops grown by the local people are generally wheat/ fodder in winters and millets/ sorghum during summers.

The major part of the catchment has a sparse vegetation cover used as pasture. Runoff in the area is very high. Geological erosion of these young mountains is active and has been further accelerated by man, stripping the vegetation. This has rendered this terrain ecologically dead. Many nullahs drain into the Kurram River bed. The main roads are the Thal-Bannu road and the Thal-Miranshah road. About 25 km from the Afghanistan-Pakistan border, the Kurram watershed starts to display a range of features such as cultivated land (mostly on the left bank), moderate to high erosion, a number of scattered settlements (Bagh, which is south of Parachinar) and a series of Kurram River tributaries falling into the river from the (north) eastern hills. This entire region is intensively irrigated and cultivated through a network of canals, off taking from the River, and constructed by the local

residents, and includes farms, crops as well as terraces being fed by Kurram River water. Just under half a km downstream of the road bridge in Bagh, a large tributary falls into Kurram River.

1.5 km downstream of this point, signs of erosion become more visible, although there is some scattered vegetation cover present in this area. This trend continues further downstream and patches of cultivated and fallow land can be observed here. A few km to the north, large settlements, such as Arawali and Alizai and associated cultivated land start to appear on both river banks. The stretch of the Kurram River between Manduri and Thal is mostly barren with some scattered vegetation on either side of the river. Downstream of Thal, the river turns to the south and agriculture on both the banks is more intensive up to the proposed reservoir area.

The Kurram River catchment area upstream of the Kurram Tangi dam site is shown on Map 4-19. The land use in the Kurram Tangi catchment area upstream of the dam is presented in Table 4-15 below.

Table 4-15: Land Use in Kurram Tangi Catchment Area

GIS Data 2013			KTDC,2004 (a)
Land Use Category	**Land use coverage (Square miles)**	**% of watershed area**	**% of Watershed area**
Cultivated Land	219	9	19 (b)
Forest	321	13	12 (c)
Barren/ Hills	1,896	75	69
Glacier	19	0.5	
Built-up areas	38	1	
Rivers/ Nullah beds	44	1.5	
Total	2,535	100	
Watershed in Pakistan	1,624		
Watershed in Afghanistan	**911**		

Source: Map 4-19.
Notes
(a): calculated over a catchment area of 6,080 sq. miles
(b): defined as cultivable land, including inhabited areas
(c): defined as forest (1.4 percent) and Scrub forest (10.5 percent)

Kurram Tangi Reservoir Area. The reservoir area is generally hilly and barren. There are some forest shrubs and grazing lands. Many nullahs drain into the Kurram River. The main roads are the Thal- Bannu road and Thal-Miranshah road. Agricultural land (1,589 acres), both rain fed and flood/spring cultivated is mainly under wheat and some fodders in winter and some millets and sorghum during summer. Forest cover and barren hills are also present in the reservoir area. Most agricultural land is located along the river banks and the barren areas are mainly on the surrounding hills and mountain slopes. The creation of the reservoir is a potential residual impact and further details on loss of agricultural land, houses and other local resources due to inundation are available in the RPF. Barren/hilly terrain covers 8,025 acres and built up areas 326 acres. Table 4-16 below provides a breakdown of land use classes in the reservoir area.

Table 4-16: Kurram Tangi Reservoir Land Use Statistics	
Kurram Tangi Reservoir Land Use Statistics	
Land Use Category	**Area (Acres)**
Barren/ Hill	8,028
Built up	326
Cultivated	1,589
Nullah	1,493
Water body	0.10
Flood Plain	6.33
Grand Total	11,443

Source: Map 3-3
Note: According to the KTDP Design report (PES at al, 2011a, Ch.1, Introduction) the full reservoir level is 2,127 ft msl with a reservoir area of 10,939 acre.

4.2.4.4 Component 3

Catchment Area. The catchment area of Component 3 comprises the Catchment area of the Kurram River up to the Kurram Garhi Head works, including the catchment area of Kaitu River. The size of the catchment area at the Kurram Garhi head works is 4,684 Sq. miles. A breakdown of the catchment sub areas is presented in Table 4-17.

Table 4-17 :Catchment Sub areas of Kurram River		
Sub-Catchment Areas (Sq. miles) of Component 3		
Kaitu River at confluence with Kurram River	=	1,978
Kurram River at KT dam site	=	2,536
Kurram River between KT dam site and Kurram Garhi Headworks, excluding the Kaitu River Catchment	=	110
Kurram River at Kurram Garhi Headworks	=	4,684
Kurram River between Kurram Garhi Headworks and confluence with the Indus River	=	5,263
Total:	=	9,947

Source: Map 3-15

The existing land use in Component 3 mainly consists of cultivated land (wheat, sugarcane and turmeric). The area east of Kurram Garhi head works is highly fertile land which consists of 30 percent fallow land. This component also includes the Kurram River Flood plains near Bannu, Ghoriwala and Sadakhel. Guava and banana are cultivated around Bannu town. There are also various plantations and vegetation including some forest area in the southern stretch of the project area. There are some open areas north east of Lakki Marwat and few nullahs that drain into the river. This is the area with most built up areas (scattered and clustered) of the three components. Major settlements in Component 3 include Domail, Sada Khel, Bannu, Mobatti, Ghoriwala, Multani Landidak, Naurang Sarai, Janikhel, Gandi Khan Khel, Tajori, Daulat Tajazai, Behram Khel, Khairo Khel, Tatta Khel and Lakki Marwat. There are also many roads connecting this region with the rest of the country. The main road is the Indus Highway which has three link roads joining it from the towns of Alam Shiri Kala from the Thal Plains, and Tajori and Behramkhel from the west of Lakki Marwat. Other roads in the area include the Essa Khel-Mianwali road, Lakki-Gambatti road, Bannu-Kohat road, Bannu road and Miranshah road. These features are shown on Map 3-15.

Within Component 3, four areas can be distinguished in which the project interventions could potentially have impacts on land use:

- The Thal Command Area.
- The Civil Canals Command Area.
- The Marwat Command Area.
- The Riparian Areas of the Kurram River. The land use of these areas is described in section 4.2.5.

Thal Command Area. A breakdown of the land use categories for the Thal Canal Command area is presented in Table 4-18 and shown on Map 4-26. As was the case for Spaira Ragha and Sheratalla there is a significant differencs between the GIS interpretation and the Feasibility Study. The reasons for the difference cannot be determined in the absence of groung truthing of the GIS data.

Table 4-18: Existing Land use of Thal Canal Command Area (in 2013)

Based on GIS interpretation 2013			KTDC,2004
Land use Category	**Acreage**	**% of CGA**	**% of CGA**
Cultivated land	97,042	64.3	35
Natural Vegetation	642	0.4	
Barren/ Hills	515	0.3	
Flood Plain	6,362	4.2	
Built-up areas	7,600	5	
Rivers/ Nullah beds	16,548	11	
Open	5,502	3.7	
Orchards	840	0.6	
Plantation (forest & trees)	8,752	5.8	
Miscellaneous	7,030	4.7	
Gross Command Area	**150,833**	**100**	

Source: Map 4-26.

Note: KTDC (2004) mentions a cultivated land area of 29,405 acre (Table 3.29) in a GCA of 83,600 acres.

The main cultivated crops are wheat, gram, maize, sorghum, berseem and millets. Some vegetables are also cultivated on a limited scale under tube well water irrigation.

Other land use includes shifting sands, built-up areas, hill torrent/river beds and roads.

Civil Canals and Marwat Canal command areas. A breakdown of the land use categories for the Civil Canals and Marwat Canal Command areas is presented in Table 4-19 and shown on Map 4-22.

Table 4-19: Existing Land use of Civil-Marwat Canal Areas (2013)

Land use Category	Acreage
Cultivated	309,178
Orchard	377
Vegetation	3,746
Built up	953
Gross Area	**313,302**

Source: Map 4-22.

The data collected in the 14 sites studied in Component 3 in 2013 confirm that these sites have productive agricultural land under irrigation except Sarai Naurang (salinity), Ghani Khel (erosion and

lack of drainage) and Sheikhan Wala Bahu (barren and saline). Many areas in The Marwat Command area suffer from water scarcity.

In the lower riparian areas of the Kurram River, irrigation is practiced through diversion of river water. The cultivated area in these areas amounts to approximately 27,280 acres (Map 3-15).

4.2.5 Agriculture and Irrigation

4.2.5.1 Introduction

This section assesses and evaluates the actual status of agriculture and irrigation in the project area. Irrigation and agriculture are closely related to soils, land use and economics. This section complements the land use section in the sense that it will concentrate on the cultivated land. The relevant agricultural baseline data (crops, acreages, yields and input application) are necessary for the economic analysis of project interventions.

Sources of Information. The document is based on different sources. The main secondary sources are the Feasibility Study (KTDC, 2004) and its annexures and tables. The agronomical (crops, acreages, cropping periods) and irrigation (crop water requirements) parameters in the design documents of KTDP are entirely based on this feasibility study. The available documents have no information on agricultural and irrigation activities in the (riparian) areas of the Kaitu and Kurram River catchment.

Satellite and Google Earth imagery are important sources of information. They have been used to collect and complete relevant data from the project areas Section 4.1). The GIS analysis of the different command areas use different values of Gross command areas (GCA) and Culturable command areas (CCA) to those in the Feasibility study (KTDC,2004) and the KTDP Design report (WAPDA/Pakistan Engineering Services, 2011). The differences are considerable in the Sheratalla and particularly in the Thal command area.

The IDC field team collected primary agricultural and irrigation data during field visits to 25 sites in the project area. These sites are shown on Map 4. These data represent observations of small areas. As the extent to which these sites are representative of agriculture and irrigation in the various components is unknown, it is impossible to generalize and extrapolate these data. Agricultural and irrigation conditions were assessed by visual observation and interviews with residents of the sites. Data have also been collected from district and provincial agencies. However, the baseline data collected in 2013 are not complete and not contextualized (e.g. results are presented without mentioning that the results refer to barani or irrigated land) and sometimes contain multiple contradictions (for instance data from field visit vs. data collected from agencies vs. statistics derived from satellite imageries). The baseline data are not sufficient to draw clear conclusions about changes in the agricultural and irrigation domain that could have been occurred since 2004. Moreover, some of presented results are questionable and contradictory, particularly those of yield levels and cropping acreages. An important limitation is that essential information is limited, particularly on the use of pesticides, water rights, water distribution and water management. Relevant results of the baseline study are discussed in the respective Components.

Principal Result of Baseline study 2013. As far as agriculture is concerned, the principal result of the 2013 baseline study (findings as well concerns, answers and statements of the local respondents and agencies) is that irrigation is the basic and critical condition for development of the project region, particularly for agricultural development.

This is also confirmed by the Water Balance of Bannu (see Table 4-20 and Figure 1-1) which can be considered a reasonable proxy for the agroclimatic conditions of the whole project area. It shows clearly that average rainfall is not even sufficient to supply the half of the crop water requirements (a good proxy for crop water requirements is ETo, reference evapotranspiration).

Table 4-20: Water Balance at Bannu (based on 1970-2000 climate data)

Months	Tem ⁰C			Rainfall	Evapotranspiration (Eto) (mm)		Moisture Balance
	Max	Min	Mean	mm	Full	Half	
Jan	19	5	12	15	46	23	Deficit
Feb	21	7	14	26	61	31	Deficit
Mar	25	12	19	51	97	49	Surplus
Apr	31	18	25	28	142	71	Deficit
May	37	24	31	20	224	112	Deficit
Jun	41	28	35	14	285	143	Deficit
Jul	39	28	34	63	266	133	Deficit
Aug	36	27	32	67	220	110	Deficit
Sep	35	24	30	15	163	82	Deficit
Oct	31	17	24	12	124	62	Deficit
Nov	26	12	19	7	73	37	Deficit
Dec	21	6	14	13	51	26	Deficit
				331	**1,752**		

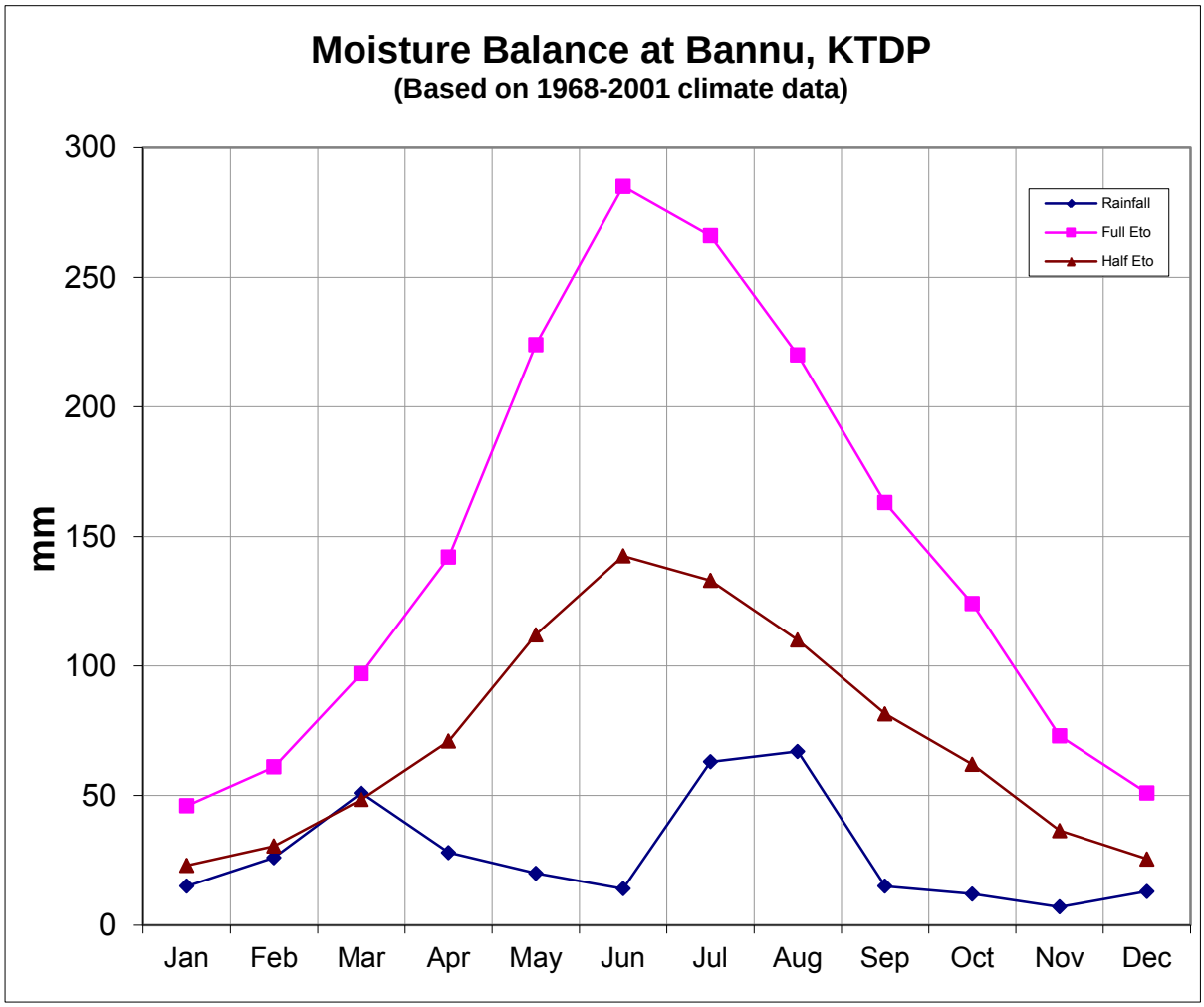

Figure 4-1: Moisture Balance at Bannu KTDP
Source: Fig. 5.2.5(1) of Feasibility Study

4.2.5.2 Component 1

Component 1 is located in North Waziristan as shown on Map 4-15 Component 1 consists of the Spaira Ragha and Sheratalla Command Areas and the downstream and upstream riparian areas affected by the construction of the Kaitu weir.

Previous reports are silent about the status of agriculture in the riparian areas upstream and downstream of the Kaitu Weir. However specific information has been added about these areas after evaluation by GIS interpretation.

The command areas and affected riparian areas in Component 1 are shown on Map 4-17.

Spaira Ragha Command Area. Information from different sources about yields and cropping areas is highly contradictory.

KTDC (2004) mentions a culturable command area (CCA) of Spaira Ragha of 4,020 acres out of a gross command area (GCA) of 5,245 acres. The land use intensity is 45 percent, while cropping intensity[29] is only 33 percent corresponding to a yearly cropped area of 1,320 acres (KTDC, 2004). Meanwhile, Map 4-26 (Land use in Spaira Ragha Command area) shows a cultivated area of 2,668 acres (about 62.01 percent) out of a total CCA area of 4,302 acres. The difference in cultivated area between the GIS analysis and KTDC (2004) is significant, in the order of 100 percent. The reason for this difference cannot be determined.

According to KTDC (2004), the main reason for the poor agricultural status is the low availability of irrigation water from river sources. The contribution of ground water is also zero. This is in agreement with the information collected from the Irrigation Department FATA, that there are no dug wells in this command area.

KTDC (2004) mentions that only one crop, wheat, is grown in the Rabi season with low yields in the order of 130 kg/acre. The cropping intensity for Kharif is zero. But according to FATA Development Statistics 2011, 2011-2012 and 2012-2013 statistics from the Agriculture Department FATA , and data obtained in the 2013 field studies during consultation with agriculture officials, maize (a Kharif crop) is cultivated on an area of 369 acres, with a crop yield of 474 kg/ acres. Similarly Wheat (Rabi) is cultivated on 442 acres and the crop yield is 423 kg/ acre. The extent to which these yields and acreages refer to barani and/or irrigated land is unknown.

Although information of different sources is contradictory, it can be concluded that irrigated land already exists in Spaira Ragha (cultivation of maize as an irrigated Kharif crop) and a larger cropped area (from GIS analysis) than indicated in KTDC (2004).

There are no reports of current water logging and salinity problems.

The use of agricultural input per unit area is very low (KTDC, 2004). A low seed rate and no fertilizer or pesticide is applied to the wheat crop. The labor deployed to raise the crop is also low. The low input use is due to erratic and low rainfall in the Rabi season. Most farmers do not take the risk of investing in inputs for higher yields.

Most of the command area is occupied by small land owners as 99 percent of the farmers have less than 12.5 acres and only one percent farmers have more than 12.5 acres (KTDC, 2004).

[29] Land use intensity is defined as cultivated area/CCA. Cropping intensity is defined as cropped area/CCA. The cultivated area is equal to current fallow plus net area sown. Cropped area is equal to the net area sown plus area sown more than once.

Sheratalla Command Area. According to the KTDC (2004), the command area of Sheratalla Plain is 11,590 acres (CCA) out of a gross area (GCA) of 15,840 acres. The Land use intensity is 40 percent, whereas cropping intensity is 23 percent, corresponding to a yearly cropped area of 2,660 acres (KTDC, 2004). Only one crop, wheat, is grown during the Rabi season. There is no cultivation during Kharif. Meanwhile, the Satellite imagery, Map 4-24 shows a cultivated area in the Sheratalla Canal Command of 5,982 acres (about 32 percent) out of a GCA of 18,426 acres.

According to FATA Development Statistics 2011, 2011-12, 2012-13 statistics from theAgriculture Department FATA and data obtained in the IDC 2013 field studies during consultations with agriculture officials, maize (Kharif) was cultivated on 2,640 acres with a crop yield of about 520 kg/acre. In the case of Wheat (Rabi), the cultivated area was 2,696 acres and the crop yield was about 480 kg/ acre. It is not clear to what extent these yields and acreages refer to barani and/or irrigated land.

Although information of different sources is contradictory, it can be concluded that there is already irrigated land in Sheratalla (cultivation of maize as and irrigated Kharif crop) and a larger cropped area now than was the case at the time of the Feasibility Study (KTDC, 2004).
The Irrigation Department of FATA (personal communication, 2013) reports that six dug wells are currently used for irrigation in the Sheratalla Plains. These dug wells have existed since 2002-2003 and their water level depth is approximately 80 feet below the ground surface. The dug wells were installed by the Irrigation Department but are operated and maintained by farmers. Irrigation is applied following the tribal distribution system. The farmers at the head end have the first right to irrigate, then mid after head and then tail will subsequently follow the mid. It was also mentioned that soils are fertile, and land has the potential for agricultural development but frequent electric load shedding puts crops at risk. Very high fuel costs prevent farmers from operating their dug wells on diesel engines. The Irrigation Department intends to provide the farmers with alternative energy resources (solar power systems) to resolve the power problem.

According to the Deputy Director Irrigation and Ground Water, FATA, the main cereals being grown in the vicinity of the Sheratalla command area (in Tehsil Mir Ali and Tehsil Miran Shah) are wheat, maize and vegetables which are irrigated by surface/canal water. Orchards of apple, pear and grapes are also present in these areas. The new crops cultivated in these areas show that diversified cropping is possible in the Sheratalla Command Area if irrigation water is available.

The Feasibility study, Ch. 3 and Annexure 2 (KTDC, 2004), mentions the presence of 53 acres of slightly to strongly salt affected soils, which corresponds to 0.3 percent of the Sheratalla command area. Other sources do not report any salinity in Sheratalla.

According to KTDC (2004) the use of agricultural inputs is low. No fertilizers and pesticides are applied to the wheat crop. In addition farmers do not deploy much labor to raise the crop. One of the major causes of use of low inputs is the uncertainty about water availability and the erratic nature of precipitation particularly in the Rabi season. All these factors contribute to low yields of the wheat crop in the order of 100kg/acre

Most of the command area is occupied by small land owners. Only one percent of farmers have landholdings of more than 12.5 acres (KTDC, 2004).

Riparian Areas downstream of the Kaitu Weir. Both the upstream and downstream areas of Kaitu River where agriculture is being practiced are shown on Map 3-8.

There is no information is about the agricultural status in the lower riparian areas of the Kaitu River catchment in the previous studies. These areas could potentially be impacted by reduced water flows after construction of the Kaitu Weir. GIS imagery shows patchily developed agriculture along the river banks. The irrigation source is flood water of the Kaitu River or the water that diverted by

temporary weirs of stones across the river (Plate 4-1). Agriculture is practiced in the lower riparian areas in the surroundings of Datta Khel. There is a small canal network created by the local villagers. There is a small weir as about 0.6 km downstream of the Kaitu Bridge that diverts river water into a canal which runs on the left bank. The canal then supplies irrigation water into a small canal network that branches nearly 1.3 km downstream of the Kaitu Bridge and stretches for approximately four km irrigating a cluster of cultivated land and scattered vegetation areas. The canal network is also joined by a few non-perennial nullahs in the east. On the right bank, another small locally developed canal system diverts water from the Kaitu River approximately two km downstream of the Kaitu Bridge. This canal network has an approximate length of over two km.

Plate 4-1: View of a temporary weir, Datta Khel, North Waziristan Agency

The riparian areas downstream of the Kaitu Weir in the Datta Khel area have an estimated acreage of about 477 acres. Maximum irrigation water demands (Table 5-9) are about two percent of the combined design discharge to the Sheratalla and Spaira Ragha Canals (Table 3-2).

Areas upstream of the Kaitu weir. No information is available about the agriculture status in the upstream areas of Kaitu River in previous studies. However the GIS imagery shows patchy agricultural activity along the river banks (16.5 acres). The irrigation source is flood water of the Kaitu River or the water that is diverted by temporary weirs of stones across the river. Moreover, in Spinwam, there are two operational dug wells which also contribute towards agricultural activities.

IDC field observations in Component 1 in 2013 can be summarized as follows:

- In most irrigated areas, river water is the prime source of irrigation but there also tubewells and dug wells which tap groundwater.
- Methods of irrigation at the farm level are basin irrigation (by flooding); no other practices such as furrow and bed and furrow are adopted.
- Main crops include wheat (Rabi) and maize (Kharif).
- Water rights in this component are not documented.
- Most of the farms at these sites were observed to be between 5-10 acres with only four farms above 20 acres (two were > 25 acre). All the land is fragmented, and the tenure system in place is owner cum tenant.

- Applied fertilizers are DAP (50-70 kg/acre), Urea (50-55 kg/acre) and manure or dung (approximately 50,000 kg/acre).

Pesticide use in North Waziristan. Table 4-21 lists the pesticides, crops and sprayed area in North Waziristan according to the North Waziristan Agricultural Agency Officer. Appendix 9.6 lists banned pesticides in FATA and Khyber Pakhtunkhwa. The pesticides mentioned in Table 4-21 are not in the list of banned pesticides. It can be concluded that hardly any pesticides are used in Component 1, which is only a part of North Waziristan.

Table 4-21: Pesticides Treated Area in North Waziristan Agency 2012-2013

Crop	Total area (Acres)	Area Sprayed (Acres)	Quantity	% of total area sprayed	Pesticide
Maize	10800	30	120 Kg	0.3	Furadan
Wheat	2820	45	20 liters	2	DDVP
Rice	250	5	20 Kg	2	Furadan
Tomato	300	20	10	7	DDVP
Potatoes	-	50	10 Kg		Sevin Dust
Lady finger	240	5	3	2	DDVP
Citrus	230	8	4 liters	3	Cypermethrin

Source: Agriculture Agency Officer, North Waziristan (17.09.2013)

4.2.5.3 Component 2

Component 2 is located in the rural areas of F.R. Bannu and North Waziristan as shown on Map 4-15.

According to the GIS interpretation**,** the total reservoir area is 11,443 acres**.** Within this reservoir area there are about 1,580 acres of cultivated land (see Map 3-3). The full reservoir level is 2,127 ft msl and the reservoir area is 10,939 acres (PES et al, 2011a; Ch. 1, Introduction).

Detailed baseline data are being collected in the framework of the RAP. A summary of IDC baseline data, regarding agriculture and irrigation is presented below:

- Many owners of the cultivated land in the reservoir are against the implementation of the KTDP.
- Cultivated land consists of Barani and irrigated land.
- The main cultivated crops are wheat and maize while also some peanuts (Kharif) are cropped.
- Irrigation sources include tube wells, dug wells and canals diverting water from the Kurram River.
- Methods of irrigation at the farm level are basin irrigation (by flooding) and to a minor extent bed and furrow.
- Most of farms at these sites were observed to be between 5-10 acres with only five farms above 20 acres (two were > 25 acres). All the land is fragmented, and the tenure system in place is mainly owner cum tenant.
- Applied fertilizers are DAP (50-100 kg/acre), Urea (50 kg/acre) and manure or dung (25,000-50,000 kg/acre).

4.2.5.4 Component 3

Component 3 consists of the Command Areas of the Thal Canal, Civil Canals and Marwat Canal. The project interventions will also affect the riparian areas along the Kurram River. Previous reports contain no data on the status of agriculture in these riparian areas.

Command Areas

The Thal Command Area. This section is mainly based on data in Chapter 3 of the Feasibility Report (KTDC, 2004). The existing Thal Plain command area lies on the left Bank of Kurram River. The command area of Thal Plain is 68,000 acres (CCA) out of a gross area (GCA) of 83,600 acres. The cropping intensity of the command area is 43 percent of CCA, corresponding to a yearly cropped area of 29,250 acres (KTDC, 2004). The cropping intensity in Kharif is less than 1 percent. The major crops are wheat and gram (Table 3.37, KTDC, 2004).

Satellite imagery, Map 4-26 shows a cultivated area in the Thal Canal Command area of 97,042 acres (about 64 percent) out of a total area of 150,833 acres. Orchards cover 840 acres.
Other sources give different data. Data from Khyber Pakhtunkhwa Development Statistics 2011, 2008-09 to 2011-12 data[30] from the Agriculture Department, and the IDC 2013 field studies during consultations with agriculture officials are summarized in the table below.

Table 4-22: Cropping statistics – Thal Command Area

Crop	Kharif		Rabi	
	Acreage	Yield (kg/acre)	Acreage	Yield (kg/acre)
Maize	70	372	-	-
Sorghum	1,256	163	-	-
Millet	420	187	-	-
Ground nut	3,272	538	-	-
Wheat	-	-	19,447	227
Gram	-	-	4,895	114
Barley	-	-	217	141
Oilseeds	-	-	255	94

Total cultivated area in Kharif was about 5,000 acres. Total cropped area in Rabi is about 24,800 acres. This results in a total yearly cultivated area (Rabi plus Kharif) of about 30,000 acres, a similar figure to KTDC (2004). However, the low acreage of maize and the high acreage of groundnut are questionable because it is against farmer logic and all other historical data of farming in the area and Pakistan as a whole. Maize is almost always one of the most important Kharif crops with the highest acreage, as it is very important for the subsistence needs of small farmers. Groundnut has much less importance. Groundnut could have only become an important cash crop if a commercial agro-industrial enterprise actively promoted this crop for their own profit.

The command area is mainly rain fed but there is also irrigated land. Supply of water comes from torrent streams or the Kurram River itself. Torrent watered cultivation or spate irrigation in narrow belts along the hill torrents and drainage ways is an important land use. In this system the torrent water and the runoff are diverted by dykes on to rectangular fields laid at right angles to the torrent courses. The fields are embanked for ponding and conserving water. The main crops grown are wheat, gram, maize, berseem and millets. Some vegetables are also cultivated on a limited scale. Tube well irrigation is generally practiced near habitations on a limited scale (Chapter 3, Annexure 2, Section 3.15; KTDC, 2004).

There are moderately to strongly saline soils on about six percent of the gross command area, i.e. about 5,000 acres (KTDC, 2004).

The level of the applied inputs is low due to the low availability of irrigation water and low but erratic rainfall. Farm yard manure is applied on most crops whereas very low doses of nitrogenous

[30] KP Chief Planning Officer, Agriculture, livestock and Cooperative Department (2013), District wise yearly agricultural data for Bannu, Lakki Marwat and Karak Districts in the period 2007-2012

and phosphorus fertilizers are applied to the wheat crop. There is no use of potash fertilizers in the Thal Plain (KTDC, 2004). No information is available on micronutrient application in the reports. There is no pesticides use in the entire plain.

Labor is applied in crop cultivation to a limited extent. Mostly family labor is engaged but wage labor is also hired. Fewer than five man-days per acre are applied to mature crops.

The average farm size, about three acres, indicates that the majority of land owners are very small farmers. 97 percent of the owners have farms less than 12.5 acres (KTDC, 2004).

The Civil Canals Command Area. The Civil Canals command area is shown on Map 4-22. It covers 107,000 acres. The agriculture status of Civil Canal is much better than the other command areas of the project. However, the current Civil Canal system is unlined and leaks all along the channels, which drastically impairs irrigation efficiency and has resulted in water logging and salinity. There is also a serious head-tail end problem. In the Civil Canals the users of the upstream ends of the canals take a disproportionate share of the irrigation supply so that little water is left for the tail enders. Only flood waters of the Kurram River can reach the tail ends.

The cropping intensity in the Civil Canals is higher than in other command areas. The current cropping intensity of 112 percent (KTDC, 2004) reflects a better supply of irrigation water. The cropping intensity of Kharif and Rabi is 47 percent and 65 percent respectively. The major crops are wheat, maize, fodders, rice and sugarcane. There is only one orchard, guava, is in the command area. Though the agricultural production per unit area (yield) is lower than optimum, it is higher than in other command areas.

Data from Khyber Pakhtunkhwa Development Statistics 2011, 2008-09 to 2011-12data from the Agriculture Department, and collected by IDC in the 2013 field survey during consultations with agriculture officials 2013, the total cultivated area in Kharif was about 28,000 acres, and in Rabi about 50,660 acres. Details of the cropping patters are shown inTable 4-23. Perennial crops include Sugarcane cultivated on 2,232 acre (yield 1,6201kg/ acre), orchards cultivated on 6,000 acre (yield 8,270 kg/ acre), dates cultivated on 522 acre (yield 2,428 kg/ acre) and citrus cultivated on 1,803 acres (yield 10,000 kg/ acre).

Map 4-22 indicates that orchards amount to only to 377 acres in the Civil Canals and Marwat command areas. This value is in clear contradiction with the above mentioned value of 6,000 acres.

Table 4-23: Cropping statistics – Civil Canals Command Area

Crop	Kharif		Rabi	
	Acreage	Yield (kg/acre)	Acreage	Yield (kg/acre)
Maize	15,390	750	-	-
Sorghum	365	283	-	-
Fodders	2,266	5,439	9,437	12,690
Musk melons	1,161	3,754	-	-
Lady fingers	2,573	3,243		
Rice	4,789	742		
K. Pulses, Mung, Guara	1,442	3,544		
Wheat	-	-	38,823	626
Gram, pulses	-	-	541	166
Barley	-	-	469	214
Oilseeds	-	-	106	214
Root vegetables	-	-	658	4.866
Onion/garlic	-	-	635	2,567

Thirty percent of the soils of the Bannu SCARP area (considered a good proxy for the soils of the Civil Canals command area) are salt affected, with 10, 5 and 15 percent of the area strongly, moderately and slightly saline, respectively (WAPDA, 1981).

The level of applied inputs in this area is below the optimum level. Farm yard manure, nitrogenous and phosphate fertilizers are applied on almost all cash crops. Use of N and P is not balanced (KTDC, 2004). No potassium is applied in this command area. The reports contain no information on application of micro nutrients[31].

Pesticides are used especially on orchards, vegetables, sugarcane, maize and wheat. About 60 percent, 45 percent, 30 percent, 30 percent, 25 percent, and 20 percent area of tomatoes, orchards, sugarcane, wheat, rice and maize are being treated respectively. Vegetables (tomatoes) are treated twice whereas other crops are treated once in their cropping period. Herbicide application and seed treatment is only carried out on wheat. Granular pesticides such as Padan[32] are applied to rice and sugarcane against borers (KTDC, 2004).

Intensive labor is applied in orchards and vegetables. Mostly family labor is engaged but wage labor is also hired. About 70, 45, 44, 30, 25 and 20 man days per season are utilized for tomatoes, lady finger, orchard, sugarcane, rice and maize respectively (KTDC, 2004).

The average size of farm (three acres) shows that most farmers are smallholders. 97 percent of the owners have farm sizes less than 12.5 acres (Table 3.36, KTDC, 2004)).

The Marwat Canal Command Area. The Marwat command area is shown on Map 4-22 and covers 170,000 acres. The cropping intensity of the command area is only 17 percent owing to the shortage of irrigation water. The cropping intensity in Kharif is less than one percent. Almost 140,000 acres, about 82 percent of the command area, are not cultivated and remain fallow because no irrigation supply is available. The major crops are wheat, maize, fodders and gram (KTDC, 2004).

Data from Irrigation Department Khyber Pakhtunkhwa two years record 2011-12, 2012-13, Khyber Pakhtunkhwa Development Statistics 2011, 2008-09 to 2011-12 data from the Agriculture Department, and collected by IDC in the 2013 field survey during consultations with agriculture officials indicate that about 2,000 acres are cropped in Kharif (cropping intensity one percent) and 9,100 acres in the Rabi season (cropping intensity five percent). Table 4-24 presents more detailed cropping statistics.

Table 4-24: Cropping statistics – Marwat Canal Command Area

Crop	Kharif		Rabi	
	Acreage	Yield (kg/acre)	Acreage	Yield (kg/acre)
Maize	1,075	750	-	-
Sorghum	28	283	-	-
Fodders	450	5,209	597	12,238
Musk melons	99	5,705	-	-
Lady fingers	12	3,243	-	-
Rice	291	398	-	-
K. Pulses, Mung,	28	243	-	-
Wheat	-	-	6,353	626
Gram, pulses	-	-	2,071	166

[31] In some areas of Pakistan, the deficiency of micro nutrients has been identified. For example, the application of zinc in rice crop is very common in rice growing areas.
[32] A product and impact description of PADAN is available at www. Agrichem.com.my, section products & services

Oilseeds	-	-	46	250
Root vegetables	-	-	38	4.866
Onion/garlic	-	-	11	3,120

Perennial crops include 93 acres of sugarcane (yield 1,6201kg/ acre) and two acres of orchards (yield 5705 kg/ acre). This resulting yearly cropping intensity is about 6.5 percent.
Thirty percent of the soils of the Bannu SCARP area (considered a good proxy for the soils of the Marwat command area) are salt affected, with 10, 5 and 15 percent of the area strongly, moderately and slightly saline, respectively (WAPDA, 1981).

The level of applied inputs is below the optimum. This is due to the shortage of irrigation water. Farm yard manure, nitrogenous, phosphorus and potassium fertilizers are applied to almost all cash crops. The reports contain no information on the application of micro nutrients.

Pesticides are used, especially on orchards, vegetables, sugarcane, maize and wheat. One hundred percent, 60 percent and 60 percent of respectively the guava, dates and citrus orchards of the command area are sprayed twice a year. Eighty percent, 65 percent, 40 percent, 35 percent, 30 percent, and 25 percent respectively of the area of musk melons, tomatoes, sugarcane, wheat, rice and maize are treated annually. The vegetables and musk melons are treated twice where as other crops are treated once during their cropping periods. Herbicides are only applied to wheat. Granular pesticides are applied to rice and sugarcane against borers.

Intensive labor is used in orchards and vegetable plots. Mostly family labor is engaged but wage labor is also hired. About 84, 72, 70, 48, 47, 40, 40, 40 man days per season are utilized for guava, musk melon, tomatoes, dates, lady finger, citrus, Rabi vegetables and onion respectively.

The average farm size (11.5 acres) is larger than in other command areas of the project but 70 percent of the owners have farms less than 12.5 acres in size.

Riparian Areas downstream of the Kurram Garhi head works. Satellite imagery indicates many signs of agricultural use of riparian areas downstream of the Kurram Garhi head works. Currently these areas are being irrigated with river water. Previous studies present no data on the agricultural situation in these areas. The extent of these areas has been determined through GIS processing of satellite imageries. The total cultivated area present in lower riparian areas of the Kurram River is about 27,280 acres as shown on Maps 4-24 and 4-35.

A small stretch of more than 0.5 km of agricultural land starting just downstream of Kurram Garhi Headworks is situated within the flood plains of Kurram River. Patches of vegetation and cultivated land are observed on both banks of the Kurram River. They are irrigated by canals diverting water from the river. Further downstream as the River turns towards the southeast, there is more cultivated land along the Kurram River banks. For approximately 40 km downstream, there is a vast network of canals diverting water using locally built weirs in the Kurram River to irrigate large patches of agriculture on both banks. Downstream of this cultivated area there is a small stretch of un-cultivated area on the banks which have a scattered vegetation/shrub cover. Further downstream, some land is cultivated on the left bank only. Further downstream, the only significant signs of cultivated areas on both banks appear a few km upstream of the confluence of the Kurram and Indus Rivers.

The findings of the IDC field studies are summarized below:

- The sites studied are shown on Map 4-15.
- There are no government facilities or institutes in this region. The Irrigation and Agriculture department exists but lacks any capability to provide any training to farmers. This has also led to the absence of agriculture extension research.

- The main crops in Component 3 include Kharif crops (rice, maize), Rabi crops (wheat, gram) and permanent crops (sugar cane, orchards, and date palms).
- In much of Component 3 there is a shortage of water for agriculture which is rain fed. The irrigation water source is mostly river water applied by gravity feed in diversion canals. In some places water rights are defined, in other places they are not. In some areas privately owned tube wells are used to irrigate land (approximately 80 tube wells). Irrigation costs are 180-200 Rs/hr. and 600 Rs/acre. Ghoriwala is the only place where spring water is used for irrigation.
- Existing irrigation techniques are basin (flood), furrow and bed and furrow. Drip and sprinkler techniques are also said to be used in combination with tubewells but this information is considered questionable, since drip and sprinkler irrigation are rare irrigation techniques in Pakistan, and the field survey provided no site photographs showing the use of these techniques.
- At individual sample farms in Component 3 no saline or sodic spots were observed.
- Sugarcane is the most profitable crop of the area. If water is available farmers prefer to grow sugarcane instead of wheat.
- Most farms at these sites were observed to be between 5-10 acres with only eight farms above 20 acres (three were > 25 acres). Most of the land is fragmented but there are also some consolidated lands. The tenure system in place is mainly owner cum tenant. Mechanical technologies including tractors and latest equipment are used.
- Fertilizer applications include DAP (50-80 kg/acre.), Urea/ Sona Urea (50-70 kg/acre) and manure or dung.

4.2.6 Waste Generation and Management

The solid waste and wastewater management baseline in the AOI of the KTDP was established through field studies (primary data) which supplemented an initial literature review (secondary data). All existing KTDP documents, as well as reports from other ongoing projects in FATA (Table 4-25) were consulted. Only documents containing data pertaining to waste management are listed in the following two tables.

Table 4-25: KTDP Documents/Reports Consulted

Sr. No.	Reports/Documents Consulted
1	Initial Environmental Examination, USAID (Annex C), February 2012
2	Feasibility Study Report-Kurram Tangi Dam Consultants (KTDC, 2004)
3	EIA and RAP[33]-(KTDC, 2004)

Table 4-26: Other Project Documents/Reports Consulted

Sr. No.	Reports/Documents Required	Location of the Project	Agencies/Authorities that can Provide these Documents
1	IEE and EIA of Bara Dam	Khyber Agency	WAPDA
2	Khalifa Gul Nawaz Hospital	Bannu	W&S Dept. Khyber Pakhtunkhwa
3	Draft IEE Report of Re-Activation/ Rehabilitation and Replacement of Damaged Transformers and Ht/Lt (33KV) Lines At Mehsud Area during Army Operation in South Waziristan Agency.	Mehsud Area, South Waziristan Agency	FWO
4	Draft IEE Report of Re-Activation/ Rehabilitation and Replacement of Damaged Transformers and Ht/Lt	Mehsud Area, South Waziristan	FWO

[33] EPA-KPK approved the documents

	(11KV) Lines At Mehsud Area during Army Operation in South Waziristan Agency.	Agency	
5	Draft IEE Report of Upgrading of 66KV Grid Station Wana into 132KV Level in Swaand Interlinking of Existing 7X Feeders with the Grid Station.	Wana	FWO
6	Draft IEE Report of Dhana Irrigation and Water Supply Project, South Waziristan Agency, FATA.	South Waziristan Agency	FWO

The baseline data given in the Feasibility Report (KTDC, 2004), Chapter 9.0 (EIA and RAP), presents the broader condition of waste management practices being conducted presently in the villages within the dam site. Waste management practices are not only under capacity but are also being carried out using unsanitary procedures. Table 4-27 summarizes the current waste management situation and significant data gaps based on the above documents. None of the documents provide quantitative data on waste management.

Table 4-27: Evaluation of Documents

Sr. No.	Project Stage	Baseline Data
1.	Policy	There is no waste management policy in the project area.
2.		There is no project agreement signed with any responsible body for implementation of a Solid Waste Management Plan (SWMP).
3.		There is no project agreement for waste management compliance with environmental legislation.
4.	Procurement	There is no responsible body for evaluation of the materials to be procured w.r.t over-ordering and waste reduction.
5.		There is no responsible body that will consider less waste generating construction methods.
6.	Project Planning and Design	Only the waste that will be generated from construction camps and excavated material is identified. There is no quantification. Only possible disposal options for the excavated material from the dam are presented.
7.		No specific location is designated for the construction camps in Spaira Ragha and Bannu.
8.		There will be at least 1,000 workers during construction and 400 during operations.
9.		Construction camps within the project area will produce about 400 kg/day of solid waste. During operations office buildings and staff colonies will generate about 160 kg/day.
10.		Construction activities, i.e. curing, soaking of bricks, pilling etc. will generate about 9,500,000 gallons of wastewater. Domestic wastewater from construction camps will be about 32,000 gallons per day. During operations office buildings and staff colonies will generate about 12,800 gallons/ day.
11.		Currently a waste management plan has yet to be prepared for the project.
12.		No waste disposal site has been identified for project waste disposal.
13.		There is no layout plan of natural water bodies of the project area.
14.		There is no layout plan of borrow areas in the project area.
15.	EA of Project	There are no water quality data for water bodies for the parameters of BOD, COD, TSS, TDS etc.
16.		Sensitive receptors are not identified.

During field investigations data was collected using checklists. The locations to be investigated (Map 4-27) were preselected by the waste management expert in order to guide the field investigators.

Owing to the security situation it was not possible to characterize and quantify waste and wastewater generation in the project area during field investigations. Nevertheless, direct observation did allow determination of the main constituents of the waste.

4.2.6.1 Component 1

Four sites, Sinagul (Tehsil: Shewa), Spinwam (Tehsil: Spinwam), Mir Ali (Tehsil: Mir Ali) and Kand (Tehsil: Spinwam) were studied (Map 4-27). These villages and/or settlements are all located in North Waziristan Agency. Table 4-28 summarizes solid waste and wastewater generation rates for these sites. These estimates are based on an assumed per capita solid waste generation rate of 0.4 kg/day, and a per capita water consumption of 40 gpd of which 80 percent ends up as wastewater.

Table 4-28: Solid Waste and Wastewater Generation Rates in the Component 1 Area

Village/ Settlement	Tehsil	Estimated Population	Solid Waste Generation (Kg/day)	Wastewater Generation (gallons/day)
Sinagul	Shewa	450	180	14,400
Spinwam	Spinwam	1,800	720	57,600
Mir Ali	Mir Ali	810	324	25,920
Kand	Spinwam	360	144	11,520

In the Component 1 area, most solid waste and wastewater is generated at houses, clinics, shops and workshops. Domestic wastewater results from water consumption for washing, bathing, etc. Significant quantities of wastewater are generated from irrigation runoff from the fields surrounding Bobali and Spinwam.

The main constituents of solid waste are paper, plastic, and organic waste (food waste, garden waste, animal waste). There is no solid waste dumping site. Residential and commercial waste is discarded haphazardly near houses or workplaces in open heaps. Hazardous wastes such as medical waste and waste oil are also generated in the project area and dumped openly as shown in plate 1 below.

Plate 4-2: Medical waste dumped openly at Spinwam Bazar near the Kaitu River

There are no authorities/departments/agencies responsible for waste management in the area. As a result, quantitative information on solid waste and wastewater generation rates could not be obtained. The primary cause of pollution by waste is the lack of adequate sanitation, as well as the

absence of a proper sewerage network in the area. There are only open drains which are mostly choked by dumping of solid waste and siltation (Plate 2).

Plate 4-3: A silted open sewage drain silted, Shana Gald, North Waziristan Agency

Solid waste and wastewater are disposed of in the two main streams in the area, the Kaitu River and the Shana Algad which ultimately feeds into the Kaitu River.

No sensitive receptors are directly affected by current solid waste and wastewater collection, transport and disposal practices.

4.2.6.2 Component 2

Two sites, Madi Khel (Tehsil: Shewa) and Gumatti (Tehsil: Daryoba), located within North Waziristan Agency and F.R Bannu respectively, were the subject of field investigations in Component 2. Based on the same assumptions as in Section 4.2.6.1, the waste generation rates for these sites were estimated (Table 4-29).

Table 4-29: Solid Waste and Wastewater Generation Rates in the Component 2 Area

Village/ Settlement	Tehsil	Estimated Population	Solid Waste Generation (Kg/day)	Wastewater Generation (gallons/day)
Madi Khel	Shewa	225	90	7,200
Gumatti	Daryoba	630	252	20,160

Most waste is generated by domestic activities (e.g. kitchen waste) and dairy farms. The major constituents of solid in the area are paper, plastic, and organic waste (food waste, garden waste, animal waste).

As there are no responsible authorities/departments/agencies for waste management in the area, no data were available for quantification of solid waste and wastewater generation rates. There is no wastewater management system in this area, and open dumping is a common practice (Plate 3).

Plate 4-4: Open waste dumping site, Bannu

Domestic sewage or wastewater mostly drains into open drains and there is no collection, treatment and reuse system. There is one stream at Gumatti into which municipal wastewater is discharged. This wastewater stream is ultimately discharged into agricultural fields.

No sensitive receptors are directly affected by solid waste and wastewater collection, transport and disposal.

4.2.6.3 Component 3

In Component 3, six sites were studied. These are Domail Bazar (Tehsil: Domail, District Bannu), Sada Khel (Tehsil: Domail, District Bannu), Serai Naurang (Tehsil: Serai Naurang, District Lakki Marwat), Sayed Khel (Tehsil: Lakki Marwat, District Lakki Marwat), Bannu City (Tehsil: Bannu, District: Bannu), Sheikhan Wala Bahu (Tehsil: Esa Khel, District: Mianwali). Waste generation rates for these sites are shown in Table 4-30 below.

Table 4-30: Solid Waste and Wastewater Generation Rates in the Component 3 Area

Village/ Settlement	Tehsil	Estimated Population	Solid Waste Generation (Kg/day)	Wastewater Generation (gallons/day)
Madi Khel	Shewa	21,600	8,640	691,200
Gumatti	Daryoba	7,200	2,880	230,100
Domail Bazar	Domail	16,200	6,480	518,400
Sada Khel	Domail	720,000	288,000	230,40,000
Serai Naurang	Serai Naurang	1,035,000	414,000	33,120,000
Sayed Khel	Lakki Marwat	180	72	5,760

In Component 3, waste is generated by commercial activities (markets, service station, fodder sellers and shops), dairy farming and other agricultural residues and domestic activities.
As is the case in the other two components the major solid waste constituents are paper waste, plastic waste, glass waste, organic waste (food waste, garden waste, and animal waste).

The main authority responsible for environmental management in the Component 3 area is Environmental Protection Agency (EPA) Regional Office D.I. Khan. The sanitation operations in the project area are carried out by the Local Government (Municipality), D.I. Khan. Information obtained from these authorities indicates that on average 250 kg of solid waste and 1000 m^3 of wastewater are generated in settlements in the area, which appears to seriously underestimate the magnitude of waste generation.

Four streams are used for waste disposal in the Component 3 area, namely the Kurram River at Sada Khel, Naurang Bazar stream, Fatima Khel Nullah and Kot Barara stream. These streams carry agricultural and domestic wastewater and waste from dairy farms. In general waste management procedures are not implemented correctly (Plate 4).

Plate 4-5: Solid waste blocking an open sewer, Domail Main Bazar

However, at Miryan Gate, the waste was being collected from the dumpsites and then disposed of in the areas away from the city. There is no wastewater management system in this area.

Agricultural fields, seasonal drains (Domail) and natural river bodies are also affected by the existing waste handling practices. For example, at the Kurram River near Kot Barara, the municipality disposes of all type of waste including construction and demolition waste. The construction waste consists of bricks and concrete. Waste has been dumped at this site for about three to four years. Although there is no specific sensitive receptor at this site, uncontrolled waste disposal will lead to environmental degradation and is already degrading the aesthetics of the area.

The sensitive receptors for wastewater streams are Domail Bazar, Serai Naurang and Chashma Stream.

4.3 Climate and Climate Change

4.3.1 Introduction

Changes in the climate can potentially have a significant impact on infrastructure viability and operation, as well as on the surrounding communities. Therefore, an important challenge is to estimate the potential impacts of climate change on temperature, precipitation, and storm frequency and intensity for a water-based infrastructure project like the KTMDP. The most general definition of climate change is a change in the statistical properties of the climate system when considered over long periods of time, regardless of cause. Accordingly, fluctuations over periods shorter than a few decades, such as El Niño, do not represent climate change. The term sometimes is used to refer specifically to climate change caused by human activity, as opposed to changes in climate that may have resulted as part of Earth's natural processes.

Global Circulation Models (GCMs) Regional Climate Models (RCMs) are one of the most popular tools used to simulate the long term potential impacts of increased greenhouse gases on climatic variables such as precipitation and temperature within a particular river basin. An analysis was

conducted to determine what changes may be likely over the lifetime of the Kurram Tangi Dam. To do this historical data and the existing body of research and literature were studies, and an analysis of eighteen GCMs was conducted. The research looked at climate changes over seasons, years, and decades, assessing the relative change over time of temperature and precipitation. The potential carbon impacts of the project were also assessed, and the potential socio-economic impact of climate change was reviewed.

4.3.2 Climate of the Project Area

The climate of Kurram River watershed is directly related to its altitude besides latitude. The altitude varies from north to south and east to west, and so does the climate: (i) the temperature changes from subtropical in the south to temperate-cool, cold and very cold (Tundra) in the north and northeast, (ii) the rainfall varies from semi-arid (330 mm at Bannu) in the south to sub-humid (850 mm at Fort Lockhart) in the east and (810 mm at Parachinar) in the north, and (iii) the rainfall pattern also gradually shifts from monsoonal (August to September) in the south to Mediterranean (winter-spring) in the north.

The winter-spring precipitations combined with the prevailing low temperatures have a significant effect on climate. On the other hand, the summer rainfall happens under high temperature conditions and in torrential form. Thus, summer months are subject to high evapotranspiration, as well as high erosivity, more runoff and soil erosion. It snows on Koh-e-Sufaid and valleys in the north frequently during the winter season. Above 14,000 ft (4,267 m) the mountains remain under permanent snow. The snow melts in summer. The snow-melt water in this season when combined with rainfall runoff, the accumulative water in most rivers, causes flash floods damaging property and infrastructures and sometimes loss of human life and livestock.

Seasons are hot in the low altitude zones. June, July and August are the hottest months when peak temperatures vary between 39°C and 41°C. In the high altitude zones, summer days are pleasant with daily peak temperatures varying from 25°C to 31°C.

South facing slopes of mountains receive maximum tropical sunshine and they heat up very early in the day and stay warm till late in the evening. Sunshine comes to the western slopes after midday. Since the northern slopes are in the shadow of high peaks, they receive sunshine at an oblique angle, often only for few hours, when the sun is high in the sky. Eastern slopes receive sunshine from early morning until the sun moves to the west. In these hours not much heat is transferred to the snow surface, because the air is cool and sun rays fall at an oblique angle. So on northern and eastern slopes rate and volume of daily snow melt is less than the southern and western slopes.

The majority of the Kurram River catchment area, 75 percent, has an elevation greater than 1,500 m and hence receives precipitation about 1.5 times the precipitation falling in the Bannu area (Plains). The mean annual rainfalls at Bannu, Fort Lockhart and Parachinar are 330mm, 850 mm and 810 mm respectively. Potential evaporation compared to annual rainfall at the various meteorological stations within the Kurram watershed area is high during the summer season when the temperatures are high and humidity is low. Total mean annual evaporations at Bannu, Fort Lockhart and Parachinar are 1,752 mm, 1,114 mm and 900 mm respectively.

Based on rainfall-amount and seasonal distribution, temperature, continentality and vegetation, the latter an indicator of the climate, the following bio-climates have been distinguished in the watershed.

- Tundra zone (Snow desert above EL. 14,000 ft).
- Dry very cold (Alpine) zone (between EL. 12,000 and 14, 000 ft)
- Dry cold (Sub-alpine forests) cum pastures (between EL. 10,500 and EL. 12,000 ft)
- Dry temperature monsoonal /Mediterranean, mixed forest zone (between EL. 7,500 and EL. 10,500 ft)

- Sub-humid Sub-tropical/Sub-temperate/ broad-leaded forest zone (between EL. 4,000 and EL. 7,500 ft)
- Sub-humid Sub-tropical monsoonal/Mediterranean, broad-leaded forest zone (between EL. 2,000 and EL. 4,000 ft)

Arid Subtropical monsoonal scrub forest zone (below EL. 2,000 ft).

4.3.3 Historical Precipitation and Temperature of Kurram Tangi Region

Historic precipitation and temperature data were assessed based on the meteorological data from the nearest stations. These are shown in the Figure 4-2, and though four stations were chosen only three have sufficient data to allow for analysis. The selected three stations were: Parachinar, Bannu and Kohat. It must be noted that none of the stations had full and continuous data, and there are periodic gaps of years and seasons. Figure 4-2 also notes the elevation of each of these stations, it should be noted that Parachinar is at a much higher elevation than Bannu or Kohat.

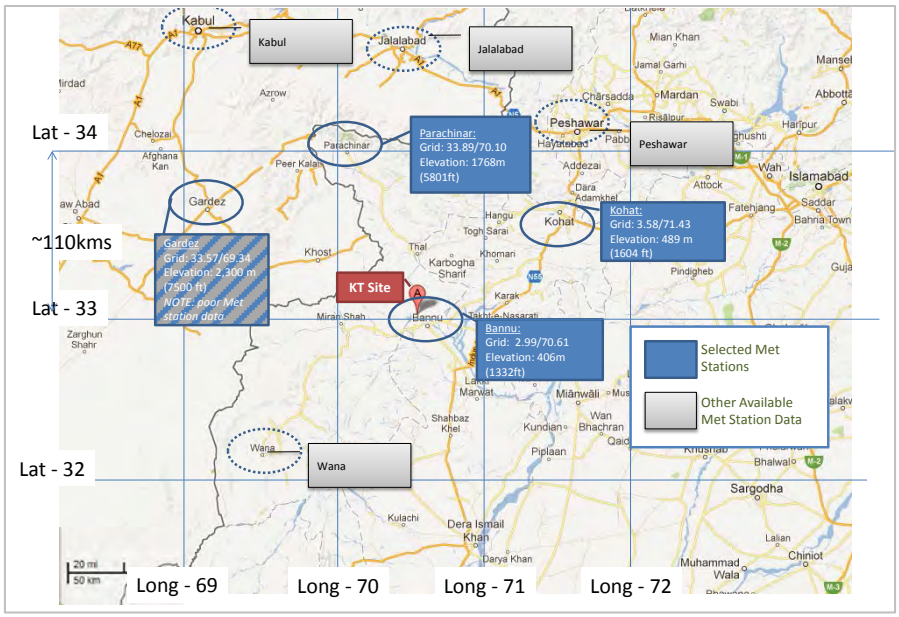

Figure 4-2 Locations of Meteorological Stations in the Project Area

4.3.4 Historic Seasonal Averages

In order to prepare for comparison of the historic data against the projected GCM modeled data, a decadal analysis of the meteorological station precipitation and temperatures was conducted (Figure 4-3). The decadal periods selected are as close to the GCM past decadal data as possible. For all of the meteorological stations there is a gap in data that extends from the early 1900's to around 1948.

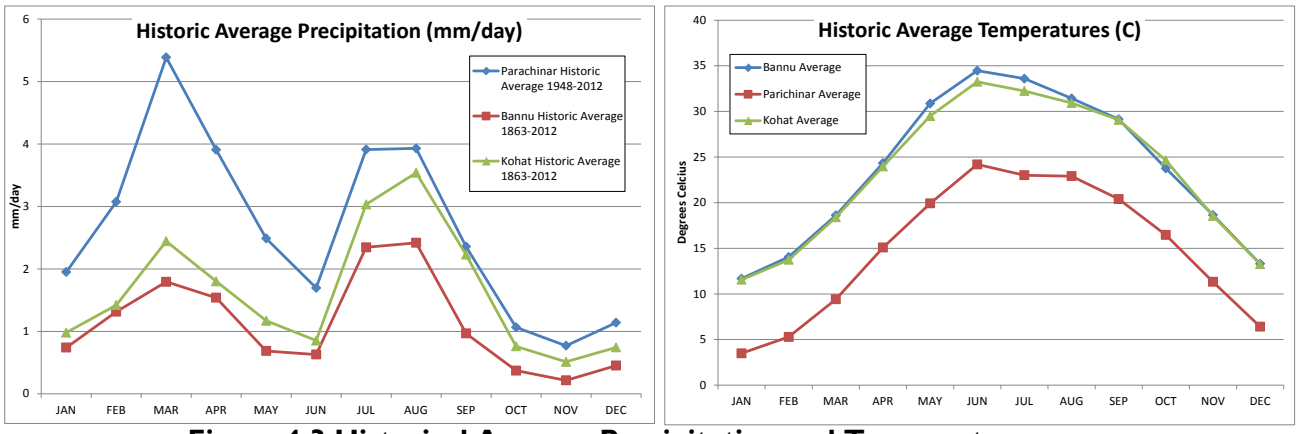

Figure 4-3 Historical Average Precipitation and Temperatures

The seasonal data for precipitation shows relatively consistent seasons across the Kurram Tangi zone, with:

- Early spring rainy season (Feb-Apr).
- Spring dry season (May-Jun).
- Summer rainy seasons (Jul-Sept).
- Winter dry season (Oct-Jan).

It is significant to note the timings of the start and end of both the rainy and the hot seasons because these timings have a direct impact on the growing season of the region, especially at high elevations.

The decadal historic precipitation, presented in Figure 4-4, shows little significant deviation over time. The average temperatures for the two lower elevation meteorological stations show a 0.4 °C increase from the 1940-1960 period to 2012. While the one mountain station (Parachinar) shows a nearly 2 °C drop in temperature over the same period.

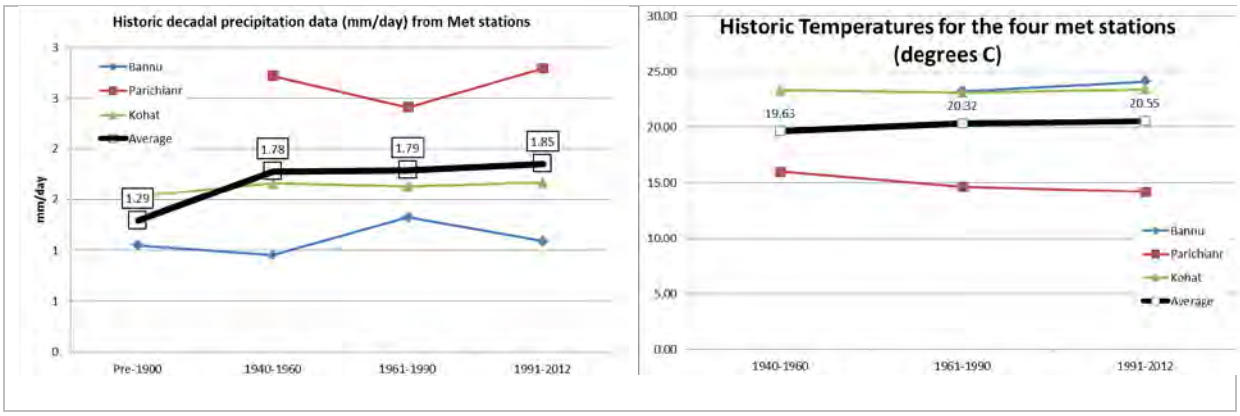

Figure 4-4 Precipitation and Temperature Historical Decadal Averages

The three graphs of Figure 4-5 show the seasonal temperature data for each of the meteorological stations. Historic temperatures for Kohat are stable. Bannu shows some warming in summer months over the two decadal periods of time available. Parachinar's decreasing temperature appears to occur primarily in the summer, fall, and early winter months.

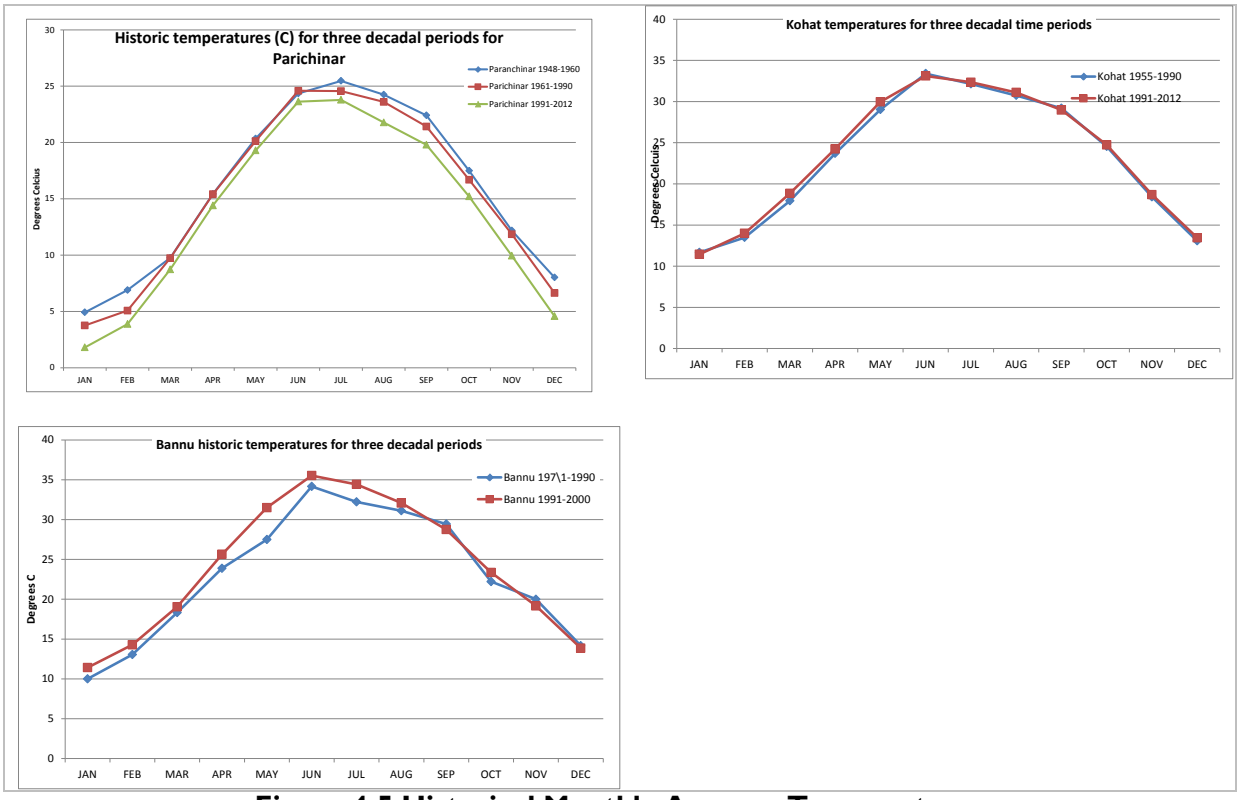

Figure 4-5 Historical Monthly Average Temperatures

4.3.5 Using GCMs to Project Season and Overall Climate Change in the Kurram Tangi Region

In order to understand climate impacts, particularly those for mountain regions, it is important to understand if and how seasons may shift The GCM data for this analysis was obtained from the IPCC Fourth Assessment Report (AR4) for the GHG emissions scenario A1B. Scenario A1B represents a median value for future emissions, and is described as "A future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies, with the development balanced across energy sources". The AR4 report was produced in 2007 and represents the latest IPCC comprehensive documentation on climate change, the Fifth Assessment Report will be released in 2014.

The AR4 GCM data was extracted for the closest available latitude and longitude to the two meteorological stations selected for analysis: Parachinar and Bannu. These two stations were selected because they represent the two extremes of the meteorological stations: the plain station and the mountain station. Bannu has the best historic data volume and quantity of the two plains stations against which to compare the GCMs.

Each GCM produces historic decadal temperature and precipitation data as well as projected future decadal data. The historic GCM data for each model was compared to the actual historical data for the relevant met station, and analyzed for best fit correlation. An ensemble of three of these GCMs was then used to represent the possible future decades.

4.3.6 GCM Analysis of Precipitation Data

The historical correlations for most of the selected eighteen models were not good, with many missing one of the two rainy seasons. GCM's tend to have much less precision in their data around areas with a significant amount of terrain, or variation, within the grids of analysis. For this reason, plains areas have the most reliable projections and mountainous regions can have less reliable projections.

Three GCM models were then selected for further analysis. Two of these, HADCM3 and MROC3_2Hi, were selected based on having the highest r^2 value. The third GCM, ECHAM5, was selected because it was used by PMD for their downscale study. Because the GCM data did not correlate well, an analysis of the relative change in precipitation forecast by the GCMs was conducted. This percent change for each GCM was then used as a multiplier on the actual historic data for each met station. The result is a representation of the possible relative change that might be likely in the future. The average of the GCMs was then taken as an ensemble value for each decadal projection period.

After precipitation at each station was calculated, an average was taken to represent possible precipitation changes across the Kurram Tangi region as shown in Figure 4-6.

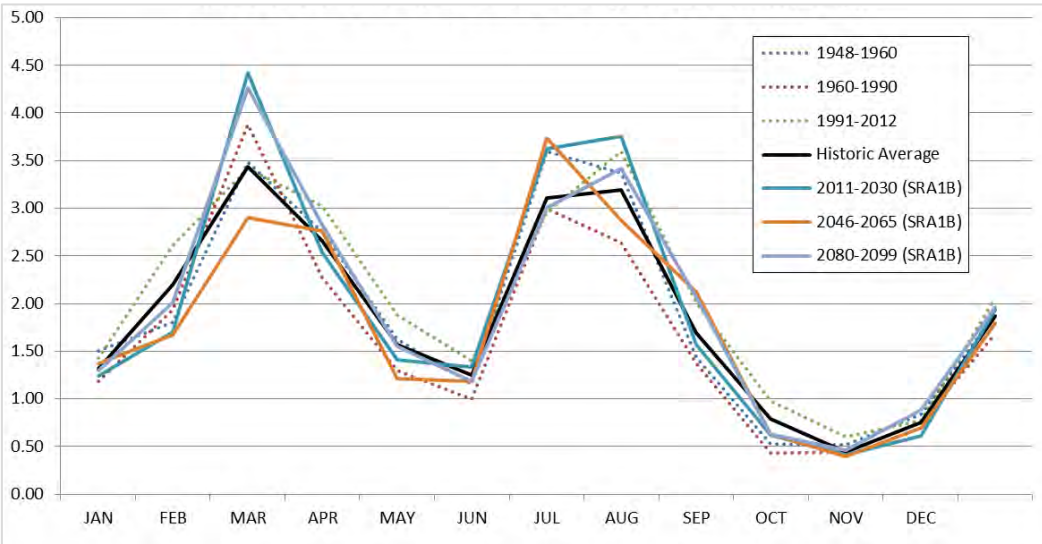

Figure 4-6 Average GCM Ensemble Projection vs. Historical Precipitation Data

The final combined averages for the GCM projections across the area show little projected future change in precipitation. The percent difference by the Year 2099 of 4 percent is well within the historic decadal range of variation, which has gone from as much as +10 percent to -10 percent of the historical average. The only exception is the spring rainy season, which may experience additional precipitation in future decades. In addition, there is no real seasonal shift in future time-periods when compared to historic data, i.e. rainy seasons will not begin or end at significantly different times of the year than they have in the past.

4.3.7 GCM Projections of Temperature Data

The correlations of historic temperature data estimated by GCMs with the historic temperature data recorded at meteorological station are very close. The same three GCM models were evaluated for temperature projection into the future as were used for the precipitation projections: ECHAM5, HADCM3 and MROC3_2Hi. A comparison of the temperature seasonal data for each decadal period in the future as well as the past decadal periods is shown in Figure 4-7.

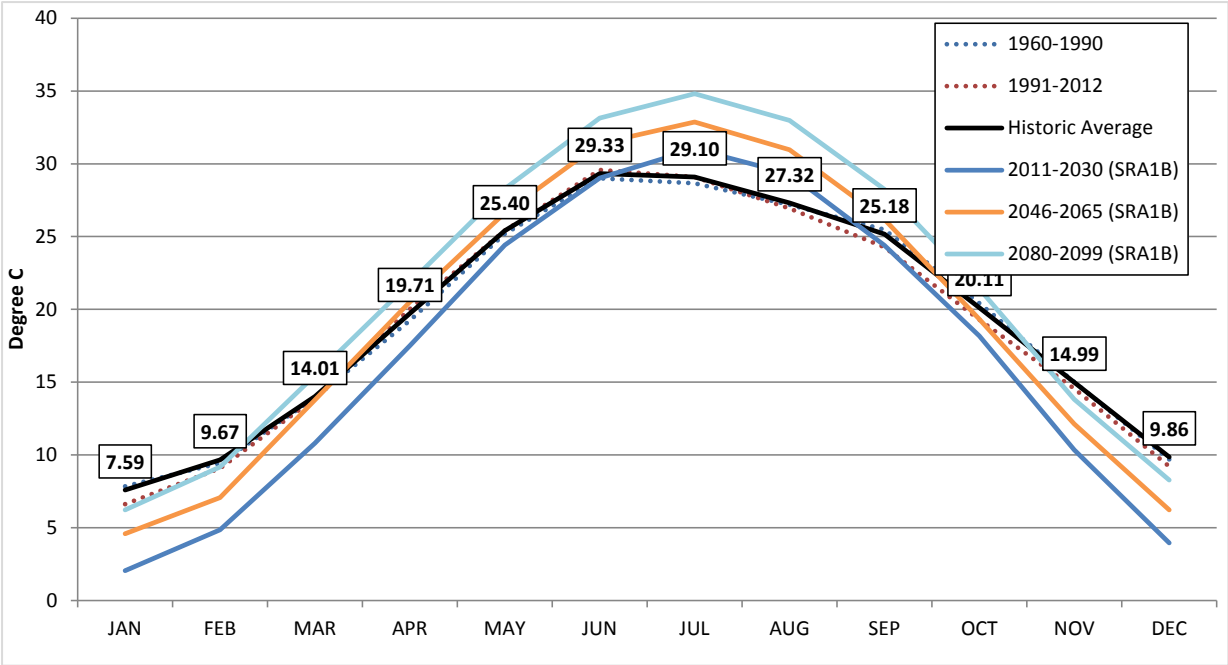

Figure 4-7 Average GCM Ensemble Projection vs. Historical Temperature Data

The average projected air temperature increase is between 3-4 °C above the 1990 base by 2065, and 5 °C by 2099. The increase in temperatures is projected to occur primarily in the summer season. However, since the modeled historic data is biased toward lower values in winter months than actually occurred, it is likely that future temperature changes may actually be relatively uniform across the seasons, peaking in the summer months. As such, we may see a lengthening of the summer season and shortening of winters by 2065. At higher elevations this may lead to an earlier snow melt. Since snowpack serves as an effective water storage mechanism, this may ultimately impact late spring or summer water availability. Additionally the spring stream hydrology may change, with earlier and increased water levels and a higher probability of flash flooding. With the most dramatic temperature increases in summer, this could result in higher evapotranspiration rates in soils and water bodies and a resultant reduction in agricultural productivity.

4.3.8 Results Summary

This analysis shows that the Kurram Tangi region is likely to experience hotter summers and shorter winters. The Kurram Tangi drainage area is likely to show a slightly higher average annual precipitation of 4 percent by 2099. This is well within the historic decadal range of variation, which has gone from as much as +10 percent to -10 percent of the historical average. There appears to be no overall seasonal shift in projected scenarios: the spring rains and fall/winter rains are likely to begin and end at approximately the same time as they have historically. The potential impact to the overall project operation is a possible slight increase in flow rates and volumes in the early spring months than have historically been the case.

The average projected air temperature increase is between 3-4°C above the 1990 base by 2065, and 5°C by 2099. The increase in temperatures appears to be relatively uniform across the seasons. As such, we may see a lengthening of the summer season and shortening of winters. At higher elevations this may lead to an earlier snow and glacier melt, but this is not critical to the Kurram Tangi project as the area with glaciers is very limited and less than one percent of the total watershed area.

4.4 Ambient Air Quality

The Project area is located in a hot and arid subtropical monsoonal zone. During the brief monsoon season, strong winds cause dust to blow. Similarly, winds during the hot summer season carry dust great distances. Smoke pollution in the rural environment of the Project area is due to wood burning

for heat during the winters, and for cooking all year around. Since the Project area is surrounded by mountains, smoke emissions are prone to atmospheric inversions; cold air is trapped for several days under a layer of warm air. The trapped air causes pollutants to accumulate.

Baseline air quality conditions are described based on an analysis of previous studies and from site visits. IDC was hired and trained to collect data at specific points in the AOI. Visual assessments of the air pollution, dust, smells and fuel sources in the AOI are described in the sections below for each KTDP component. Interviews with residents of settlements were also conducted. A total of nine sites were visited. It should be noted that field teams were unable to collect quantitative air quality data due to security concerns.

4.4.1 Air Quality Data from Previous Studies

While no existing air quality information was available for the KTDP AOI, such information was available for the nearby cities of Kohat and Ghalanai (see Table 4-31 and Table 4-32, respectively). Air quality in Kohat exceeded Pakistan's National Environmental Quality Standards (NEQS; Appendix 9.3-3) and the United States Environmental Protection Agency's (USEPA) National Ambient Air Quality Standards (Table 4-33), while in Ghalanai, air quality was within the standards.

Satellite imagery analysis for air pollution sources in the AOI shows that the Component 1 and 2areas are likely to have better air quality conditions than Component 3. The Component 1 and 2 areas are sparsely populated, as is Ghalanai. Similar to Kohat, the Component 3 area is heavily populated, has a dense and heavily used road network, and includes many domestic / small-scale industries.

Table 4-31: Ambient Concentrations of Air Pollutants in Kohat

Location	Meteorological Information	Pollutant	Av. Value (ppm)	Max. Value (ppm)	Min. Value (ppm)
Kohat	Calm Wind	Nitric Oxide (NO)	8.15 (10 mg/m³)	124.7 (153 mg/m³)	0.82 (1 mg/m³)
	30-35°C	Nitrogen Dioxide (NO_2)	83 (156 mg/m³)	350.27 (659mg/m³)	15.41 (29 mg/m³)
		Sulfur Dioxide (SO_2)	1.91 (5 mg/m³)	86.34 (226 mg/m³)	0
		Carbon Monoxide (CO)	2916.54 (3340 mg/m³)	5064.64 (5800 mg/m³)	0
	Sunny	Ozone (O_3)	7.64 (15 mg/m³)	50.94 (100 mg/m³)	1.53 (3 mg/m³)

Source: EIA and RAP KTDC (2004)

Table 4-32: Air Quality in Ghalanai, Mohmand Agency

Sr. No.	Parameters	Measurement Data/Results	
		Ghalanai Site – I	Ghalanai Site - II
1	Oxygen Level (%)	20.9	20.9
2	Carbon Monoxide	0	0
3	Hydrocarbon	0	0
4	Oxides of Sulfur	0	0
5	Oxides of Nitrogen	0	0

Source: Environmental Assessment for Construction of Gandao Dam/Drinking Water Supply Scheme for Ghalanai, Mohmand Agency, NPSL- Islamabad (18/02/2010)

Table 4-33: USEPA National Ambient Air Quality Standards (NAAQS)

Pollutant		Averaging Time	Level	Form
Carbon Monoxide		8-hour	9 ppm	Not to be exceeded more than once per year
		1-hour	35 ppm	
Lead		Rolling 3 month average	0.15 µg/m3	Not to be exceeded
Nitrogen Dioxide		1-hour	100 ppb	98th percentile, average□d over 3 years
		Annual	53 ppb	Annual Mean
Ozone		8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	**PM2.5**	Annual	12 µg/m3	annual mean, averaged over 3 years
		Annual	15 µg/m3	annual mean, averaged over 3 years
		24-hour	35 µg/m3	98th percentile, averaged over 3 years
	PM10	24-hour	150 µg/m3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		3-hour	0.5 ppm	Not to be exceeded more than once per year

4.4.2 Data from Site Visits

4.4.2.1 Component 1

IDC visited two sites in the Component 1 area. Air quality and air pollution sources were discussed with local informants in the village and tehsil during the site visit. Table 4-34 summarizes the data collected. Air quality was generally described as being good. However, the local residents identified dust from high winds, emissions from generators and vehicles as (potential) sources of air pollution. Ten informants were interviewed regarding the source of fuel for heating and cooking. Wood was mainly used for cooking. Liquefied petroleum gas (LPG) cylinders were used for heating, and sometimes for cooking when wood was wet from rains.

Table 4-34: Summary of Component 1 Area Air Quality Data Obtained from Site Visits

Sr. No.	Location	Tehsil	District/ Agency	Source of Fuel (used for cooking and Heating)	Sources of Air Pollution/ Dust Generating Activities (if any)	Quality of Air (based on visual assessment)
1	Kand	Spinwam	N.W.A	Cooking: wood Heating: LPG cylinders	Katcha (unmetalled) roads in Kand	Air quality is good. There is no smoke or industry in this area. However, there is dust from high winds.
2	Kaitu River	Spinwam	N.W.A	Cooking: wood Heating: LPG cylinders	Katcha roads in Spinwam Bazaar	

4.4.2.2 Component 2

Two sites were visited in the Component 2 area. Table 4-35 summarizes the data collected. Air quality was generally described as being good. Dust from high winds and sand storms was the only problem identified by informants. Ten informants were interviewed regarding the source of fuel for heating and cooking. Wood/forest shrub was mainly used for cooking. Wood and dung cakes were used for heating. LPG gas cylinders were substituted for wood when wood was wet from rains.

Table 4-35: Summary of Component 2 Area Air Quality Data Obtained from Site Visits

Sr. No	Location	Tehsil	District/ Agency	Source of Fuel (used for cooking and Heating)	Sources of Air Pollution/ Dust Generating Activities (if any)	Quality of Air (based on visual assessment)
1	Shewa	Shewa	N.W.A	Cooking: wood Heating: wood	Minor traffic in Shewa	Air quality is good. Motor vehicles and other air polluting sources are few.
2	Gumatti	Daryoba	F.R. Bannu	Cooking: Shrub Forest Heating: Forest wood, Dung Cakes	No sources	Air quality is good. The area is rural and has no industries. The only source of dust is from sandstorms.

4.4.2.3 Component 3

Five sites were visited in the Component 3 area. Table 4-37 summarizes the data collected. Air quality was generally described as being good. Dust from high winds and sandstorms was identified as a problem by informants. At Site 7 informants mentioned air pollution from vehicles at the bazaar, while at Site 9 informants complained of air pollution from a brick kiln about one mile away.

Twenty-one informants were interviewed regarding the source of fuel for heating and cooking. For both cooking and heating, wood was mainly used. At Site 9, natural gas was also available.

4.5 Existing Noise Levels

Baseline noise levels are described based on an analysis of previous studies and data from site visits. International Development Consultants (IDC) was hired and trained to collect data at specific points in the Area of Influence (AOI). Assessments of the existing noise and noise from proposed construction and operational activities are described in the sections below for each KTDP component. As depicted in Map 4-28 a total of nine sites were visited. Field teams were unable to collect quantitative noise data due to security concerns.

4.5.1 Baseline Data from Previous Studies

While no existing noise information was available for the KTDP AOI, noise information was available for the nearby city of Ghalanai in Mohmand Agency (see Table 4-36). Ghalanai is about 85 mi (138.5 km, as the crow flies) from Akhtar Kili in the KTDP Component 2 area. The noise level measurement was taken on February 18th 2010.

Table 4-36: Noise Level Measurement at Ghalanai in Mohmand Agency

Sr. No.	Parameter	Measurement	
		Ghalanai Site I	Ghalanai Site II
1.	Noise Level dB (A)	46.0	49.8

Source: Environmental Assessment for Construction of Gandao Dam/Drinking Water Supply Scheme for Ghalanai, Mohmand Agency, NPSL- Islamabad (18/02/2010)

Noise levels in Ghalanai were observed to be low in comparison to Pakistan NEQS (Appendix 9.3-9) permissible levels.

Table 4-37: Summary of Component 3 Area Air Quality Data Obtained from Site Visits

Sr. No.	Location	Tehsil	District/ Agency	Source of Fuel (used for cooking and Heating)	Sources of Air Pollution/ Dust Generating Activities (if any)	Quality of Air (based on visual assessment)
1	Kurram Garhi Headworks	Daryoba	F.R. Bannu	Cooking: wood Heating: wood	No sources.	Air quality is good. Traffic and other polluting sources are minimal.
2	Fatima Khel	Bannu	Bannu	Cooking: wood Heating: wood	No sources	Air quality is good. Traffic and other polluting sources are minimal.
3	Main Bazar Domail	Domail	Bannu	Cooking: wood Heating: wood	Heavy traffic in Domail Main Bazaar	Air quality is good. Heavy traffic and dust at the Bazaar were noted.
4	Alamshri	Takhti Naurati	Karak	Cooking: wood Heating: wood	No sources	Air quality is good.
5	Ziarat Umer Khan	Lakki Marwat	Lakki Marwat	Cooking: Natural gas, wood Heating: Natural gas, wood	Katcha roads in Ziarat Mian Umer Lakki Marwat	The presence of some unmetalled (Katcha) roads leads to dust in the air.

4.5.2 Data from Site Visits

4.5.2.1 Component 1

IDC visited two sites in the Component 1 area. Noise levels and noise pollution sources were discussed with local informants in the village and tehsil during the site visits.

Table 4-38 summarizes of the data collected. Major sources of noise pollution in Kand were generators (which are only present in some of the houses) and flour grinding machines. In the Spinwam Bazaar generators and automobiles were the major sources of noise pollution.

Table 4-38: Summary of Component 1 Area Noise Data Obtained from Site Visits

Sr. No.	Location	Tehsil	District/ Agency	Assessment of Noise Sources	Location of Noise Monitoring Point	Comments
N1	Kand	Spinwam	N.W.A	Generators and flour grinding machines	Kand	Generators were only present in some of the houses
N2	Kaitu River	Spinwam	N.W.A	Generators and automobiles	Spinwam Bazaar	Generators are used in shops, houses and hospital

4.5.2.2 Component 2

IDC visited two sites in the Component 2 area. Noise levels and noise pollution sources were discussed with local informants in the village and tehsil during the site visits. Table 4-39 summarizes of the data collected. No major sources of noise pollution were identified in either Shewa or Gumatti.

Table 4-39: Summary of Component 2 Area Noise Data Obtained from Site Visits

Sr. No.	Location	Tehsil	District/ Agency	Assessment of Noise Sources (if any)	Location of Noise Monitoring Point	Comments
N3	Shewa	Shewa	N.W.A	No sources	None	• No industries, traffic jams or construction activities were observed
N4	Gumatti	Daryoba	F.R. Bannu	No sources	Gumatti	• No noise pollution generating sources were observed

4.5.2.3 Component 3

IDC visited five sites in the Component 3 area. Noise levels and noise pollution sources were discussed with local informants in the village and tehsil during the site visits. Table 4-40 summarizes of the data collected. No major sources of noise pollution were identified in the Kurram Garhi Headworks area or Alamshri. In Fatima Khel, Main Bazar Domail and Lakki Marwat, vehicular traffic was identified as a source of noise pollution.

Table 4-40: Summary of Component 3 Area Noise Data Obtained from Site Visits

Sr. No.	Location	Tehsil	District/ Agency	Assessment of Noise Sources (if any)	Location of Noise Monitoring Point	Comments
N5	Kurram Garhi Headwork	Daryoba	F.R. Bannu	No sources	Kurram Garhi	No industries, traffic jams or construction activities were observed.
N6	Fatima Khel	Bannu	Bannu	Automobiles in Fatima Khel	Fatima Khel	The population near the road side was disturbed by tractor and Rickshaw transport
N7	Main Bazar Domail	Domail	Bannu	Vehicles in the Main Bazaar	Main Bazar Domail	Transport was the source of noise pollution
N8	Alamshri	Takhti Naurati	Karak	No sources	None	
N9	Ziarat Umer Khan	Lakki Marwat	Lakki Marwat	Automobiles	Lakki Marwat	Heavy on the road was the source of noise pollution

4.6 Water Resources

4.6.1 Hydrology

4.6.1.1 Component 1

River Flow Data and Analysis.

River Flow Data

The availability of discharge records of the Kaitu Rivers is described in Table 4-41.

Table 4-41: Available Discharge Records - Kaitu River

Sr. No	Station	River	Agency	Type of Data	Period of Record	Data used for Analysis
1	Spinwam	Kaitu	PID, KPK	Daily Discharge	1980-1981, 1985-2002	-
2	Spinwam	Kaitu	PID, KPK	10-Daily	1980-2001	-

The following average flows were determined from the above data sets. The mean annual flow of Kaitu River at Spinwam for the period 1980-2011 is 718 cfs, based on daily average flows. Monthly mean, minimum and maximum discharges are given in Table 4-42 below. All values are in cubic feet per second.

Table 4-42: Kaitu River at Spinwam for the period 1980-2011

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	457	531	714	755	777	647	1,440	1,193	772	458	399	442
Maximum	2,381	3,185	4,696	5,089	4,835	7,404	30,690	10,368	10,368	2,733	763	2,915
Minimum	58	50	50	65	59	59	50	65	53	50	58	25

The percentile annual and monthly flows are given in the table below. All values are in cubic feet per second.

Table 4-43: Percentile Annual and Monthly Flows – Kaitu River

	Annual (1980-2011)	Monthly (1980-2011)
25%	788	738
50%	606	550
75%	489	395

Wet season daily average, Dry season daily average and 7Q10 low flow are given in the table below.

Table 4-44: Seasonal Daily Average and 7q10 Low Flows – Kaitu River

	Discharge (Cfs)
Dry Season Daily Average	506
WET Season Daily Average	921
7Q10 Low flows	433

Data Consistency and Homogeneity: The quality of the discharge data has major effects on the viability of a water resources project. Therefore, it is essential to check the reliability of the discharge data. The Review Consultants checked for consistency and homogeneity of the data, based on Smirnov-Kolmogorov (S-K Test) and double mass curve analysis. The double mass curve method was applied on flow data of Kaitu River at Spinwam, and showed inconsistency of the estimated flow data of Kaitu River at Spinwam.

Flow Duration Curves: Flow duration curves are not available for Kaitu River. It is recommended that flow duration curves are developed for Kaitu River during the design phase.

Design Flood Analysis. Analysis of the design flood for the Kaitu River is not discussed. Analysis of the anticipated design floods for the Kaitu River is recommended for design of Kaitu Weir and other project features in Component 1.

Catchment Areas. Accuracy in the delineation of the catchment area is essential to compute appropriate estimation of design flood, sediment estimation and water availability. During detailed design of Kurram Tangi Dam Survey of Pakistan (SOP) maps with a minimum scale of 1: 50,000 were used to delineate catchment areas. Digital Elevation Model (DEM) data is available for the project area; therefore a comparison of catchment areas using both sources was performed and a difference of up to 5 percent was noted. Differences in catchment areas can make a major influence on the magnitude of flood and catchment sediment yield; therefore the calculations shall be updated to consider the catchment areas obtained using DEM data.

Sedimentation. Analysis of sedimentation along Kaitu River is not discussed. Analysis of sedimentation in Kaitu Weir, potential channel degradation impacts downstream of the Kaitu Weir, and sediment issues in the power tunnels is recommended.

4.6.1.2 Component 2

River Flow Data and Analysis. The river flow data and analysis is discussed in the following paragraphs.

River Flow Data: The availability of discharge records of the Kurram River is described in Table 4-45. The discharge records from PID were used for analyses. Data records from SWHP, WAPDA were not considered in the study.

Table 4-45: Available Discharge Records - Kurram River

Sr. No	Station	River	Agency	Type of Data	Period of Record	Data used for Analysis
1	Thal	Kurram	SWHP, WAPDA	Daily Discharge	1968-2002	-
2	Kurram Garhi Headworks	Kurram	PID, KPK	Daily Discharge	1971-2001	1971-2001
4	Thal	Kurram	SWHP, WAPDA	10-Daily	1971-2000	-
5	Kurram Garhi Headworks	Kurram	PID, KPK	10-Daily	1971-2001	1971-2001

The following average flows were determined from the above data sets. The mean annual flow of the Kurram River at Thal is 878 cfs, based on daily average flows. Monthly mean, minimum and maximum are given in the table below for the Kurram River at Thal. All values are in cubic feet per second.

Table 4-46: Kurram River at Thal for the period 1971-2011

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg	598	604	856	1200	1338	987	1146	1184	845	624	574	582
Max	2,474	3,246	16,206	13,922	9,807	13,600	29,450	12,325	14,172	4,627	2,499	2,549
Min	87	80	93	101	98	88	113	116	128	36	25	85

The percentile monthly and annual flows are given in the table below

Table 4-47: Percentile Annual and Monthly Flows – Kurram River at Thal

	25%	50%	75%
Monthly	1,021	719	520
Annual	827	574	440

Wet season daily average, Dry season daily average and 7Q10 low flow of the Kurram River at Thal (1971-2011) are given in the table below.

Table 4-48: Seasonal Daily Average and 7q10 Low Flows – Kurram River at Thal

	Discharge (Cfs)
Wet Season Daily Average	1,119
Dry Season Daily Average	635
7Q10 Low Flow	566

The mean annual flow of Kurram River at the Kurram Garhi Headworks for the period 1971-2012 is 1342 cfs based on daily average flows. Monthly mean, minimum and maximum discharges for the period 1971-2012 are given in Table 4-49 below.

Table 4-49: Kurram River at Kurram Garhi Headworks for the period 1971-2011

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg	725	817	1604	2210	1835	1212	2018	2283	1159	825	631	682
max	18,904	12,432	30,085	36,263	41,465	45,927	76,792	104,248	29,943	25,250	5650	6,135
min	320	100	108	108	108	55	55	74	75	50	228	260

The percentile annual and monthly flows are given in Table 4-50 below. All values are in cubic feet per second.

Table 4-50: Percentile Annual and Monthly Flows – Kurram River at Kurram Garhi Headworks

	Annual (1971-2012)	Monthly (1971-2012)
25%	1,653	1,634
50%	1,311	921
75%	969	657

Wet season daily average, Dry season daily average and 7Q10 low flow are given in the table below:

Table 4-51: Seasonal Daily Average and 7q10 Low Flows – Kurram River at Kurram Garhi Headworks

	Discharge (Cfs)
Dry Season Daily Average	897
WET Season Daily Average	1,801
7Q10 Low flows	664

Review of daily flow data indicated that flow measurement at Kurram Garhi Headworks was considered good by the Design Consultants, whereas potential flow measurement errors were observed at the Thal station. Consequently, the historic Kurram River flows at Kurram Garhi Headworks were used to estimate flows at other sites.

Data Consistency and Homogeneity: The quality of the discharge data has major effects on the viability of a water resources project. Therefore, it is essential to check the reliability of the discharge data. The Review Consultants checked for consistency and homogeneity of the data, based on Smirnov-Kolmogorov (S-K Test) and double mass curve analysis. The S-K test proved that the Thal data was consistent. The double mass curve method was been applied to the flow data of the Kurram Garhi Headworks and the Kurram River at Thal, and showed that there was a weak correlation between flow data of the two stations.

Flow Synthesis using Thal Data: Discharge data of the Kurram River at Thal have been found consistent and their application to developing flow synthesis scenarios is more viable than discharge data of the Kurram River at the Kurram Garhi Headworks. In case a drainage basin has no stream flow record, flows may be synthesized directly from other catchments, which are hydrologic ally and meteorologically homogeneous. This exercise should be taken up by the Feasibility/Design Consultants.

Flow Synthesis at the Kurram Tangi Dam Site: The synthesized average annual flow volume computed in the Design Report was 908 Th.AF (PES *et* al., 2011a) and by using the discharge data of the Kurram River at Thal, the annual flows are 987 Th.AF.

Flow Duration Curves: Flow duration curves were developed at Thal and Kurram Garhi Headworks. The flow durations are provided in in terms of the percentage of time of the year (ranges). Annual daily discharge records of 30 years (1971-2000) have been used for this analysis. The flow duration curves are given on Figure 4-8 and Figure 4-9.

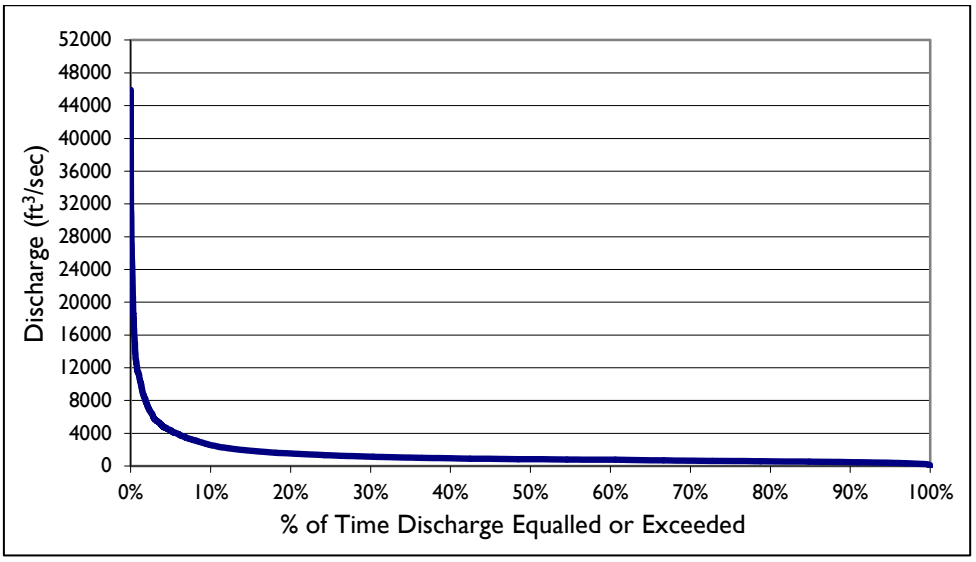

Figure 4-8: Flow-Duration Scenario of Kurram River at Kurram Garhi Headworks

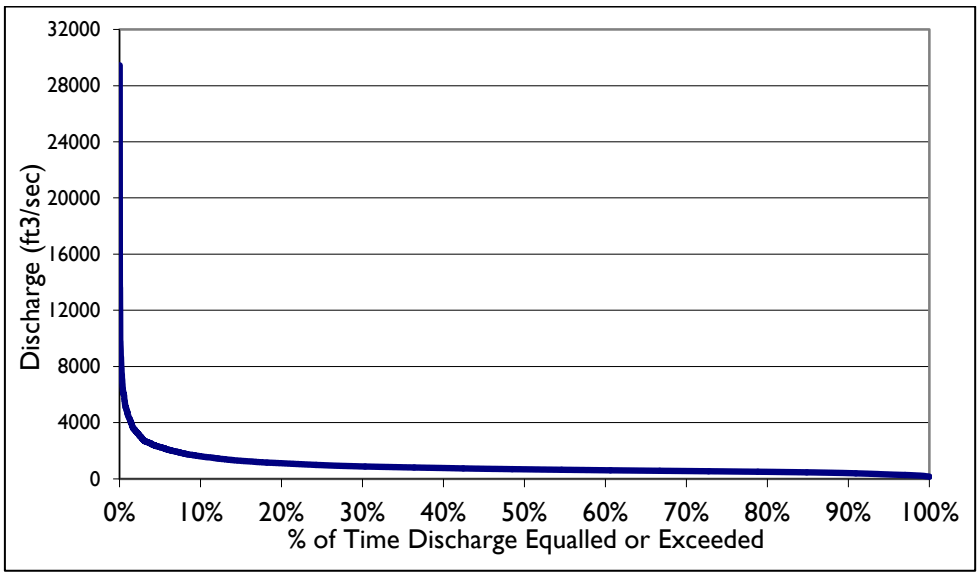

Figure 4-9: Flow-Duration Scenario of Kurram River at Thal

In order to optimize flow synthesis scenarios, the methodologies adopted in Feasibility/Detail Design were considered. It is concluded from various tests and comparisons of data analysis that:

- The discharge data of Kurram River at Thal are consistent and representative of the catchment area to the Kurram Tangi Dam site.
- In the Detailed Design Report, the average annual water availability at the Kurram Tangi Dam site is 908,000 acre-feet, while with Thal discharge data it is estimated at 987,000 acre-feet. The detail design report shows an underestimation of flows.

Design Flood Analysis. A flood frequency analysis and Probable Maximum Precipitation (PMP) estimate are calculated to provide an estimate of the magnitude of floods occurring over a particular time period. For instance, the probability of a storm event being equaled or exceeded once in five years would be considered a 5-year event. These storm events are then used to estimate the requirements for stream diversion during construction and for the design of project features such as the emergency spillway.

In the Detailed Design Report (PES *at al.*, 2011a), the Log-Pearson Type III distribution was used to estimate storm events. A frequency analysis was carried out using Gumbel and Log Pearson Type III distributions, and the results of both frequency analyses versus the Design Report are given in Table 4-52.

Table 4-52: Flood Frequency Analyses for Kurram River at Thal

Return Period	Estimated Discharge (cusecs)		
(Years)	Gumbel	Log Pearson Type-III	Log Pearson Type-III (Design Report)
2.33	28,403	24,963	27,358
5	46,539	45,248	53,815
10	61,310	63,556	68,650
20	75,478	78,212	79,979
30	83,629	89,023	85,279
50	93,818	99,107	90,798
100	107,561	114,695	96,581

On the basis of frequency analysis of the Thal instantaneous peak discharge data with two frequency analysis techniques, it is concluded that the results obtained in this review are similar, while differing with the results of frequency analysis presented in the Feasibility Report due to increased data availability for this analysis.

The PMP rainfall for Kurram Tangi Dam was studied by the Pakistan Meteorological Service (PMS) for the Kurram River basin in 1968, at the behest of WAPDA, using precipitation data from 1891 to 1965, and resulted in a PMP of 4.3 inches for 60 hours. However, storm events with significantly higher precipitation have occurred at locations in the vicinity of the Kaitu and Kurram River basins during multiple storms following the study period considered. Therefore, preliminary review of existing PMP studies in the general vicinity of the project indicates that the PMP for the Kurram Tangi Dam was underestimated and needs to be revisited.

Catchment Areas. See discussion in Section 4.6.1.1

Sedimentation. The sedimentation study carried out at the feasibility and detailed design stages of the Kurram Tangi Dam has been reviewed to determine its overall adequacy for the purpose of undertaking Environmental Assessment (EA) studies. This review comprised the examination of sediment and discharge data and the methodology used for estimation of the time for filling of reservoir with sediments.

Data Review: The feasibility report utilized the long-term sediment yield of Kurram River at Thal, as calculated by Surface Water Hydrology (SWH) of WAPDA in its publication Sediment Appraisal of Pakistan Rivers 1960-2005. It is noted in the 2004 Feasibility Report that the observed discharge data of Kurram River at Thal is faulty as it underestimates low flows and high flows. With this observation at the feasibility stage, it is imprudent to rely on the sediment yield based on the observed suspended sediment concentrations at that station. In order to obtain reliable sediment information, data from other gauging stations, available in the same or adjoining basins should have been utilized.

Findings on Estimation of Sediment Yield: An effort has been made to find out a correlation of mean annual runoff and mean annual sediment yield per unit catchment area up to the respective gauging stations. The SWH published yield is almost half the calculated mean annual sediment yield of 2.89, or say, 3.0 acre-ft per sq. mile. This indicates that the sediment yield was underestimated. It is recommended that a discharge and sediment measurement program be performed at either Thal or at the dam site until the construction phase begins to provide a better understanding of variation in discharges and sediments over the observation period and help for verifying the estimates made at feasibility/detailed design. Such verification would further help in final decision making in terms of fixing the sediment storage of the reservoir.

Reservoir Sedimentation: Reservoir sedimentation was estimated in the Feasibility and Detailed Design Reports using Brune's curve and empirical area-reduction methods. As discussed above, the mean annual sediment yield of the Kurram River at Thal is underestimated, which then indicates a longer time needed to fill the reservoir with sediment. Given the importance of loss of reservoir storage due to sedimentation it is recommended that during the design stage to develop a phenomenon-based numerical model for predicting future sediment patterns in the reservoir.

Channel Degradation Downstream of the Dam: Review of the Feasibility Report and detailed design report indicates that channel degradation downstream of the dam has not been studied. Since almost all of the sediments will be trapped in the reservoir, the water spilled past the dam will be sediment hungry and will cause channel erosion starting downstream of the dam. Such channel degradation will depend upon the channel bed gradation and the magnitude of flow flowing past the dam. It is recommended that a numerical model be developed to predict the river degradation under the predicted dam operational scenarios.

Other Sediment Related Issues: Besides channel degradation below the dam, other important associated issues related to sedimentation phenomena are:
Coarse sediment ingress into power tunnels
Optimization of sediment flushing

Though both of above aspects are not directly relevant for undertaking EA studies, they may have an indirect relation to determining the overall sediment integrity of the system.

Based on a review of sedimentation the following conclusions may be drawn:

- Mean annual sediment yield of Kurram River at Thal used in the feasibility study and detailed engineering design of KTMD is underestimated.
- SWH published mean annual sediment yield is half of the yield calculated by the regression equation developed in the current study.
- Reservoir sedimentation estimated in the feasibility study and the detailed engineering design utilized SWH published sediment yield therefore indicates liberal estimates and needs to be revised.
- Channel degradation in the river stretch downstream of the dam has not been studied in both feasibility and detailed design studies.
- Beside the channel degradation, sediment ingress into the power tunnel and optimization of sediment flushing, have not been studied at feasibility and detailed design stages.
- To quantify the channel degradation downstream of the dam, sediment ingress into the power tunnel and the flushing optimization, there is a need of development of a numerical model covering the reservoir extent and the river stretch downstream of the dam and duly capable of simulating the envisaged reservoir operation on long-term basis.

4.6.1.3 Component 3

River Flow Data and Analysis. A separate river flow analysis was not performed for Component 3. Refer to Section 4.6.1.2 for discussion of Kurram River data availability and analysis.

Design Flood Analysis. Analysis of the design flood along Kurram River is discussed in Section 4.6.1.2

Catchment Areas. See discussion in Section 4.6.1.1

Sedimentation. Analysis of sedimentation along the Kurram River is discussed in Section 4.6.1.2

4.6.2 Surface Water Quality

Baseline surface water quality information has been obtained from previous studies and from site visits. IDC was hired and trained to collect data at specific points in the KTDP AOI.

Fish, water quality and ecological data were obtained in 2007 at six locations on the Kurram River Table 4-53. Sampling locations were located within KTDP Component 2 and Three areas, including; Kharlachi, Sultan, Sadda, Domail, Kechi and Thanedarwala (Kurram River). Another three samples were taken from the Tochi River at Datta Khel, Khajuri Post and Sarai Gambila. Samples from the Tochi River are relevant to the KTDP, because a large part of the river flows within the AOI.

Table 4-53: Kurram and Tochi River Water and Ichthyofauna Sampling Locations(2007)

Sr. No.	Station Sampling Location	Coordinates		River/Stream	Reach	District
		°NL	°E			
1	Kharlachi	33,51,46	69,57,56	Kurram	R27	Kurram Agency
2	Sultan	33,47,41	70,11,24	Kurram	R27	Kurram Agency
	Sadda	33,47,44	70,20,19	Kurram	R27	Kurram Agency
4	Domail	33,02,06	70,45,25	Kurram	R29	Tank
5	Keechi Kamar	33,40,42	70,59,26	Kurram	R29	Tank
6	Thanedarwala	32,38,24	71,10,21	Kurram	R29	Tank
7	Datta Khel	32,55,20	69,46,56	Tochi	R29	Tank
8	Khajuri Post	32,57,38	70,20,44	Tochi	R29	Tank
9	Sarai Gambila	32,41,55	70,47,11	Tochi	R29	Tank

Source: Rafiq (2007).

Sampled reaches of the Kurram and Tochi rivers were divided into 6 ichthyoecological zones, with the Kurram River falling into Zone III, the Abasin zone. Zone III, is further divided into two parts: (a) Himalayas-plain interface sub-zone (which includes the Jhelum River) and (b) Kurram-Zhob sub-zone (which includes the Kurram River). The Kurram Zhob sub-zone receives less of the summer monsoons and exhibits higher water level fluctuations. The Kurram River is usually small and shallow, but prone to torrential flows from its headwaters in Afghanistan.

As shown in Table 4-54, the average altitude of the Abasin area is 3,880 ± 1,925 ft (range 1,470 – 9,150 ft) The average temperature is 21.9 + 3.71 °C (range 14 – 28 °C), with lower temperatures at higher elevations. The Abasin Zone has an average D.O. of 8.07 ± 0.92 mg/l (range 6.5 – 10.7 mg/l). Average and range values of other Abasin physico-chemical parameters like turbidity, alkalinity and salinity are provided in Table 4-54.

Table 4-54: Average values of different physico-chemical parameters in the Abasin Zone of Pakistan (2007)

Sr. No.	Parameters	Abasin Zone Average Values	Abasin Zone Range of Values
1	Average Altitude (ft asl)	3,880 ± 1,925	range 1470 – 9,150
2	Average Temperature (°C)	21.9 ± 3.71	14 – 28
3	Average Dissolved Oxygen (DO) (mg/l)	8.07 ± 0.92	6.5 – 10.7
4	Average Turbidity (NTU)	79.4 ± 83.6	0 – 380
5	Average Alkalinity (mg/l)	73.6 ± 24.7	2.4 – 132
6	Average TDS (ppm)	133 ± 111	45 – 760
7	Conductivity (µS/cm)	238 ± 126	60 - 880
8	Salinity	0	0
9	Stream Order	1.83 ± 0.88	1 – 4
10	Water Depth (m)	0.6 ± 0.52	0.1 – 0.3
11	%Sandy	3.22	-
12	%Gravely	82.84	-
13	%Rocky	5.56	-
14	%Rocky Gravely	8.25	-
15	%Muddy Bed	0	-

Source: Rafiq (2007)

4.6.2.1 Component 1

Baseline Data from Previous Studies

Surface water quality was monitored for the KTDP at the Kaitu River's Spinwam Bridge. The objective of this water quality monitoring was to assess its suitability for irrigation. As shown in Table 4-55**,** the water was considered fit for irrigation as the Electrical Conductivity (Ec) was <1 dS/m, Sodium Adsorption Ratio (SAR) < 10 and Residual Sodium Carbonate (RSC) < 1.25 and pH was also around 8.0.

Table 4-55: Kaitu River Surface Water Quality

Sr. No.	Source	EC x 10^6 (dS/m)	SAR	pH	Cl' (meq/l)	Category
1	Kaitu River Spinwam Bridge	890	1.6	7.9	0.7	Useable

Source: WAPDA (1992)

Surface water quality was again monitored at the Kaitu River's Spinwam Bridge in May 2003 for the KTDP Feasibility Report (KTDC, 2004). Results (Table 4-56) are generally consistent with those from the 1992 Pre-Feasibility Report (WAPDA, 1992).

Table 4-56: Kaitu River Surface Water Quality (May 2003)

Field Sample No.	Location	EC (dS/m)	SAR	RSCmeq/l	pH	Cl'(meq/l)	Category
ST – 3 Kaitu River	Spinwam Bridge	1.00	1.8	0	7.8	1.1	Useable

Source: KTDC (2004)

While there have been many reports of arsenic contamination in Punjab and Sindh (e.g. Baig, 2011; Nickson et al, 2004; Soomro et al, 2011) no specific data on arsenic contamination of surface waters was found in the existing literature for the project AOI and its immediate environs.

Baseline Data From Site Visits. IDC visited three sites in the Component 1 area during August-September 2013. Surface water quality was evaluated (Table 4-57) based on visual assessment and public consultation.

Table 4-57: Summary of Component 1 Area Water Quality Data Obtained from 2013 Site Visits

Sr. No.	Type of Surface Water Body	Location of Water Body	Source of Contamination (if any)	Water Quality Assessment	Present Use	Problems/ Concerns
1	Kaitu River	Spinwam (proposed Kaitu Weir site)	Soil erosion	Turbid and has odor	Drinking, irrigation, washing, and cleaning	No proper drainage system
2	Nullah	Spinwam	No sources	Transparent and odorless	Drinking and domestic use	Water shortages
3	Ephemeral stream	Sheratalla	Mixing of soil during heavy rain	Turbid and odorless	Irrigation	No proper drainage system

The above table reveals that although the water found in Kaitu River (proposed Kaitu Weir site) in Spinwam is turbid, it is used for drinking, irrigation, washing and cleaning purposes. Soil erosion in the area was the cause of turbidity. Kaitu River (Spinwam) local residents stated that the lack of a proper drainage system was their main concern. Water in the Nullah (Spinwam) appears to be of good quality and is used for drinking and other domestic uses. However, Nullah local residents stated that a shortage of water is a grave problem. A non-perennial stream in the Sheratalla Plains was turbid, due to mixing of soil during heavy rainfall. The water is used for irrigation. Sheratalla residents were concerned that the area lacks a proper drainage system.

Water Quality Sampling. A laboratory was contracted to collect water samples for analysis in the Component 1 area as part of the EA studies. The primary purpose of this sampling was to verify whether the water meets drinking water standards or not.

The following locations were selected for sampling (Map 4-29):

- W1 –Upstream of Kaitu Weir.
- W2 – Downstream of Kaitu Weir.
- W5 – Upstream of Powerhouse IV.
- W6 – Downstream of Powerhouse IV.
- W3 – Upstream of Powerhouse V.
- W7 – Sheratalla Canal near Bobali.
- W10 – Spaira Ragha Canal near Spinwam.

However, a NOC for carrying out the sampling was not issued by the relevant authorities, therefore it could not be carried out.

4.6.2.2 Component 2

Baseline Data from Previous Studies

As described in KTDC (2004), water temperatures in the Component 2 area of the Kurram River vary between 12 ◦C and 27 ◦C (Table 4-58).

Table 4-58: Annual Temperature Range of Kurram River

Month	Temperature in Kurram River (°C)
December	12
February	16
March	21
April	21
May	23
June	26
July	27
August	24
October	19
November	18

Source: KTDC (2004)

Water samples were collected at the proposed site of the Main Dam in May 2003. As shown in Table 4-59, the water was found to be useable for irrigation.

Table 4-59: Kurram River Surface Water Quality Results (May 2003)

Field Sample No.	Location	EC dS/m	SAR	RSCmeq/l	pH	Cl′meq/l	Category
Kurram River	Dam Site	0.46	0.8	0	7.8	0.5	Useable

Source: KTDC (2004)

As discussed in Section 4.6.2.1 no specific data on arsenic contamination of surface water was found for the project AOI and its immediate surroundings.

Baseline Data from Site Assessments. Six sites in the Component 2 area were visited during August-September 2013. Three of these sites were in Gumatti, one in Zarwam, one in Tariq Piquet and one in Biland Khel. The sources of surface water in Gumatti and Zarwam are springs, which had transparent and odorless water. The water is used for irrigation and domestic purposes including cleaning, washing, bathing etc. Water in the Kurram River at Biland Khel was turbid and had an odor. This water is usually used for irrigation only. Lack of drainage systems, water shortages, and blocked canals were identified by locals as concerns. Water quality data obtained from Component 2 area site visits are summarized in Table 4-60.

Table 4-60: Summary of Component 2 Area Water Quality Data Obtained from Site Visits

Sr. No.	Type of Surface Water Body	Location of Water Body	Source of Contamination (if any)	Water Quality Assessment	Present Use	Problems/ Concerns
1	Spring	Gumatti	No sources	Transparent and odorless	Irrigation, cleaning, bathing and washing	No drainage system
2	Kurram River	Biland Khel	Soil erosion	Turbid and has odor	Irrigation	No drainage system

3	Spring	Gumatti	No sources	Transparent and odorless	Irrigation, cleaning, bathing and washing	No drainage system
4	Spring	Gumatti	No sources	Transparent and odorless	Irrigation and domestic uses	Water shortages
5	Spring	Zarwam	No sources	Transparent and odorless	Irrigation, cleaning, bathing and washing	Blocked Canals
6	Non Perennial stream	Tariq Piquet	No sources	Transparent and odorless	Irrigation and agriculture	No proper drainage system

Water Quality Sampling. A laboratory was contracted to collect and analyze water samples in the Component 2 area as part of the EA studies. The following locations were selected for sampling (Map 4-29):

- W11 – Upstream of anticipated upstream extent of reservoir.
- W12 – Upstream of Kurram Dam.
- W13 – Downstream of Kurram Dam.
- W14 – Downstream of Powerhouse I.
- W4 – Upstream of Powerhouse II.
- W15 – Downstream of Powerhouse II.
- W16 – Confluence of Kaitu River with Kurram River.
- W23 – Downstream of Powerhouse III and upstream of Kurram Garhi Head Works.

However, a NOC for carrying out the sampling was not issued by the relevant authorities, therefore it could not be carried out.

4.6.2.3 Component 3

Baseline Data from Previous Studies. Surface water quality was monitored at the Kurram Garhi Headworks, Tochi River, Baran Dam, Kashu Algad, Marwat Canal at outlet and Marwat Canal at farm gate for the KTDP Pre-Feasibility Report (WAPDA, 1992). The objective of this water quality monitoring was to assess its suitability for irrigation. With the exception of Kashu Algad the quality of surface water streams was considered fit for irrigation (Table 4-61). The non-perennial stream at Kashu Algad had high salinity.

Table 4-61: Surface Water Quality

Sr. No.	Source	EC x 10^6 dS/m	SAR	pH	Cl′ (meq/l)	Category
1	Kurram River, Kurram Garhi Headworks	570	0.5	8.0	0.7	Fit
2	Tochi River	770	1.1	8.2	1.6	Fit
3	Baran Dam	550	0.9	8.0	0.8	Fit
4	Kashu Algad	8740	34.0	8.0	72	Unfit
5	Marwat Canal at outlet	510	1.3	8.0	0.7	Fit
6	Marwat Canal at farm gate	520	1.4	8.0	0.8	Fit

Source: WAPDA (1992)

Water samples were collected at Dua Nullah and Kashu Aglad in May 2003. Water at Dua Nullah was found to be useable for irrigation, while water at Kashu Aglad was found to be hazardous (Table 4-62).

Table 4-62: Surface Water Quality Results (May 2003)

Field Sample No.	Location	EC dS/m	SAR	RSCmeq/l	pH	Cl′meq/l	Category
Thal – 1 Dua Nullah	Bannu – Kohat Road Crossing	0.46	0.4	0	7.8	0.6	Useable
Thal – 5 Kashu Algad	Domel-Azim Kele Road Crossing	10.60	36.2	0	7.8	81.0	Hazardous

Source: KTDC (2004)

As discussed in Section 4.6.2.1 no specific data on arsenic contamination of surface water was found for the project AOI and its immediate surroundings.

Baseline Data from Site Assessments. Ten sites in the Component 3 area were visited in August-September 2013. Sites were visited at Daryoba in F.R. Bannu, Ghoriwal, Kot Barara and Sataro Chashma in Bannu District, Katchi Kamar, Wandha Kajjar and Tajbi Khel in Lakki Marwat District and Sheikhan Wala Bahu, Boota Wala and Ali Khanewala in Mianwali District. While water was transparent and odorless at some sites, it was contaminated due to mixing of soil and domestic waste at others (Table 4-63). Lack of proper drainage was the main concern raised by the local residents.

Table 4-63: Summary of Component 3 Area Water Quality Data Obtained from 2013 Site Visits

Sr. No.	Type of Surface Water Body	Location of Water Body	Source of Contamination (if any)	Water Quality Assessment	Present Use	Problems/ Concerns
1	Kurram Garhi Canal	Daryoba	No sources	Transparent and odorless	Drinking, irrigation, washing, cleaning and bathing	No proper drainage system

2	Kurram Headworks	Ghoriwala	Mixing of soil with water	Turbid and has odor	Irrigation and livestock	No proper drainage system is available and wastes are contaminating the irrigation channels
3	Baraganati Dam	Sataro Chasma	Soil erosion	Turbid and has odor	Irrigation	
4	Kurram River	Katchi Kamar	Mixing of soil causes turbidity, while mixing of domestic and waste water causes odor	Turbid and has odor	Irrigation and livestock	No proper management of waste and water.
5	Kurram River	Wandha Kajjar	Mixing or soil, organic and inorganic substances	Turbid and has odor	Irrigation	
6	Kurram River	Kot Barara	Sedimentation mixing of water from different channels	Turbid and has odor	Irrigation and livestock	Locals believe KTDP will reduce availability of water.
7	Kurram River	Sheikhan Wala Bahu	Soil contamination	Turbid and has odor	Agriculture	Water is saline
8	Kurram and Indus Rivers	Boota Wala	No sources	Transparent and odorless	Irrigation and bathing	Poor drainage system
9	Indus River	Ali Khanewala	No sources	Transparent and odorless	Irrigation and bathing	Poor drainage system
10	Tangi Nullah	Tajbi Khel	No sources	Transparent and odorless	Irrigation, bathing, cleaning and washing	Water shortage and no drainage system

Water Quality Sampling. A laboratory was contracted to collect water samples in the Component 3 area as part of the EA studies. The following locations were selected for sampling (Map 4-29):

- W24 – Downstream of Kurram Garhi Headworks.
- W25 – Thal Canal near Gumati.
- W17 – Kurram River near Bannu.
- W18 – Kurram River near Lakki Marwat.
- W19 – Kurram River downstream of Lakki Marwat.
- W20 – Upstream of confluence of Kurram River with Indus River.
- W21 – Confluence of Kurram River with Indus River.
- W22 – Downstream of confluence of Kurram River and Indus River.

However, a NOC for carrying out the sampling was not issued by the relevant authorities, therefore it could not be carried out.

4.6.3 Ground Water

Baseline ground water quality information has been obtained from previous studies and from site visits. IDC was hired and trained to collect data at specific points in the AOI. A laboratory sampled ground water at specific points in the AOI. These sampling points, selected to identify the onset of the potential impacts of KTDP activities, are shown on Map 4-30.

4.6.3.1 Component 1

Baseline Data from Previous Studies. Ground water quality data has been extracted from the KTDP Pre-Feasibility Report (WAPDA, 1992) and KTDC (2004). Thirty-three boreholes, some within the Component 1 area, were drilled in the Bannu Basin in years 1964 – 1966. Over 250 open wells were sampled during this same period. WASID and WAPDA produce a report in 1968 entitled 'Geohydrological Investigation in Bannu Basin, West Pakistan'. A second report was produced in November 1982 by the Directorate General of Hydrology titled 'Hydrological Data of Bannu Basin Vol. 1'. Table 4-64 shows the ground water quality results for Sheratalla and Spaira Ragha, as described in the 1992 Pre-Feasibility Report.

The results revealed that groundwater was marginally fit to fit for irrigation. The tubewells were not tested for drinking water quality parameters, although groundwater from tubewells was used for drinking purposes.

Table 4-64: Sheratalla and Spaira Ragha Ground Water Quality

Sr. #	Source	EC x 10^6 dS/m	SAR	pH	Cl′ (meq/l)	Category
1.	Tubewell at Sheratalla	2500	6.1	7.0	4.4	Marginally fit
2.	Tubewell at Spaira Ragha	890	1.4	7.2	0.8	Fit

Source: WAPDA (1992)

During a field visit in May 2003, ground water samples were collected from the open wells, dug wells and tubewells. These were again tested for irrigation parameters only, though the water was consumed for drinking purposes, as well. The results (Table 4-65) revealed that groundwater was marginal to hazardous.

Table 4-65: Component 1 Area Open Well/ Hand Pump Ground Water Quality (May 2003)

Field Sample No.	Location	EC (dS/m)	SAR	RSC (meq/l)	pH	Cl′ (meq/l)	Classification
Open Well, 1	Bobali, Sheratalla	1.06	1.9	0	7.8	1.8	Marginal
Open Well, 1	Spaira Ragha	1.60	4.1	0	7.8	2.7	Marginal
Tubewell, 11	Thal, Spinwam Tangi Village	2.60	23.2	2.1	7.8	17.2	Hazardous
Tubewell, 2	Vakil Khan Khel Sheratalla	2.60	8.1	0	7.8	3.0	Marginal

Source: KTDC (2004)

While there have been many reports of arsenic contamination in Punjab and Sindh (e.g. Baig, 2011; Nickson et al, 2004; Soomro et al, 2011) no specific data on arsenic contamination of groundwater was found in the existing literature for the project AOI and its immediate environs. One of the causes of arsenic enrichment of shallow groundwater in Sindh was salt concentration resulting from water-logging from irrigation (Baig, 2011).

Baseline Data From Site Visits. Six sites in the Component 1 area were visited in August-September 2013. Water found was to be transparent and drinkable at four of six sites (Table 4-66). Water at Spinwam and Datta Khel was transparent/brackish and turbid/brackish, respectively.

Table 4-66: Summary of Component 1 Area Ground Water Obtained from 2013 Site Visits

Sr. No.	Sources of Ground Water	Water Table Depth (feet)	Source of Contamination	Quality of Ground Water	Location	Present Use
1	Tube wells Hand pumps Dug Wells Motor pumps	80 – 120	No sources	Transparent and drinkable	Bobali	Irrigation, drinking, cleaning and bathing
2	Dug Wells Hand Pumps	40	Soil erosion (calcium)	Transparent and brackish	Spinwam	Irrigation, drinking, cleaning and bathing
3	Tube wells Hand pumps Dug Wells Motor pumps	24	Soil	Turbid and brackish	Datta Khel	Irrigation, drinking, cleaning and bathing
4	Tube wells Hand pumps Dug Wells	45	No sources	Transparent and drinkable	Kand	Irrigation, drinking, cleaning and bathing
5	Hand Pumps	80	No sources	Transparent and drinkable	Spaira Ragha Plains	Irrigation and domestic uses
6	Tube Wells Hand Pumps	120	No sources	Transparent and drinkable	Sheratall a Plains	Irrigation and domestic uses

Water Quality Sampling. A laboratory was contracted to collect and analyze ground water samples in the Component 1 area as part of the EA studies.. The following locations were selected for sampling (Map 4-30):

- Tubewell near Bobali.
- Tubewell in Spaira Ragha Plains.
- Tubewell in Sheratalla Plains.
- Tubewell near Spinwam.

However, a NOC for carrying out the sampling was not issued by the relevant authorities, therefore it could not be carried out.

4.6.3.2 Component 2

Baseline Data from Previous Studies. No baseline data is available from previous studies regarding ground water quality in the Component 2 area.

Baseline Data from Site Visits. Eight sites in the Component 2 area were visited during August-September 2013. Water was found to be transparent and drinkable at all eight sites (Table 4-67).

Table 4-67: Summary of Component 2 Area Ground Water Data Obtained from 2013 Site Visits

Sr. No	Sources of Ground Water	Water Table Depth (feet)	Source of Contamination	Quality of Ground Water	Location	Present Use
1	Tube well Hand pump	350-400	Nil	Drinkable and Transparent	Gumatti	Irrigation, drinking, cleaning and bathing
2	Dug well Hand pumps	40	No sources	Transparent and drinkable	Adam Kali	Irrigation, drinking, cleaning and bathing
3	Tubewell Hand pump Dug Well	80	No sources	Transparent and drinkable	Uch Garang	Irrigation, drinking, cleaning and bathing
4	Tubewell Hand pumps	80	No sources	Transparent and drinkable	Gumatti	Irrigation, drinking, cleaning and bathing
5	Tubewell	180-220	No sources	Transparent and drinkable	Gumatti	Irrigation, drinking, cleaning and bathing
6	Tubewell Hand pump	80-360	No sources	Transparent and drinkable	Zarwam Poya	Irrigation, drinking, cleaning and bathing
7	Tubewell Hand pump	60	No sources	Transparent and drinkable	Wam Qazi Khel	Irrigation, drinking, cleaning and bathing
8	Tubewell Hand pump Dug Well	50	No sources	Transparent and drinkable	Tariq Piquet	Irrigation, drinking, cleaning and bathing

Water Quality Sampling. No sites were selected for ground water sampling in the Component 2 area during 2013.

4.6.3.3 Component 3

Baseline Data from Previous Studies. Ground water data has been extracted from the WASID, WAPDA's 1964-1966 study conducted in 1964 to 1966 in the Bannu Basin, and from TNO - DGV the Netherlands/ Hydrogeological Directorate WAPDA, Peshawar in 1984 to1985. As shown in Table 4-68, tubewells at Tarkhoba and Foquela were unfit for irrigation purposes, while tubewells at Dabakhel and Khawargai were deemed fit. The tubewells were not tested for drinking water quality parameters, although ground water was used for drinking purposes.

Table 4-68: Component 3 Area Ground Water Quality (1964-1966, 1984-1985)

Sr. #	Source	EC x 10^6 dS/m	SAR	pH	$Cl^{'}$ (meq/l)	Category
1	Tubewell at Dabakhel	550	1.7	7.7	0.7	Fit
2	Tubewell at Khawargai	630	2.5	7.6	1.1	Fit
3	Tubewell at Tarkhoba	6060	19.0	7.6	47.7	Unfit
4	Tubewell at Foquela	8620	33.0	7.7	72.0	Unfit

Source: WAPDA (1992)

During a field visit in May 2003, ground water samples were collected from open wells/hand pumps and tubewells (Table 4-69).The Feasibility Report (2004) stated that water from open wells and hand pumps is used for drinking water purposes, but water samples were tested for irrigation purposes only. The results revealed that water from these sources varied from useable to hazardous for use as irrigation water.

Table 4-69: Component 3 Area Open Well/ Hand Pump Ground Water Quality (May 2003)

Field Sample No.	Location	EC dS/m	SAR	RSC meq/l	pH	$Cl^{'}$meq/l	Classification
Open Well, 2	Taziri, Thal	1.20	1.1	0	7.8	1.2	Marginal
Open Well, 7	Jandu Khel, Thal	2.24	2.7	0	7.8	2.6	Marginal
Hand pump, 9	Shoblay, Thal	1.48	6.3	0.3	7.8	3.8	Marginal
Tubewell, 3	Thal, Dabak Syed Khel	0.75	2.8	0.1	7.8	1.0	Useable
Tubewell, 4	Painda Khel near Kashu Algad	3.65	15.7	0	7.8	23.0	Hazardous
Tubewell, 6	Thal, Sadarwan Village	0.84	1.3	0	7.8	0.9	Useable
Tubewell, 8	Thal, Surdog Village	5.00	15.3	0	7.8	30.8	Hazardous
Tubewell, 12	Kotka Alam Shokhel	1.58	8.6	0.6	7.8	6.0	Marginal
Tubewell, 13	Tarkhoba Village	3.04	21.7	1.7	7.8	16.8	Hazardous
Tubewell, 10	Thal, Komali Village	4.00	17.0	0	7.8	35.2	Hazardous

Source: Feasibility Report KTDP, 2004

As discussed in Section 4.6.3.1 no specific data on arsenic contamination of groundwater was found for the project AOI and its immediate surroundings.

Baseline Data from Site Visits. Eleven sites were visited in the Component 3 area during August-September 2013 (Table 4-70). According to the locals, ground water was drinkable, transparent and used for various domestic, drinking and irrigation purposes at each site.

Table 4-70: Summary of Component 3 Area Ground Water Data Obtained from 2013 Site Visits

Sr. No.	Sources of Ground Water	Water Table Depth (feet)	Source of Contamination	Quality of Ground Water	Location	Present Use
1	Tubewell Dug wells	70-80	No sources	Transparent and drinkable	Ghoriwala	Irrigation and other domestic purposes
2	Tubewell Turbine motor Hand pump	30	No sources	Transparent and drinkable	Gandhi Khan Khel	Irrigation and other domestic purposes
3	Tubewell	50-60	No sources	Transparent and drinkable	Baraganati	Irrigation and other domestic purposes
4	Tubewell Hand pump	150	No sources	Transparent and drinkable	Kot Barara	Irrigation and other domestic purposes
5	Tubewell Hand pump	50-100	No sources	Transparent and drinkable	Katchi Kamar	Irrigation and other domestic purposes
6	Tubewell Pressure pump	60	No sources	Transparent and drinkable	Wanda Khajjar	Irrigation and other domestic purposes
7	Hand Pump Petrol engine	100	No sources	Transparent and drinkable	Sheikhanwala Bahu	Irrigation and other domestic purposes
8	Tubewell Hand pump	20-300	No sources	Transparent and drinkable	Boota Wala	Irrigation and other domestic purposes
9	Tubewell Hand pump	40	No sources	Transparent and drinkable	Ali Khanewala	Irrigation and other domestic purposes
10	Dug well Hand pumps	70	No sources	Transparent and drinkable	Tajbi Khel	Irrigation and other domestic purposes
11	Tubewells Boreholes	420	No sources	Transparent and drinkable	Kurram Post	Irrigation, drinking, washing and bathing

Water Quality Sampling. A laboratory was contracted to collect and analyze ground water samples in the Component 3 area as part of the EA studies. The following locations were selected for sampling (Map 4-30):

- W8 – Tubewell near Jandu Khel (South of Kohat Road).
- W9 – Tubewell near Kotka Alam Khan.
- Tubewell near Jandu Khel (North of Kohat Road).
- Tubewell near Sadarwan.
- Tubewell near Tarkhoba.
- Tubewell near Painda Khel.
- Tubewell near Dabli Khel.
- Tubewell near Surdag Banda.
- W26 – Tube well near Dabak.

However, a NOC for carrying out the sampling was not issued by the relevant authorities, therefore it could not be carried out.

4.7 Biological Resources

4.7.1 Vegetation, Habitat and Protected or Sensitive Zones

4.7.1.1 Methodology

Associated Consulting Engineers (ACE) was engaged to carry out a flora and fauna survey in the Kurram Tangi Dam Area. The methodology used for these studies is described below.

Flora Survey

Literature Review: Information on the vegetation is lacking even in the old colonial literature such as Gazetteers: Bannu (1894) that mentions only the grasses and scrub and occasional trees of Shisham, *Dalbergia sissoo*. Grazing areas termed as *rakhs* were set aside for the specific use of the domestic livestock and the camels and horses and managed by the communities. Champion *et al.* (1965) and Roberts (1991, 1997) described the vegetation from localities situated in the same climatic zone in Kurram Agency, Bannu FC areas, and Bannu areas. Scott (1989) reported plant species from wetlands located in the vicinity. Vegetation of the wetlands in the vicinity has also been compiled for then designated Ramsar sites (1990); Kurram River Valley including Baran Dam and Malugul Dhand (Bannu district) and Thanedarwala Game Reserve (Lakki Marwat district) (both sites now denotified).

Field surveys: Field studies were conducted from May to July 2013. Plant species were collected by the local residents, brought to Bannu in polyethylene bags. The plant species were identified following the binomial nomenclature. As the density of natural vegetation was very low (two to five percent) standard vegetation studies were not attempted. The elders and knowledgeable people from the area were contacted and their views on the presence/occurrence/anthropogenic interventions were recorded. Photographs and drawings of plant species believed to be occurring in the area were shown to the residents of the area working in Bannu, and their presence or absence was confirmed.

The Divisional Forest Officer North Waziristan was interviewed to record the history of vegetation dynamics and the role that Forest Department plays in the area to improve the vegetation structure, in ameliorating the natural environment and to provide small timber and firewood. The use of rangelands and the occurrence and the management of forests were also discussed. Discussions were held with the Conservator of Forests, Federally Administered Tribal Areas (FATA) to discuss the legislation and policy issues.

Postgraduate students and the academic staff of Botany and Environment Departments of Peshawar University, Islamia College University Peshawar and Post Graduate College Bannu were contacted to discuss the vegetation of the area.

Fauna Survey

Review of Literature: Only a few reports are available on the study of local fauna. The report on the fauna of the Kurram and Kaitu River watersheds was prepared by KTDC as part of the Feasibility studies (KTDC, 2004). This was based on the available literature for the general habitat types/ecozones existing in areas of similar topography, climate, elevation, latitudinal/altitudinal range (Birds – Roberts, 1991, 1992; Mammals – Roberts, 1997; Reptiles and Amphibians – Khan, 2000) and Forest Working Plans rather than on actual field studies. Scott (1989) reported animal and bird species from the wetlands located in the vicinity. Animal and bird species of wetlands in the vicinity were also compiled for the then Ramsar sites (1990) described under flora above

Field Survey: Field studies were carried out in May 2013. The information on the wild animals (including mammals, birds, reptiles and amphibians was obtained through consultations with the staff of the Wildlife Department at Bannu, and the students and the staff of Zoology Department, Post Graduate College Bannu and Zoology and Environment Departments of Peshawar University, Islamia College University Peshawar. Information on the wildlife habitat was gathered from the students and the staff of Botany Department, Post Graduate College Bannu.

Local inhabitants of the area living in Bannu were also interviewed about the existence and distribution of animal species in the area. They were shown the pictures of animals and birds to get a confirmation on their occurrence. The team collected this information through questionnaires filled in at the spot. The data were later compiled.

The elders and knowledgeable people from the area were contacted and their views on the presence/occurrence/anthropogenic interventions were recorded. Photographs of animal and bird species believed to be occurring in the area were shown to the residents of the area working in Bannu, and their presence or absence was confirmed.

The District Wildlife Officer Bannu was interviewed to record the presence or otherwise of animal and bird species in Project influence areas. The use of rangelands and the occurrence and management (rather the lack thereof) of wildlife were also discussed. The Chief Conservator Wildlife KP provided information on legislation and policy issues.

The Ph. D., M. Phil. and M.Sc. students and the academic staff of Zoology and Environment Departments of Peshawar University, Islamia College University Peshawar and Post Graduate College Bannu were contacted to discuss the animal and bird species of the area and their knowledge of the area; vegetation and fauna were also considered while reporting on the fauna of the area. Libraries were searched for information on animal and bird species of the area; research theses were also consulted.

4.7.1.2 Life Zones

The various vegetation zones of the Kaitu and Kurram River catchments are described below. Their key characteristics and status is summarized in Table 4-71. The vegetation zones are spread across both catchment areas, with little difference between the two catchments. The descriptions of these zones are derived entirely from the Feasibility Report (KTDC, 2004).

Table 4-71: Vegetation Zones in the Project AOI

Vegetation	Elevation (ft)	Urban Centers	Project Components	General Condition
Snow Desert	Above 14,000	None	None	No Intervention
Alpine Zone	12,000 – 14,000	None	None	Some tree cutting by herders in summer
Subalpine Zone	10,000 – 12,000	None	None	Heavily used by herders. Heavy grazing has removed palatable species of grasses.
Dry, Cool, Coniferous Forest Zone	9,000 – 10,500	Rekhmil 10,874 Mykaikili 9,941 Gawi 9,225	None	Heavy use for grazing, timber cutting, fuel wood; scattered tree only
Dry, Cool Temperate Mixed Forest	7,500 – 9,000	Gul Ghundai Kalai, Afghanistan 8,400	None	Heavy extraction of timber, fodder, fuel wood; few large trees, dense shrub layer where left alone
Dry Temperate Zone	5,500 – 7,500	Shalazon 6,530	None	Heavy grazing, lopping, fuel wood and timber extraction. Little left of native plant community
Warm Temperature/ Subtropical Zone	3,000 – 5,500	Karlachi, 5,713 Sultan Kallay 5,050 Kalachi 5,070 Sadda 4,026	None	Heavy grazing and lopping of fodder; timber cutting. Few large trees left (privately owned only)
Dry Sub-Tropical Forest	2,000 – 3,000	Thal 2,840 Shewa 2,500 Spinwam 2,400	Component 1 Component 2 (Part)	A scrub formation due heavy pressure by the human population
Hot Sub-Tropical Thorn Forest	1,000 – 2,000	Zarwam 1,750 Bannu 1,240 Domail 1,145	Component 2 (Part) Component 3	Original closed canopy forest has been reduced to a patchy scrub community.

The KTMDP lies within two of the zones as follows: Component 1 is entirely within the Dry Subtropical Forest Zone, being wholly above 2,000 feet in elevation; Component 2 lies in both the Dry Subtropical Forest Zone and the Hot Subtropical Thorn Forest Zone; and Component 3 is entirely within the Hot Subtropical Thorn Forest Zone.

Snow Desert. The highest zone of the two basins lies above tree line in the Sof-e-Khaid Mountains at an altitude greater than 14,000 ft. On the peaks of the mountains there is snow nearly all year and little vascular vegetation grows. In late summer there are lichens on some rock surfaces.

Alpine Zone. This vegetation zone lies mostly between 12,000 and 14,000 feet of elevation. It contains three basic vegetation communities: Dry Alpine Plateau Pasture, Dwarf Juniper Scrub, and Rhododendron Scrub. The first of these supports a steppe vegetation community of herbs and grasses, the most common genera of which are *Lonicera, Artemesia, Viola, Thymus, Hyoscymus,* and *Withania.* In some dryer areas, one finds the Dwarf Juniper Scrub community. The Dwarf Rhododendron community is found primarily at the more moist sites. In addition to rhododendron, it includes willow (*Salix*).

This area is routinely visited in summer by herders of sheep and goats, who cut the trees for building shelters and uproot the woody vegetation for fuel, leaving the soil vulnerable to erosion.

Subalpine Zone. This zone lies between about 10,500 and 12,000 feet of elevation and is accessible by road as several passes. It is characterized by Birch, Blue Pine, Deodar, Juniper, and Silver Fir. At the upper limits of the zone, only birch is able to survive in unprotected areas, whereas lower down there is an understory of smaller trees and shrubs, such as willows and birches.

The Subalpine Zone is heavily utilized by herders, who have cut the larger trees to build huts and for fuel, leaving only some of the shrubs. In some areas a pasture has developed, with a variety of grasses and low broad-leafed species. Heavy grazing of this pasture has resulted in some areas dominated by unpalatable species, such as *Aconitum*. Certain medicinal plants are also found here, or the genera also found in the Alpine Zone. Being mostly owned by the tribes, the land is used without any management and is subject to severe erosion in places.

Dry, Cool Coniferous Forest Zone. This zone is a largely coniferous region, from about 9,000 to about 10,500 feet. It contains a variety of trees and shrubs of the conifer genera *Pinus, Cedrus, Picea, Juniperus,* and *Albies*, and broad leafed trees of the genera *Quercus* (oaks), *Populus* (poplars), *Cotoneaster* (cotoneaster), and *Eleagnus*. There is a rich shrub community, as well, for the most part containing xerophytic species.

This zone represents the upper limit of urban development, with only a few communities found here: Rekhmil (10,874 ft), Mykaikili (9,941 ft), and Gawi (9,225 ft). These grazing communities exert a heavy pressure on the plant communities, through timber cutting, fuelwood gathering, and grazing, leaving much of the soil surface bare of vegetation. Human activities have reduced the standing trees to scattered individuals.

Dry, Cool, Temperate Mixed Forest. In the zone lying at 7,500 to 9,000 feet of elevation, one finds a predominantly broad-leafed forest dominated by Oak (*Quercus ilex*). In areas where the trees have survived heavy lopping for fuelwood and fodder, the trees are mostly about 30 feet tall, with spreading crowns. With the reduction in canopy, the plant community is invaded by light-seeking shrubs, such as *Berberis* and *Artemesia*.

This vegetation zone and the next have traditionally been major sources of timber for house construction and fuelwood.

Dry Temperate Zone. Lying between 5,500 and 7,500 feet in elevation, the Dry Temperate Zone contains the city of Parachinar (5,633 ft). This is a more open forest, of free standing oaks and pines, with a well-developed layer of xerophytic shrubs, characterized by small leaves and grayish color. Some of the herbaceous plants have strong bulbs for storing energy in periods of hard time.

This formation is subject to grazing, lopping, and felling for timber and fuelwood, as well as occasional fires, which burn with more violence that in the better watered lower slopes. Near human settlements, human activities have virtually eliminated this plant community, leaving the land vulnerable to erosion.

Warm Temperate/Sub-tropical Zone. Lying between 3,000 and 5,500 ft in elevation, in its mature form this is a community of trees with a continuous or nearly continuous canopy. Gaps in the canopy exist where soil moisture is deficient. When spaces develop, shrubs of *Rosa, Berberis, Artemesia* and other genera are found. During the rainy season, a ground cover of grasses and low shrubs develops. Many of the trees and shrubs have xerophytic features, such as thorns and small, leathery leaves. The pastoralists place considerable pressure on this forest community, in the form of cutting for construction timber and fuelwood and lopping for fodder. Many substantial towns along the Kurram River, such as Mandori (3,200 ft), Sadda (4,026 ft) and Sragalla (5,238 ft) lie in this zone.

Dry Sub-tropical Forest. Lying between about 2,000 and 3000 feet in elevation, this ecological zone contains many of the project features: the sites of the Kurram Tangi Dam, the whole reservoir, and the Kaitu Weir. The zone also contains the Sheratalla and Spaira Ragha Plains, as well as the important towns of Thal (2,838 ft), Spinwam (2,403 ft), and Shewa (2,500 ft).

The Dry Sub-tropical Forest community is a scrub formation of small trees that rarely form a closed canopy, due to human action.

Hot Sub-tropical Thorn Forest. Lying about 1,000 to 2,000 feet above sea level, this forest community extends from the mouth of the Kurram River to the dam site. It contains the Thal Command Area, the Kurram Garhi Weir, and the Marwat and Kachalot Canals. As the name implies, in its pure form, it is dominated by thorny tree and shrub species, such as *Acacia* and *Zizyphus*. Once a continuous closed canopy woodland, it has been reduced during the last two centuries to an open and patchy community dominated by shrubs, as the trees have been cut for forage and fuelwood. Of course, large areas once covered by this forest community are now devoted to agriculture.

4.7.1.3 Component 1

Component 1 lies entirely within the Dry Sub-Tropical forest Zone, a scrub formation that is subject to much anthropogenic pressure.

4.7.1.4 Component 2

The plant communities in Component 2 parallel those of Component 1. As noted above, the Kurram Tangi Reservoir will be entirely within the Dry Sub-tropical Forest Zone, which does not exist as climax vegetation within the reservoir area. Adjacent to the reservoir, remnants of this community may be found but they have been and continue to be subjected to severe degradation by grazing and cutting for fuelwood and fodder.

The Hot Sub-tropical Thorn Forest Zone, in addition to containing much of the remaining Component 2 structures, will contain most of the road construction, borrow and spoil areas, the transmission corridor, and camps.

4.7.1.5 Component 3

Component 3 lies entirely within the Hot Sub-tropical Thorn Forest Zone. With the exception of the foothills north of the Thal Plain and some near Baran Reservoir, this vegetative zone has ceased

to exist within the Area of Influence of the KTDP, except in remnant patches. In the Bannu and Thal Plains it has been entirely replaced by irrigated and rainfed agriculture.

4.7.2 Terrestrial Ecosystems

Within all three Components the biological environment has been highly disturbed by human activity, which has profoundly modified the vegetation as well as the animal species present within the area. This modification has occurred across all the components, and in combination with the limited access to the areas during field studies, it has not been possible to identify specific aspects of the natural terrestrial ecosystems that pertain to individual project components. Therefore the description of the terrestrial ecosystems is presented as whole for the entire Project AOI and not broken down by component.

4.7.2.1 Effects of Human Activities

Forests. Historically, in the hot subtropics all the thorn forest zone was under thick, evergreen bushy forest. Even up to the time of the Moghal invasion, these forests were intact. Subsequently, however, ingress of human population unleashed exploitation of these resources, for small-sized timber, fuelwood, and livestock fodder. The result was open woodland with almost no large trees. The influx of Afghan refugees that began during the Russian occupation and has continued since then has further degraded these forests. The refugees began to establish their settlements near Parachinar and spread downstream in the basins, cutting trees and shrubs for fodder and construction timber. As the above-ground vegetation was destroyed, the root systems were removed for fuel, leaving a denuded landscape incapable of recovery. Currently, the overall forest cover is about two percent, as the degraded forests comprise about ten percent of their original area of 30 percent.

This wholesale destruction of the forest cover on steep to very steep slopes, with persistent overgrazing and the uprooting of shrubs has accelerated erosion in the basin, with the slopes losing fertility irreversibly. Rain falling on bare rock, not being absorbed by soil, runs off at greater velocity, carrying greater amounts of sediment and causing flash floods. These sediments, deposited in the Kurram Tangi Reservoir, will shorten the life of the project.

Rangelands. Similar effects are observed on rangelands. The additional load of Afghan livestock, coupled with already heavy use by local herds of cattle, sheep, and goats, has severely degraded the rangelands of the southern part of the project area, leaving about half of the mountainous rangelands dead and the remainder dying. Generally grasses and shrubs in the area have decreased to an alarming extent. Currently they are producing only 10-20 percent of their potential production.

This has created a serious imbalance between forage production and requirements in the area. The overload leaves the livestock underfed, with low body weights, poor wool and hair production, low reproductive capacity, little resistance against disease, and high mortality.

If the present trend of range and watershed areas deterioration continues, the remaining rangelands will lose their productivity in the next decade. In addition, sediment loads in run-off will increase thereby increasing siltation rates in with potential negative impact on the proposed Kurram Tangi Dam and its reservoir.

Wetlands. The Kurram, Kaitu and Tochi rivers are the perennially flowing rivers that swell immediately after the rains in the watersheds. Many torrents (natural nullahs that come in spate after the rains that occur mainly during winter and spring) feed the rivers. The torrents spread far and wide, the run-off water collects in depressions that might stay for a considerably long period of time. Permanent wetlands however are not known from the area.

The wetlands in the depressions support ephemeral vegetation. Pioneer plant species on these wetlands include grasses such as *Saccharum spontaneum, Aristida depressa, Cynodon dactylon* and *Cyprus rotundus*. *Tamarix dioica* and *T. gallica* are the shrubs that follow the grasses. Other plant species

growing along the wetlands include reeds and grasses including elephant grasses. The aquatic vegetation includes *Hydrilla verticillata, Nelumbium speciosum, Nymphaea lotus* and *Potamogeton pectinatus*.

Agricultural Areas. The landscape of the project area has been altered into an agricultural one because of irrigation arranged through a network of water channels originated from Kurram and Kaitu Rivers, and natural torrents wherever soil, topography, and water availability permit the production of crops. Some tubewell irrigation also is practiced, when pumping from surface water is not possible. The principal crops are wheat, maize, and tobacco, along with vegetables and fodder. In the lower reaches of the basins fruit orchards are also grown.

Trees are raised as pure crops and as agroforestry crops, along the water channels and field boundaries. Willows, poplars and eucalypts are generally grown as pure crops and occasionally along field boundaries and water channels. Shisham and Kikar (*Prosopis juliflora*) are grown with the agricultural crops.

River Red Gum (*Eucalyptus camaldulensis*), Shisham and Kikar are also planted as avenue plantations along all major roads and along the canals and their offshoots. Such plantations are raised and maintained by the Government Forest Department.

4.7.2.2 Endemic and Threatened Plant Species

There are no plant species in the Project Area that are endemic to Pakistan. All of the plant species identified as being present in the Project AOI are considered "of least concern" by the IUCN.

4.7.2.3 Mammals

In the area of project influence the larger mammals have been essentially hunted out. Remnants of formerly abundant wildlife populations survive in the wilder areas, but are under severe pressure. Fifteen species are recorded in the Kurram Tangi Dam area (Appendix 9.7-1). In addition to these species there are also unconfirmed reports of the occurrence of Smooth-coated otter (*Lutrogale perspicillata*) from the area. Predators are also hunted as pests, including the Spotted Hyena (*Hyaena hyaena*) and the Asiatic Jackal (*Canis aureus*). In the upper reaches of the Kurram and Kaitu Basins, Gray Wolf (*Canis lupus*) and Leopard (*Panthera pardis*) are reported, despite heavy hunting pressure. Small mammals, such as Desert Hare (*Lepus nigricollis)* are occasionally hunted for the pot.

There are a few pest rodents in grain storage bins, notably rats (*Rattus rattus*) and mice (*Mus musculus*).

4.7.2.4 Birds

Birds, being more tolerant of human activities, are more diverse with 123 species (see Appendix 9.7-2) being reported or recorded as present in the project area, with. A few species are hunted, such as the francolins (*Francolinus francolinus* and *F. pondicerianus*), partridges (*Alectoris graeca*), and, in the higher reaches of the basins, pheasants (*Lophophorus spp*.). European Cranes (*Grus grus*) and Demoiselle Cranes (*Anthropoides virgo*) visit the area on migration and are occasionally hunted. The large majority of bird species live in association with human activities, neither hunted nor encouraged.

The Kurram valley is an important seasonal migration route for birds migrating between higher latitudes of Eurasia and the Indo Pakistan sub-continent. These include the storks, flamingoes, geese and ducks, harriers, hawks, buzzards, eagles, falcons, quails, cranes (Demoiselle and Common), bustards, a variety of waders including threatened plovers, calandra larks and many species of small passerine birds (Elan Partners and Design Consultancy Engineers, 2012).

The main migration seasons are October and November, when the birds migrate from their breeding grounds to wintering grounds and in spring from March to April when they return. The

birds cross the western mountains mainly through the passes. The Tochi pass and Kurram valley are one of the major corridors of the Indus fly way (Elan Partners and Design Consultancy Engineers, 2012).

The local people have a tradition of capturing cranes and keeping them as pets. Recent reports suggest that cranes are now being shot as well. The practice is now greatly impacting the crane population. Siberian Crane (*Grus leucogeranus*) that once passed through the area no longer uses the passage and is considered extinct from the area.

Domestic fowl of various types are maintained in many households, including chickens, ducks, geese, and turkeys.

4.7.2.5 Reptiles and Amphibians

The reptile fauna of the region has not been thoroughly studied. Three amphibian species and fourteen reptile species (Appendix 9.7-3) have been recorded. In addition to these species, earlier visitors reported the presence of the Indian Cobra (*Naja naja*). Snakes in the region are routinely killed on sight.

4.7.2.6 Species of Concern, Endemic and Threatened Animal Species

The following species are considered to be of special concern because of their specific use or place in the ecosystem:

- Both Demoiselle and Common Cranes are captured and kept as pets. Pet cranes are a part of the cultural scene in these areas and may be considered as a sign of respect for the household. Reportedly the cranes are being shot, though the practice is considered as unethical and the persons who adopt such practices are looked down upon. There is a crane conservation center in Lakki Marwat District. According to senior wildlife conservationist the cranes are hunted on a large scale in KP, and as a result despite funds allocation the crane conservation center could not achieve its aims[34].

  These two species of crane are currently listed as of least concern by IUCN and are protected under Pakistan legislation. However, enforcement of legislation is an issue in the area because of the security situation.
- The following migratory species that use the Indus Fly Way and may pass through the Kurram valley (Elan Partners and Design Consultancy Engineers, 2012): Black-necked Stork (IUCN status: near threatened), Marbled Teal, (IUCN status: vulnerable), White-headed Duck (IUCN status: endangered), Saker Falcon (IUCN status: endangered) and Sociable Plover (IUCN status: critically endangered).
- The partridges and francolins (Black Francolin, Grey Francolin, Seesee and Chukar Partridge) are hunted opportunistically. Chukar Partridge, Grey Francolin and Black Francolin are also kept as pet birds.
- Asiatic Jackal, Wild Boar, Desert hare and Indian crested porcupine are considered to be pests on agricultural crops. Mongoose, wild cats and Red fox may prey upon domestic poultry. Rats and mice are also the pests on stored grain and mice on agricultural crops as well.
- In addition, the IUCN lists the Egyptian Vulture as endangered, the Houraba Bustard as vulnerable, and the Ferruginous Duck, Lagger Falcon, River Tern, Kashmir Roller and Rufous-vented Prinia as near threatened.

There are no endemic wildlife species in the Project area. Many of the mammals found in the project area are fully protected under the Pakistan Wildlife Ordinance of 1971, including the cats. Among the birds found in the project area are many species protected by the Pakistan Wildlife Ordinance notably all cranes, eagles and falcons, herons,

[34] http://dawn.com/news/721297/sarus-cranes-seen-in-pakistan-after-a-decade

4.7.2.7 Protected Areas

There are no Protected Areas in the immediate vicinity of Kurram Garhi and the Project AOI.

4.7.3 Aquatic Ecosystems

The Kurram Tangi Multipurpose Dam Project consists of three components that encompass portions of the Kaitu River and the Kurram River. The general aspects of the components are described in Section 3.1, and their locations shown in Figure 3-1. The details of the structural features and operation of Component 1 are described in Section 3.2, those of Component 2 in Section 3.3, and of Component 3 in Section 3.4. With the exception of Component 3, these components all share a common, interconnected aquatic ecosystem that is similar for each of the Components. The existing Kurram Garhi Headworks presently fragments this common ecosystem, separating the lower Kurram River and its fauna from the mid and upper reaches of the river.

The focus of the existing (baseline) conditions of the aquatic ecosystem is on the fisheries resource, whose components consist of the aquatic habitat (the physical habitat, hydrology, and water quality) and the aquatic biota (fish fauna). These conditions are addressed by Project Component, recognizing there is some overlap among them that is repetitive. Baseline conditions beyond the immediate Project Area are included to place the conditions within the Project Area in context. The general features and characteristics of the Kaitu River are described in Section 4.2.2.1; those of the Kurram River, in Sections 4.2.1.2 and 4.2.1.3.

4.7.3.1 Component 1

Component 1 of the Project is located on the Kaitu River. The aquatic resource study area for Component 1 includes the reach of the Kaitu from near its headwaters to its confluence with the Kurram, as well as portions of the Kurram River.

Physical Habitat: No published description of the physical habitat of the Kaitu River is available. Based on satellite images on Google Earth (taken apparently during low water flows), the habitat appears to consist of a series of riffle/rapids, runs, glides and a few pools flowing through braided channels extending the entire length of the river. Under high flows, the braided channels are anticipated to be submerged and follow a regular meander. The substrate throughout the river's length appears to be primarily sand and gravel, with some cobble.

The above description of the physical habitat of the Kaitu River in the immediate vicinity of Component 1 based on the satellite imagery is supported by ground-truth observations recorded as part of a limited fish sampling survey in the Kaitu at Spinwam during June and July, 2013 (see Annexure 1 in the Fisheries Management Plan, Annex IV of the EMMP). The sampling site was located about 17 river miles upstream of the confluence of the Kurram and Kaitu rivers at an approximate elevation of 2,364 feet above mean sea level. The physical habitat of the river at this site was characterized as a pool, with deep water, and slow to moderate flow velocity. The water depth ranged from one to four feet, and the substrate was dominated by cobbles, gravel silt and sand. A photograph of the site is provided in Section 5.1.2.1 of Annexure 1 in the Fisheries Management Plan.

The river gradients over much of the Kaitu are low, being mostly around (and often below) a 1% slope (Section 4.2.1.1). The low gradient of the river extends well upstream of Spinwam by over 50 miles. Even in the upper reaches of the river near the headwaters in Afghanistan, the slope does not exceed 1%. From the Pakistan-Afghanistan border, to the site of the Kaitu Weir, the slope of the river is 1.22%; then in the reach from the Weir to the confluence of the Kaitu with the Kurram, the slope is 1.08%. With the exception of the fish sampling site at Spinwam, river depths are unknown.

As with the Kaitu, published descriptions of the physical habitat of the Kurram River upstream and downstream of the confluence with the Kaitu are lacking. Based on the satellite images, the habitat of the Kurram in this reach also appears to be a series of riffles, runs and pools flowing through

braided channels. The substrate appears to be primarily sand and gravel, with some cobble. The river gradient in this reach is low, being below a 1% slope (Section 4.2.1.2). River depths are unknown.

Hydrology: The hydrologic characteristics of the Kaitu above Spinwam are unknown. Water velocities in the higher gradient sections of the reach will be proportionally higher than the lower gradient sections. Based on the gradient information, the hydrological characteristics of the Kaitu extending over a 50-mile reach upstream of Spinwam are anticipated to be similar to those at Spinwam.

The hydrologic characteristics of the Kaitu River at Spinwam are described in Section 4.6.1.1. Based on the period of record from 1980 - 2011, the mean annual flow of the Kaitu River at Spinwam (the site of the Kaitu Weir) was 718 cfs, the mean maximum flow was 7,119 cfs, and the mean minimum flow was 54 cfs. The 25 percentile, 50 percentile and 75 percentile flows were 788 cfs, 606 cfs and 489 cfs, respectively.

Water Quality: There are no water quality data available for the Kaitu above Spinwam. It may be assumed, however, that, based on the series of riffle areas, the levels of dissolved oxygen are high. Water temperature is assumed to follow a seasonal cycle, but lower in the higher elevations than in the vicinity of Spinwam.

The water quality characteristics of the Kaitu River at Spinwam are described in Section 4.6.2.1. Previous water quality sampling and analyses focused on irrigation use and did not address ecological needs. Water quality samples were taken as part of the limited fish sampling program in the Kaitu River during June and July 2013 and analyzed for pH, conductivity and turbidity. Data for these parameters of ecological interest in the vicinity of Spinwam showed that pH was 7.8 - 8.3 (slightly alkaline); conductivity was 719.00 $\pm$ 1.00 µs/cm, and turbidity was 662.33 $\pm$ 7.77 NTU. No data are available for water temperature or level of dissolved oxygen (DO). Based on the images in Google Earth, the water appears to be moderately clear under low flow conditions. During the June and July sampling at Spinwam, the water was turbid.

The water quality characteristics of the Kurram River upstream of its confluence with the Kaitu are assumed to be represented by conditions at or near the Kurram Tangi Dam site, which are discussed in Section 4.6.2.2. Data for parameters of ecological interest for the Kurram at or near the Dam site exist for water temperature, pH, conductivity and turbidity. Water temperatures of the Kurram River (presumably in the vicinity of the Kurram Tangi Reservoir) are reported in Table 5.5 (3) of Annex 9 of the Feasibility Report (KDTC, 2004). The year of measurement is not reported and is unknown. Water temperatures were 12°C - 16°C (December - February), 21°C - 23°C (March - May), 24°C - 27°C (June - August) and 18°C - 19°C (October - November). Additionally, pH was reported as 7.8 (Section 4.6.2.2).

Limited water quality samples were taken near Fida Alam (just above the Dam site) as part of the fish sampling program in the Kurram River during June and July 2013 and analyzed for pH, conductivity and turbidity. Data for these parameters of ecological interest showed pH to be 7.8 $\pm$ 0.02; conductivity to be 562.00 $\pm$ 1.73 µs/cm, and turbidity to be 2774.00 $\pm$ 2.65 NTU. No data are available for levels of dissolved oxygen (DO).

Aquatic Biota: There are no data on the aquatic biota in the upper reaches of the Kaitu River. However, information on the aquatic biota in the vicinity of Spinwam is available and is applicable to much of the Kaitu. Based on the apparent similarities of physical habitat, hydrology and water quality, the aquatic biota in the Kaitu for some 50 miles above Spinwam to the confluence of the Kaitu and Kurram rivers can reasonably be assumed to be similar. Additionally, because the aquatic fauna in the Kurram River upstream of the Kurram Garhi Headworks can freely move into the Kaitu River, information on that fauna (discussed under Component II below) also applies to the Kaitu River.

Aquatic Vegetation: No data are available on the aquatic vegetation in the Kaitu and Kurram Rivers. The images in Google Earth, however, show no rooted aquatic vegetation in either river. Baloni (1980) noted that rooted aquatic vegetation does not grown in the hill streams of the Kedar Valley (India), which are similar to the Kurram River drainage hill areas. Because of the fast currents, the only vegetation that exists in these streams are algae and diatoms that cover the rocky substrate.

Aquatic Macroinvertebrates: No data on benthic macroinvertebrates are available for the Kaitu River. For the Kurram River, the Rapid Assessment Kurram Tangi Dam or REA (Design Consulting Engineers [Pvt.] Ltd. and Elan Partners [Pvt.] Ltd., 2012), provides a list of aquatic macroinvertebrates as: "Mostly Hemiptera including water scorpion, giant water bug, backswimmer and water scavenger ....noted in shallow water." Ali (1968) is cited in Annex 9 of the Feasibility Report (no reference for this citation was provided in the Annex) as recording "several groups of invertebrate animals" (presumably in the vicinity of the Kurram Tangi Dam).

Fish: Limited fish sampling was conducted in the Kaitu River near Spinwam during June and July 2013 as part of this Environmental Assessment. The details of the survey are presented in Annexure 1 of the Fisheries Management Plan. This is the first recorded fish survey of the Kaitu River. The seven fish species found at Spinwam, their distributional status in Pakistan, as determined from FishBase (www.fishbase.org), IUCN status (www.iucnredlist.org) and recorded occurrence in the Kurram River system are provided in Table 4-72below.

Table 4-72: Fish Species Collected in the Kaitu River at Spinwam, June and July 2013

Species	Distribution Status	IUCN Status	Record of Occurrence in Kurram River System
Cabdio morar (Hamilton)	Indigenous	Not Listed	Mirza et al 2008
Barilius vagra (Hamilton)	Indigenous	Not Listed	Mirza et al 2008
Cirrhinus reba (Hamilton)	Indigenous	Least Concern	Mirza et al 2008
Labeo dyocheilus (McClelland)	Indigenous	Least Concern	Mirza et al 2008
Tor putitora (Hamilton)	Indigenous	**Endangered**	Shahjahan & Khan (1997)
Crossocheilus latius (Hamilton)	Indigenous	Least Concern	Butt and Nawaz (1978)
Garra gotyla (Gray)	Indigenous	Least Concern	Mirza et al 2008

The number of each of the species collected at Spinwam is provided in Table 5 of Annexure 1 in the Fisheries Management Plan. Measures of the diversity of this fauna, provided in Table 3 of the Annexure, show that it was the most diverse community found in the sampling program.

Although a signatory of the United Nations Convention on Biological Diversity in 1994, Pakistan presently has no legislation to protect endangered, threatened or rare fish species. However, the International Union for Conservation of Nature and Natural Resources (IUCN) identifies such species from an international perspective in a "Red Book." Based on the classification in the IUCN Red Book, species listed as Endangered are considered Species of Concern in this EA. Of the species listed in Table 4-72, *Tor putitora*, the Golden Mahseer, is listed by IUCN as "Endangered" and thus is considered a Species of Concern. IUCN assigned the "Endangered" status to this species on the basis of "severe" threats from overfishing, loss of habitat (including loss of forage and breeding habitats) and potential blocking of migrations, especially for breeding. Additionally, it is a species of "Special Importance in Pakistan" (Rafique and Khan 2012), who noted not only its Endangered IUCN status, but also its "very high" commercial value, which is derived from its status as a prized gamefish and high market price as food.

To address the remaining six species, the concept of Representative Important Species is used in this EA. Although seven species were collected at Spinwam, the number of fish species in the Kaitu River is undoubtedly much greater than those seven species collected in June and July, 2013. Fish species

present in the Kurram River above the Kurram Garhi Headworks to well upstream of the Kurram Tangi Dam site will move into the Kaitu River as far as suitable habitat is available. A total of 28 fish species is recorded in the Kurram above the Kurram Garhi Headworks (see Table 7.1 of Annexure 1 in the Fisheries Management Plan). Those species can potentially be found in the Kaitu from its confluence with the Kurram to well upstream of Spinwam. The number of species is too large to address each species individually. Hence, Representative Important Species are selected to characterize the fish fauna.

Representative Important Species are selected from the list of species and include those that are: 1) listed as being in need of protection; 2) representative of different trophic levels; 3) economically or recreationally important; 4) numerically abundant or prominent in the river; or (5) rare, threatened or endangered (Yoder 2012). Threatened and endangered species are automatically identified as Representative Important Species. Because Pakistan has no legislation to protect endangered, threatened or rare fish species (and, thus, none are so identified), the IUCN classification is used to identify these species. Similarly, because Pakistan lists no fish species as being in need of protection, species identified by Rafique and Khan (2012) as being of "Special Importance in Pakistan" are considered so listed. In particular, species endemic to Pakistan were considered by these authors to be vulnerable to extinction and in need of conservation measures.

In addition to *Tor putitora* (addressed separately as a Species of Concern because of its IUCN Endangered listing), the other Representative Important Species listed in Table 4.7.3.1 are: *Labeo dyocheilus* and *Garra gotyla*. *Labeo dyocheilus* is considered a Representative Important Species on the basis of its high commercial value and its listing by Rafique and Khan (2012) as a species of "Special Importance in Pakistan." *Garra gotyla* is selected on the basis on its abundance in the Kurram River (see Annexure 1 in the Fisheries Management Plan).

Fish sampling was also conducted in the Kurram River during June and July 2013. The results of that sampling, as well as the fish species in the Kurram reported in the literature are addressed in the discussion of Component 2 (below) to avoid duplication. Because fish freely move between the Kaitu River and the Kurram, the fish fauna in the portion of the Kurram River affected by Component 1 will include Kaitu River species, where suitable habitat exists.

4.7.3.2 Component 2

Component 2 is located on the Kurram River. The aquatic resource study area for Component 2 includes the reach of the Kurram from near its headwaters to the Kurram Garhi Headworks.

Physical Habitat: No published description of the physical habitat of the Kurram River is available. Based on satellite images (apparently some segment images taken during low flows, others at high flows), the habitat above the confluence with the Kaitu appears to consist of a series of rapids, riffles, runs, glides and a few pools flowing through a braided channel that extends the entire length of the river up to the headwater segment. Under high flows, the braided channel is anticipated to be submerged and follow a regular meander. The substrate in this reach appears to be primarily gravel and cobble, with some boulders in the segment from Thal to Sadda, becoming primarily boulder/cobble from Sadda to Parachinar.

The river gradients over much of the Kurram are low, being mostly around (and often below) a 1% slope. As noted in Section 4.2.1.2, in the 85 river miles between the Pakistan-Afghanistan border and the Kurram Garhi Headworks, the Kurram River has an average slope of 0.82%. The river gradient in the upper reach is somewhat steeper than in the lower, but the difference is not great. Upstream of the Kurram Tangi Dam site near the border the river slope is 1.24%; whereas in the 11 miles downstream of the proposed Kurram Tangi Dam site it has a slope of 0.76%. With the exception of the fish sampling sites (described below), river depths are unknown.

This description of the physical habitat of the Kurram River is supported by limited ground-truth observations that were part of the fish sampling survey during June and July 2013 (see Annexure 1 in the Fisheries Management Plan). Observations of the physical habitat were recorded near Doddar, near Baggan, near Manduri, Shapyanga, Thal (Sadaqi Kot Spin), Shiwa Bridge and near Fida Alam. The locations of these sites are shown in Figure 2 of Annexure 1 in the Fisheries Management Plan. A description of the physical habitat at each of these sampling sites, with a photograph of the site, is provided in Section 5.1.1.1 of Annexure 1 in the Fisheries Management Plan.

The sampling site near Doddar is approximately 40 river miles upstream from the Dam site and 3,552 feet above mean sea level. In July, the width of the river was approximately 980-1,300 feet. The river channel consisted of braided runs and pools. The substrate varies from gravel, silt and sand to cobbles, pebbles and gravels. The water was muddy (highly turbid), the velocity was moderate to fast, and depth was one feet to two feet.

The physical habitat at the sampling site near Bagan (approximately 27 river miles upstream from the dam site) consisted primarily of a riffle, with fast water velocity and a depth of one-two feet. In other respects, it was very similar to the habitat found near Doddar.
Near Manduri (about 23 river miles above the Dam site), the sampling site was a riffle having a depth of up to one foot, and a substrate dominated by cobble, pebbles and gravel. Water velocity was moderate to fast.

The sampling site at Shapyanga (located about 16 river miles upstream of the Dam site) is about 1000 ft lower in elevation than Doddar. The physical habitat consisted of runs and pools, with a substrate dominated by cobble, pebble and gravel. Water depths were generally between one and two feet, with some deeper areas, and water velocity was moderate.

The site at Thal (located about 12 river miles upstream of the Dam site) was a riffle/rapids having a substrate of cobble and gravel, a moderate to fast flow and depth of one to two feet.

Located about 4 river miles upstream of the Dam site, the river channel at the Shiwa Bridge is divided. The physical habitat of the sampling location consisted of a slow-flowing pool having a depth of up to five feet. The substrate is gravel, silt and sand.

Near Fida Alam (located about 2.5 river miles upstream of the Dam site), the river is much wider than upstream, being 1,300-2,600 feet at an elevation of 1,935 feet above mean sea level. The channel is braided, consisting primarily of pools, having water depths of two to six feet. Water velocity was moderate to slow.

Downstream, from the confluence of the Kaitu River with the Kurram to the Kurram Garhi Headworks, the Google Earth images under low flow conditions show that the river continues to flow through a braided channel. The habitat appears to mostly consist of glides and a few pools, interspersed with short low gradient riffles. The substrate appears to be sand and gravel, with some cobble. None of the June-July fish sampling sites were located in this reach.

Hydrology: The hydrological characteristics of the Kurram River in its uppermost reaches are unknown. Upstream of the confluence of the Kaitu River with the Kurram to the vicinity of Thal (and some unknown distance above) the hydrological characteristics of the river are assumed to be represented by conditions at the Thal Gage, which are discussed in Section 4.6.1.2. Based on the period of record from 1971 - 2011, the mean annual flow of the Kurram at the Thal Gage was 878 cfs, the mean maximum flow was 10,406 cfs, and the mean minimum annual flow was 88 cfs. The 25 percentile, 50 percentile and 75 percentile flows were 827 cfs, 574 cfs and 440 cfs, respectively.

There are no hydrological data for the Kurram River in the reach between the confluence of the Kaitu River with the Kurram and the Kurram Garhi Headworks. The flow of the Kaitu River into the

Kurram will influence the hydrological characteristics of the Kurram River downstream of the Kurram-Kaitu confluence. The extent of this influence is unknown. The influence and extent of intermittent flows from the Zangari Algad and the Kanda Algad on the hydrology of the Kurram River are also unknown. The hydrological characteristics of the Kurram in the vicinity of the Kurram Garhi Headworks are discussed under Component III.

Water Quality: Limited water quality data were obtained for the Kurram River above the Kurram Tangi Dam site as part of the fish sampling study during June and July 2013. The water quality parameters measured were pH, conductivity and turbidity. The analytical results are given by sampling site in Table 6 of Annexure 1 in the Fisheries Management Plan. During June and July, pH in the reach of the Kurram above the Dam site averaged 7.6 - 8.1; conductivity averaged from 360 µs/cm - 823 µs/cm, and turbidity averaged 1545 NTU - 4345 NTU. Turbidity and pH were higher in the upper reaches of the river than near the Dam site; conductivity was lower in the upper reaches than near the Dam site.

No data are available for water temperature or levels of dissolved oxygen (DO) in the upper reaches of the river. It may be assumed, however, based on the series of riffle/rapids in this reach of the river, that the levels of dissolved oxygen are high. Water temperature is assumed to follow a seasonal cycle, but lower in the higher elevations than in the vicinity of the Kurram Tangi Dam site, and much lower than in the segment some distance above the Kurram Garhi Headworks.

The water quality characteristics of the Kurram River between its confluence with the Kaitu and the Dam site are assumed to be represented by conditions at the Kurram Tangi Dam site, which are discussed in Section 4.6.2.2. Data for parameters of ecological interest for the Kurram in this reach exist only for water temperature and pH. Water temperatures of the Kurram (presumably in the vicinity of the Kurram Tangi Reservoir) are reported in Table 5.5 (3) of Annex 9 of the Feasibility Report. Water temperatures were 12°C-16°C (December - February), 21°-23°C (March - May), 24°-27°C (June - August) and 18°-19°C (October - November). In the Feasibility Report pH was reported as 7.8 (Section 4.6.2.2). However, the Feasibility Report does not provide the year (or years) in which the temperature data were obtained. No data are available for levels of DO, or turbidity. However, based on the images in Google Earth, the water appears to be moderately clear under lower flow conditions. Under high flows, it appears to be turbid.

There are no water quality data for the Kurram River in the reach between the confluence of the Kaitu River with the Kurram and the Kurram Garhi Headworks. The flow of the Kaitu River into the Kurram will influence, to an unknown extent, the water quality characteristics of the Kurram River downstream of the Kurram-Kaitu confluence. The influence and extent of intermittent flows from the Zangari Algad and the Kanda Algad on the water quality of the Kurram River is also unknown. The water quality characteristics of the Kurram in the vicinity of the Kurram Garhi Headworks are discussed under Component 3.

Aquatic Biota: There are no data on the aquatic biota in the uppermost reaches of the Kurram River. Information on the fish fauna in the reach between Fida Alam (near the Dam site) and near Doddar (approximately 40 river miles upstream of the Dam site) was obtained during the 2013 field studies. Based on the apparent similarities of physical habitat, hydrology and water quality, the aquatic biota in the Kurram for some distance above Doddar can reasonably be assumed to be similar to that at Doddar. However, near the headwaters (Parachinar/Kharlachi) the fauna may shift to colder water species (see Table 7.1 in Annexure 1of the Fisheries Management Plan, Annex IV of the EMMP).

There are also no data on the aquatic biota in the Kurram River between Fida Alam and the Kurram Garhi Headworks. However, the physical habitat in that reach appears to be similar to that in the reach between Fida Alam and Doddar, as well as in the Kaitu River upstream of Spinwam. The hydrological characteristics in the nine-mile reach of the Kurram between the Kurram Tangi Dam

site and the Kurram Garhi Headworks will be influenced by tributary inflows, and will be intermediary between the flows at these sites. The aquatic fauna between Thal and Sandakot, as well as the fauna in the Kaitu River (described in Component I), can move downstream to the Kurram Garhi Headworks (as well as move back upstream). Thus, the fauna in the Kurram River system from Fida Alam to the Kurram Garhi Headworks (including the Kaitu River) can be assumed to be similar, but likely changes on a seasonal basis in response to water temperatures.

Aquatic Vegetation: No data are available to address aquatic vegetation in the Kurram River, but in the images in Google Earth, no aquatic vegetation is visible. Baloni (1980) noted that rooted aquatic vegetation does not grown in the hill streams of the Kedar Valley (India), which are similar to the Kurram River drainage hill areas. Because of the fast currents, the only vegetation that exists in these streams are algae and diatoms that cover the rocky substrate.

Aquatic Macroinvertebrates: Information on benthic macroinvertebrates in the Kurram River is very limited. The REA provides a list of aquatic macroinvertebrates, cited above for the Kaitu.

Fish: A total of 64 fish species is recorded in the Kurram River system that includes the Baran Reservoir (see Table 7.1 of Annexure 1 in the Fisheries Management Plan, Annex IV of EMMP). Of these, 28 are present in the Kurram River above the Kurram Garhi Headworks, all recorded near or upstream of the Dam site. It is very likely that there are more than 28 fish species in the reach of the Kurram in which Component 2 is located. There are no records of fish collections in the reach between the Kurram Garhi Headworks and the site of the Kurram Tangi Dam. Given the wide distribution of the fish fauna of the Indus River drainage (see Section 7.5 of the Fisheries Management Plan, Annex IV of the EMMP), it is likely that many of the species in the reach of the Kurram below the Headworks are also present between the Headworks and the dam.

Of the 28 species reported above the Headworks, 10 species were collected in the fish sampling efforts at seven locations above the Dam site, conducted as part of this EA during June and July 2013. As a result of those sampling efforts, two of four new records of occurrence in the Kurram River system were found in the reach of river above the Dam site. The other new records of occurrence were found as part of the sampling conducted in the Baran Reservoir below the Kurram Garhi Headworks (discussed below under Component 3).

The 10 species collected upstream of the Dam site in this study, their distributional status in Pakistan (www.fishbase.org), IUCN status (www.iucnredlist.org) and recorded occurrence in the Kurram River system are noted in Table 4-73below. The details of the survey are presented in Annexure 1 in the Fisheries Management Plan (Annex IV of the EMMP).

Table 4-73: Fish Species Collected in the Kurram River above Thal, June and July 2013.

Species	Distribution Status	IUCN Status	Record of Occurrence in Kurram River System
Notopterus notopterus (Pallas)	Indigenous	Least Concern	Mirza et al 2008
Barilius pakistanicus (Mirza and Sadiq)	Endemic	Not Listed	Mirza et al 2008
Labeo pangusia (Hamilton)	Indigenous	Near Threatened	**New Record**
Tor putitora (Hamilton)	Indigenous	**Endangered**	Shahjahan & Khan (1997)
Cyprinus carpio (Linnaeus)	Exotic	Vulnerable (Wild)	Shahjahan & Khan (1998)
Crossocheilus latius (Hamilton)	Indigenous	Least Concern	Butt and Nawaz

			(1978)
Garra gotyla (Gray)	Indigenous	Least Concern	Mirza et al 2008
Garra persica (Berg)	Indigenous	Not Listed	**New Record**
Glyptothorax kashmirensis (Hora)	Indigenous	**Critically Endangered**	Mirza et al 2008
Glyptothorax naziri (Mirza and Naik)	Indigenous	Not Listed	Mirza et al 2008

The number of each of the species collected at each of the 2013 sampling sites and their relative abundance based on the study area are provided in Table 9 of Annexure 1 in the Fisheries Management Plan. Measures of the diversity of this fauna, provided in Table 7 of the Annexure, show that it varied by sampling site, but was lower than that found at Spinwam.

There are two Species of Concern that occur in this reach of the Kurram. These are the Golden Mahseer (*Tor putitora*) discussed briefly under Component I, and *Glyptothorax kashmirensis*, a sisorid catfish. *Glyptothorax kashmirensis* is listed by IUCN as "Critically Endangered." Rafique and Khan (2012) also list the species as being of "Special Importance in Pakistan." The IUCN listing of *Glyptothorax kashmirensis* as "Critically Endangered" is erroneous because it is primarily based on the assumption that the species is restricted to the Jhelum River in Pakistan. That assumption is incorrect. *Glyptothorax kashmirensis* is present in other river systems, in Nepal (Conway et al 2011) and India (Jayaram 2006). Nonetheless, because of the IUCN listing, restricted distribution and special importance in Pakistan, the species is considered a Species of Concern in this Environmental Assessment.

In addition to the Species of Concern described above, the Representative Important Species in this reach, and the rationale for their selection are:

- *Salmophasia punjabensis*: This species is considered to be a Representative Important Species because Rafique and Khan (2012) listed it as a species of "Special Importance in Pakistan " on the basis of its endemism in Pakistan.
- *Barilius pakistanicus*: This species is considered to be a Representative Important Species because Rafique and Khan (2012) listed it as a species of "Special Importance in Pakistan " on the basis of its endemism in Pakistan.
- *Garra gotyla*: One of the more abundant species in Kurram River and thus considered as a Representative Important Species.
- *Racoma labiata*: Rafique and Khan (2012) listed *Racoma labiata* as a species of "Special Importance in Pakistan" on the basis of its "high" commercial value.
- *Schizothorax plagiostomus*: According to Mirza *et al* (2008) this is one of the important species among the snow carps of the Kurram River, mostly found in the upper parts of the river. Stray specimens have also been recorded downstream to Bannu. It grows up to 2 feet in length and is consumed locally. Rafique and Khan (2012) also described this species as being of "high" commercial value.
- *Schistura curtistigma*: This species is considered to be a Representative Important Species because Rafique and Khan (2012) listed it as a species of "Special Importance in Pakistan " on the basis of its endemism in Pakistan.
- *Glyptothorax naziri*: This species was recorded as the most abundant species in this reach of the Kurram River. Additionally, being an endemic species, Rafique and Khan (2012) listed *Glyptothorax naziri* as a species of "Special Importance in Pakistan."
- *Mastacembelus armatus*: An indigenous species with a "high" commercial value makes this species a Representative Important Species.

4.7.3.3 Component 3

Physical Habitat: No published description of the physical habitat of the Kurram River below the Kurram Garhi Headworks is available. However, satellite images indicate that the river varies in width as it meanders through braided channels from the Headworks to its confluence with the Indus River. The substrate appears to be mostly silt, sand and gravel from the Headworks downstream to Bannu, then appears to become predominantly silt and sand thereafter to the Indus. There are a few riffle areas in the channels just downstream of the Headworks. However, the river in this reach appears to consist mostly of glides and pools. The river gradient in this reach is low, being mostly below a 1% slope from the Kurram Garhi Headworks to the confluence with the Indus River (Section 4.2.1.3). River depths are unknown.

Hydrology: The hydrological characteristics of the Kurram below the Kurram Garhi Headworks are discussed in Section 4.6.1.3. Based on the period of record from 1971-2012, the mean annual flow at the Headworks was 1,342 cfs, the mean maximum flow was 36,091 cfs, and the mean minimum flow was 128 cfs. The 25 percentile, 50 percentile and 75 percentile flows were 1,653 cfs, 1,311 cfs and 969 cfs, respectively.

Water Quality: The water quality characteristics of the Kurram below the Kurram Garhi Headworks are discussed in Section 4.6.2.3. Previous water quality sampling and analyses focused on irrigation use and did not address ecological needs. Data for parameters of ecological interest exist only for pH at the Headworks, which was reported as 8.0. No data are available for water temperature, level of DO, or turbidity. However, based on the images in Google Earth, the water appears to be very turbid.

Aquatic Biota: No data are available to address aquatic vegetation in the reach of the Kurram below the Kurram Garhi Headworks. However, based on the images in Google Earth, no aquatic vegetation is visible in this reach. No aquatic macroinvertebrate data are available for this reach, and this fauna is unknown.

Fish: Of the 64 fish species recorded in the Kurram River system that includes the Baran Reservoir, 45 are present in the Kurram River downstream of the Kurram Garhi Headworks at Bannu (see Table 1 in the Fisheries Management Plan). There are 35 species recorded in the Baran Reservoir (also listed in Table 1), seven of which are reported only for the reservoir and not recorded as present in the Kurram River. It is likely that the Baran Reservoir, as well as the Kurram River above the Kurram Garhi Headworks and the Indus River, serve as sources of recruitment for fish populations in the lower Kurram.

Fish sampling in the Baran Reservoir was conducted as part of this Environmental Assessment during June 2013. The results of that sampling are given in Table 4-74. A total of four species was collected, two of which are new records of occurrence in the Kurram system. However, the fish populations in the lower Kurram cannot move upstream into the reservoir, and the fish populations in the reservoir will not be affected by the Project.

Table 4-74: Fish Species Collected in the Baran Reservoir, June 2013.

Species	Distribution Status	IUCN Status	Record of Occurrence in Kurram River System
Labio rohita (Hamilton)	Indigenous	Least Concern	Shahjahan & Khan (1998)
Laubuca laubuca (Hamilton)	Indigenous	Least Concern	**New Record**
Ompok bimaculatus (Bloch)	Indigenous	Near Threatened	Mirza et al 2008
Parambassis ranga (Hamilton)	Indigenous	Least Concern	**New Record**

The numbers of specimens of each species collected in the 2013 study are provided in Table 12 of Annexure 1 in the Fisheries Management Plan. Of the 45 fish species present in the Kurram River downstream of the Kurram Garhi Headworks at Bannu (see Table 7.1 in Annexure 1 in the Fisheries Management Plan), there are two Species of Concern: *Tor putitora* and *Glyptothorax kashmirensis*. The bases for addressing these species as being of concern are provided in the discussions for Components 1 and 2.

In addition to these Species of Concern, the Representative Important Species in this reach, and the rationale for their selection are:

- *Salmophasia punjabensis* and *Mastacembelus armatus*. The rationale for considering these species as a Representative Important Species is provided in the discussion of Component 2, above.
- *Cirrhinus mrigala*: Rafique and Khan (2012) listed *Cirrhinus mrigala* as a species of "Special Importance in Pakistan" on the basis of its "very high" commercial value.
- *Puntius punjabensis*: This species is considered to be a Representative Important Species because Rafique and Khan (2012) listed it as a species of "Special Importance in Pakistan " on the basis of its endemism in Pakistan
- *Sperata seenghala*: Rafique and Khan (2012) listed *Sperata seenghala* as a species of "Special Importance in Pakistan" on the basis of its "high" commercial value.
- *Ompok bimaculatus*: Rafique and Khan (2012) listed *Ompok bimaculatus* as a species of "Special Importance in Pakistan" on the basis of its Near Threatened listing by IUCN.
- *Wallago attu*: Rafique and Khan (2012) listed *Wallago attu* as a species of "Special Importance in Pakistan" on the basis of its "very high" commercial value, and Near Threatened listing by IUCN.

4.8 Socio-Economic Characteristics, Settlement Patterns, Health, Education, Infrastructure and Cultural Resources

This chapter outlines the baseline socioeconomic situation in the KTMDP areas. The KTMDP will affect populations in five districts/areas in Northwest Pakistan:

- North Waziristan.
- Frontier Region Bannu (F.R. Bannu).
- Bannu District.
- Karak District.
- Lakki Marwat District.

The first two districts are located in the Federally Administered Tribal Area (FATA), the last three in the settled areas of the Khyber Pakhtunkhwa Province (KP). In terms of the KTMP program, Components 1 and 2 (with the exception of minor parts of the access roads and transmission line) lie in the FATA, while, Component 3 (plus minor parts of the access roads and the transmission line of Components 1 and 2) are located in the Districts of Bannu, Karak and Lakki Marwat. These five Districts have a total population of around two million people (See Map 1-2).

Please include administrative map with all components showing the districts and the project components

4.8.1 Demography and Population Characteristics

The five districts represent around 1.7 percent of the overall area of Pakistan, and comprise 1.2 percent of the total population of Pakistan. While population density in Bannu is relatively high, 1,400 people per square mile, twice as high as the national average of 550 people/mi^2 the densities are much lower in most of the project area, particularly in the rural districts such as Karak and Lakki Marwat and in the two FATA agencies of North Waziristan and Frontier Region Bannu. With a population density of 86 people/mi^2 and a significantly negative population growth rate of 6.65 percent F.R. Bannu, in particular, seems lightly populated. But this 'fact' results from the migration of people in F.R. Bannu to

the outskirts of Bannu in order to benefit from better security and infrastructure there, while maintaining access to their farms in the F.R. Bannu. Table 4-75 shows the main demographic characteristics of the five districts:

Table 4-75: Demography of KTMDP Area

Category	North Waziristan	F.R. Bannu	Bannu	Lakki Marwat	Karak
Total Surface Area (square miles)	1,817	288	474	1,222	1,302
Main Ethnic Group (note that each group has several subgroups that are often in conflict with each other)	Wazir	Wazir	Bannuchi	Mattizai	Khattak
Population (2013 Estimate based on 1998 Census)[35]	470,000	25,000	675,000	490,000	430,000
Average Annual Growth Rate	2.46 %	- 6.65%	2.81 %	3.16 %	3.26 %
Male	53.3 %	52.9 %	51.7 %	51.1 %	49.1 %
Female	46.7 %	47.1 %	48.3 %	48.9 %	50.9 %
Population Density (person per square mile)	260	86	1,430	400	330
Average Household Size	9.1	9.6	9.7	9.2	10.0

4.8.1.1 Component 1

Component 1 investments will mostly potentially impact the population of the Mir Ali and Spinwam tehsils in the Mir Ali subdivision of North Waziristan. The vast majority of the people living in this area are Pashtun, and the bulk of these hail from the Uthmanzai clan of the Wazir tribe. More than 99 percent of the people are Muslim and consider Pashto to be their mother tongue. Legally, the area is "semi-autonomous," is governed by customary rules and is characterized by an egalitarian and collective decision-making through consensus building on three levels: the household, the clan and the tribe. The Government of Pakistan interacts with these tribal structures through local intermediaries: maliks represent the tribes and lungi holders represent the sub-tribes or clans. Both are appointed by, and paid by, the Government. Meanwhile, the Government itself is represented by the Political Agent of North Waziristan and on a day-to-day basis by the Assistant Political Agent in charge of the Mir Ali subdivision, the two tehsildars (heading the two tehsil) with their niab tehsildars (deputy tehsildar), the local police ("khassadars") and additional security forces (here particularly the Tochi Scouts based in Mir Ali).

The total number of people within the footprint of Component 1 is estimated at 150,000, most of them living within or near the proposed Canal Command Areas (CCA) in the Spaira Ragha and Sheratalla plains.

[35] All data in this chapter are from the 1998 Census and subsequent updates and/or the Agricultural Census 2000 and 2010 all done by the Pakistan Bureau of Statistics (http://www.pbs.gov.pk/) and the Bureau of Statistics of the Khyber Pakhtunhwa Province that also covers FATA (http://www.khyberpakhtunkhwa.gov.pk/Departments/BOS/). The most detailed reports are five District Census Reports: North Waziristan 2000, F.R. Bannu 2001, Bannu 1999, Karak 2000 and Lakki Marwat 2000.

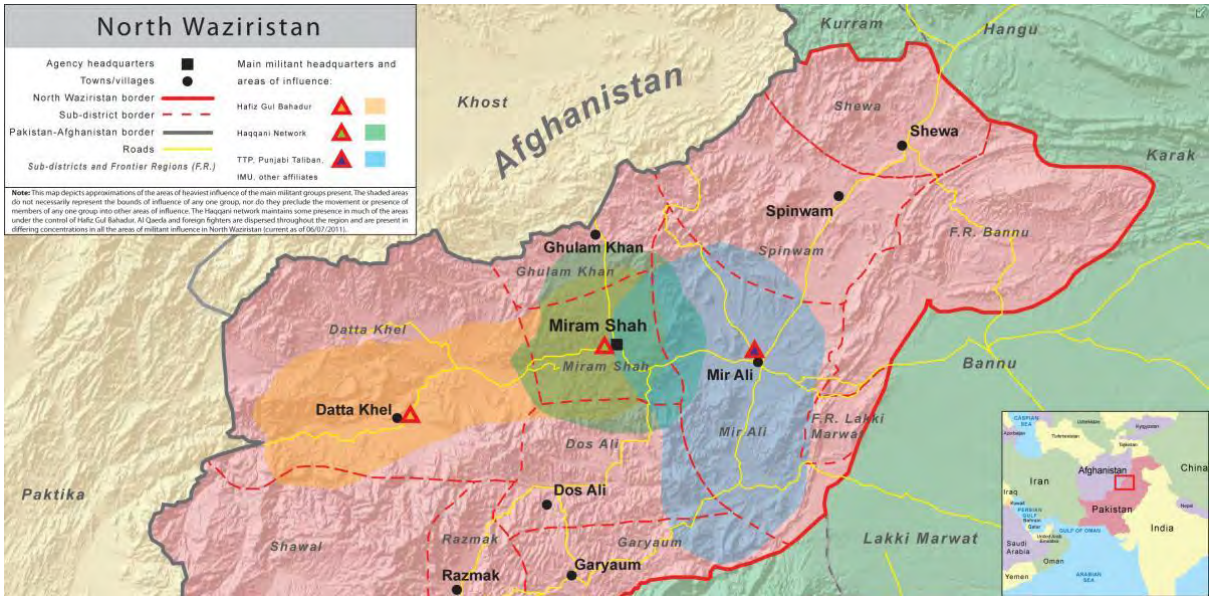

Figure 4-10: Security Challenges in Component 1 and 2

In particular, the area around Mir Ali (see Map 4-2) is exposed to security challenges from the Tehrik-i-Taliban Pakistan (TTP), the groups around Halim Khan Daur, Rasool Khan Daur, Maulana Manzoor Daur, Haq Nawaz Daur as well as a significant number of Uzbek militants (Islamic Jihad Union), smaller numbers of al-Qaeda operatives of Arab, Chechen, Uighur and Turk origin and finally a good number of "retired" jihadists.

4.8.1.2 Component 2

Component 2 will potentially impact the population of the Shewa Tehsil in the North Waziristan Agency (see
Figure 4-9) as well as the people in the F.R. Bannu. The vast majority of these people are Pashtun. While most people in and around the potential reservoir in the Shewa Tehsil are Uthmanzai Wazirs, the people downstream of the proposed Kurram Tangi Dam in the F.R. Bannu are Ahmadzai Wazirs. Both groups are Muslim and use Pashto as their mother tongue. The two tribes govern themselves in semi-autonomy, with the jirga, which comprises the heads of all households, as their central decision making body. In Shewa Tehsil, the Government is represented by the Political Agent for North Waziristan, the Assistant Political Agent for the Mir Ali Subdivision in North Waziristan and finally the Tehsildar of Shewa. In the F.R. Bannu the Government is represented the Deputy Commissioner of Bannu, assisted by an Assistant Political Agent as well as members from local police and other security forces. They interact with the local tribes ("qaum") through the maliks and lungi holders that are both appointed and paid by the Government.

The total number of people within the footprint of Component 2 is estimated to be 35,000, with 30,000 residing in the Shewa Tehsil of North Waziristan and 5,000 in the F.R. Bannu.

4.8.1.3 Component 3

Component 3 will potentially impact the population in three Districts: Bannu, Karak and Lakki Marwat. In Bannu District, five union councils are affected: Asperka Wazir, Aral Hathi Khel, Karab Kalli, Jhando Khel and Azim Killa.

In Karak District four union councils are affected: Latambar and Warana in the Karak Tehsil; and, Ahmad Abad and Jehangiri in the Takhat Nasrati Tehsil.

In the Lakki Marwat Division Mash Masti Khani union council in the Lakki Marwat Tehsil is affected..

Each of these districts is inhabited largely by a single ethnic group. Most of the people in Bannu are Bannuchi, most of the people of Karak are Khattak and most of the inhabitants of Lakki Marwat are Mattizai. All are Muslim, use Pashto as their mother tongue and claim common ancestors. In fact, they speak the same language and claim the same origin as the Wazir.

Some researchers divide Pakhtun society into two categories: (a) acephalous, egalitarian bands, living in low-production zones and (b) those with a ranked society living on irrigated lands usually within larger state systems. "Nang" (honor) is the foremost symbol of the former society, as "Qalang" (taxes/rent) is of the latter. With minor variations the boundaries between the FATA and the settled areas follow this difference in social organization. The Wazir in North Waziristan and F.R. Bannu are acephalous egalitarian groups distinct from mainstream society, while the Bannuchi, Khattak and Mattizai are significantly more integrated into the Pakistan state. Since time immemorial, there have been constant fights between the Nang and Qalang tribes, and consequently the relations between the Wazirs and the three settled tribes are not without conflict. One of the key issues among the Wazir is the claim that the Qalang tribes invited the British into the region in order to deprive the Wazir of their grazing grounds in the Bannu plains.

The three districts (Bannu, Karak and Lakki Marwat) are governed by the laws of Pakistan and administered at the lowest level by union or village councils ("sherwan"), which generally comprise 21 councilors, and are led by an appointed mayor ("nazim"). The nazim reports to the tehsildar, who is in charge of a tehsil and whose main responsibility is tax collection. The system was first established under the Mughal Empire and then maintained throughout the British Administration and now into independent Pakistan. The tehsildar is generally a powerful figure in rural areas. Nonetheless, because he is appointed by the government, he needs to obtain support of the people in order to be able to carry out his work.

The total population within the footprint of Component 3 is estimated to be 260,000 people:

- 155,000 living in the Bannu District. 48 percent of them are below the age of 15, 46 percent between 15 and 50 and six percent older than 50 years.
- 100,000 living in the Karak District. 50 percent of them are below the age of 15, 46 percent between 15 and 50 and four percent older than 50 years.
- 5,000 living in the Lakki Marwat District. 50 percent of them are below the age of 15, 45 percent between 15 and 50 and five percent older than 50 years.

4.8.1.4 Vulnerable Peoples

Women. Much has been written about gender discrimination in the Pashtun society, which defines the woman's place to be in the house and without any contact with men outside their compound. Consequently, society invests far less in women than men, which is reflected in the significant lower literacy level (women on average eight percent versus men on average 40 percent) and results in a complete absence of women in the decision making of society outside the fenced compounds. A group that is commonly exposed to severe marginalization is female-headed households that are formally considered as part of the households of their relatives (mostly the brothers of their husbands) and that have no formal or culturally acceptable access to land and property and/or participation in decision-making processes. In short, women are significantly marginalized in the societies of the project region. See the Gender Plan for further information on this topic.

Physical/Mental Health and Disability. Disabled people are vulnerable in terms of participation in decision-making and access to employment opportunities. Disabled people may also experience varying levels of social exclusion and community marginalization. The 1998 Census suggests that in the project region about two percent of the overall population are handicapped. Families tend to take care of family members with special needs, but those families headed by peoples with disabilities are often poorly represented in meetings and therefore their concerns, priorities and needs not easily captured.

Landless Serfs. The project area is basically an agrarian society in which well-being, wealth and influence are defined by the amount of land controlled by the household. People without land are forced to work as agricultural laborers that generally owe significant debts to the landlords that under normal circumstances and despite hard labor they never can repaid and therefore need to continue working for the landlords from generation to generation.

Wazirs. The separate Vulnerable Tribes Plan (VTP) documents that the Wazir are quite distinct from other populations in the region for the following reasons:

- They identify themselves and are identified by others as distinct group;
- They had negotiated with colonial authorities distinct boundaries for their territories and managed this in semi-independence since 1871; and,
- Their culture, economy, social and political institutions are significantly different from mainstream Pakistani including "settled" Pashtuns ("egalitarian and consensus oriented society").

Further, their cultural distinctness has been recognized by the Pakistani legal framework (FATA) and needs to be taken into consideration when interacting with them.

4.8.2 Economic Activities

The entire project area is rural, with only one major center, the town of Bannu, with around 50,000 inhabitants, and Mir Ali with around 15,000 inhabitants. Employment figures are significantly below the national average. Several factors underlie this sad reality. On average less than 30 percent of the people above 10 years of age are able to read or write, limiting employment opportunities, and the road network is less than half of what is available in other districts, thus limiting the possibilities of trade and commerce. The only basic source of income in the region is agriculture. But the amount of agricultural land available per person/household in the five Districts is only one-third of what is available in other parts of Pakistan. In consequence, according to Multi-Donor "Pakistan Poverty Alleviation Fund", North Waziristan, F.R. Bannu and Lakki Marwat are among the 22 of 145 districts in Pakistan with the lowest Human Development and Food Security Index, with Bannu being only slightly better.

Table 4-76: Economic Activities in the KTMDP Areas

Category	North Waziristan	F.R. Bannu	Bannu	Lakki Marwat	Karak
Population (2013 estimate based on 1998 census)	470,000	25,000	675,000	490,000	430,00
Urban Population	2%	0%	7%	10%	6%
Rural Population	98%	100%	93%	90%	94%
Employment	<10 %	25.90%	29.60%	25.80%	22.40%
Average size of agric. Land/household (acres)	0.83	1.1	2.44	1.79	2.03
Households having < 1 acre of agricultural land	35%	5%	36%	5%	2%
Households having 1-5 acres of agricultural land	59%	44%	47%	39%	70%
Road Network (miles per square miles of area)	0.04	0.08	0.51	0.12	0.29
Literacy Ratio (10 +)	10.63%	9.71%	32.11%	29.70%	41.90%

4.8.2.1 Component 1

Within the overall project region, the Component 1 area offers the fewest economic opportunities. While traditionally the Wazir were transhumant, their separation from the settled areas as well as from the mountain ranges in Afghanistan, further aggravated by the long standing conflicts within the

region, has turned most Wazir into resident farmers with very limited landholdings. Due to the rugged nature of the terrain with a very limited road network and the extremely low level of literacy (under 10 percent) hardly any employment is available. In turn, significant numbers of people temporarily migrate as seasonal laborers to other parts of Pakistan and/or abroad. One of the areas many Wazirs are involved is working as truck drivers or other jobs in transportation-related businesses.

Those who stay, practice rain-fed agriculture on very small plots that are on average only one-sixth of what is available to households in other parts of Pakistan and less than half of what is available to the people in the settled areas nearby. Each household has on average three plots with a total surface area of less than one acre. Most of the land is farmed by peasant owners. There are very few landlords who cultivate fields with farm laborers and/or tenants. Most of the work is done by the adult men. Relatively few women and children below the age of 12 reportedly work in agriculture (approximately five percent each). The low participation rate of women in agriculture is partly due to the cultural pattern that adult women below 40 years of age are generally not allowed to leave the compound without a male escort.

Agricultural production is almost exclusively for family consumption. Wheat is the dominant Rabi crop, and maize the main Kharif crop. Other common crops are rice, sugarcane and barley. Less than 10 percent of the production is marketed. Around 10 percent of the farms also have perennial crops: apricot, plums, dates, grapes, pomegranates, mulberry, malta, guavas, peaches, walnuts and lemons. Finally, nearly every household has chickens, goats and sheep, as well as a few large animals such as oxen, buffaloes, mules, camels and horses.

4.8.2.2 Component 2

The economic situation in the North Waziristan section of Component 2 is very similar to Component 1 and is only slightly better in the F.R. Bannu, where at least a quarter of the people have some form of employment and the average agricultural landholding per household is just slightly above one acre.

4.8.2.3 Component 3

The economic situation in the footprint of Component 3 is slightly better than in either Component 1 or Component 2, but it is still significantly below the national average. On average, the Karak District appears better off, but this is mostly related to some extractive industries (uranium, salt, gypsum, oil and gas) located in other parts of the district.

Nowadays, about 45 percent of the agricultural land in the Bannu District is irrigated and wheat the main Rabi and maize the main Kharif crops. Other crops grown are sugarcane, barley, jawar and bajra. In addition bananas, guavas, dates, plums, figs, loquats, apples and lemons are produced. There seems to be an arable reserve of some 40,000 acres, some of which is earmarked to be irrigated in the context of Component 3. Poultry, goats, sheep, cattle, buffalos, donkeys, camel and horses are the main livestock.

There are a number of industries in Bannu: the Bannu Woolen Mills, the Bannu Sugar Mills, the Bannu Ice Factory, a Leather Goods Service Centre and the Bannu Cement Pipes Industry Plant. In the 1998 census, about 40 percent of the people in the Bannu District indicated that their main economic activity is agriculture, while 30 percent claimed to be otherwise employed. Of these 60 percent indicated that they are self-employed, around 17 percent employed by the private sector, 15 percent in the governmental sector, five percent as unpaid helpers and finally three percent indicate that they are employers.

In Karak District around 42 percent of the people indicated that their main economic activity is agriculture, while around 25 percent claimed to be employed. Of these, 50 percent indicated that they are self-employed, around 12 percent employed by the private sector, 30 percent in the governmental sector, five percent as unpaid helpers and finally three percent indicate that they are employers.

Landholdings average two acres per household quite small, but significantly larger than in other parts of the project area. Nevertheless, as only 19 percent of the agricultural land is irrigated, the yields are not very high. The main Kharif crop are groundnuts, bajra, jowar and maize, while for the Rabi season, mostly wheat and gram are planted, with smaller quantities of barley, rape and mustard. Due to the shortage of water, there are hardly any orchards in the district. Also due to the absence of water, nearly half of the potential agricultural land is presently uncultivated. Poultry can be found in nearly every house. Goats and cattle are also very common. Donkeys, camels, buffalos, sheep and horses are relatively rare.

In the Lakki Marwat District the most common crops during Kharif are maize, sugarcane and jowar, while during Rabi mostly wheat and gram are planted. In addition there is a significant production of musk and watermelons. As for livestock, poultry can be found in nearly every house, with goats, sheep and cattle also being very common. Large animals such as buffalos, camels and horses are relatively rare.

In the 1998 census approximately 50 percent of the people in the Lakki Marwat District indicated that their main economic activity is agriculture, while 30 percent claimed to be employed: Among these 55 percent indicated that they are self-employed, around 17 percent employed by the private sector, 17 percent in the governmental sector, 10 percent as unpaid helpers and finally one percent indicate that they are employers.

4.8.3 Land Administration

4.8.3.1 Component 1

While land records were established as early as 1903 for some parts of North Waziristan (Tochi Valley etc.), and consequently detailed land revenue records kept similar to the settled areas of Pakistan, there are no such records for the two tehsils affected by Component 1.

4.8.3.2 Component 2

There are no detailed land revenue records in the Shewa Tehsil of North Waziristan and/or in the F.R. Bannu.

4.8.3.3 Component 3

As in all settled parts of Pakistan there is a handwritten and manually managed cadaster that is used to calculate and track the payment of land revenues. As the Bannu District is rather small there is no further subdivision into tehsils and consequently one tehsildar is in charge of the cadaster and land revenue collection of the entire district. He conducts his work through four girdawars, each in charge of a kanungo circle that groups the 50 patwar circles. These kanungo and patwar circles are not linked to the tehsils or union councils and go back to the Mughal Empire. Each patwar circle is managed by a patwar that updates and follows up the land records of every farmer and so is generally very knowledgeable about land issues. In Lakki Marwat District the approach is similar, but here there are 57 patwar circles grouped into four kanungo circles. In the Khattak District there are three tehsils that are then further subdivided into a number of kanungo and patwar circles (for more detail see the Resettlement Policy Framework).

4.8.4 Settlement Patterns

Settlement patterns vary significantly across the region. The general situation may be characterized as follows: the Wazir live in fortresses with high walls around their compounds and guard towers, while the people in the Bannu plains live in agricultural villages along the roads and waterways.

Table 4-77: Settlement Patterns in the KTMDP Area

Category	North Waziristan	F.R. Bannu	Bannu	Lakki Marwat	Karak
Main Ethnic Group	Wazir	Wazir	Bannuchi	Mattizai	Khattak
Population Density (person per square mile)	260	86	1,430	400	330
Urban Population	2 %	0 %	7 %	10 %	7 %
Rural Population	98 %	100 %	93 %	90 %	93 %
Average Household Size	9.1	9.6	9.7	9.2	10
Total Housing Units (total number of households)	39,000	2,000	69,000	53,000	43,000
Average number of rooms per housing unit	3.3	3.5	3.3	2.7	3.3
Pacca (Baked Brick)Housing Units	14 %	34 %	26 %	15 %	54 %

4.8.4.1 Component 1

The Wazir live in walled compounds inhabited by one or more families, which normally each have a house or cluster of houses ("ket"). The walls of mud and/or stones around these compounds ("kot") are often three to five meters high and have often a guard tower in the center that allows defending the kot against all enemies. Depending on the surroundings, these kots can cover a surface from 250 to 4,000 square feet. Many compounds contain fruit trees or other trees maintained for shade. A small truck garden may also be found inside the compound. Separate dwellings for the family of the owner and those of grown sons are found inside the walls of the compound. A separate compound may be provided for livestock outside the main compound. Less wealthy families construct their livestock compounds of thorny branches within the main compound. In areas where agricultural land and water is easily available, the compounds are clustered in villages of up to several hundred compounds but in less hospitable areas they are more widely separated.

Plate 4-6: View of a typical kot

As shown in Table 4-3 approximately 14 per cent of the houses are made out of baked bricks, blocks or stones ("pacca"), 84 percent are made out of unbaked bricks or bounded earth and the remaining 2 percent out of wood or bamboo. Within the compounds 75 percent of the houses have separate kitchens, 76 percent separate bathrooms and around one-third have separate latrines.

In the larger villages such as Spinwam, compounds are densely clustered, with narrow walkways or streets separating them. Two compounds frequently share a common wall. The larger villages are provided with primary and secondary schools, mosques and usually a basic medical unit. Mir Ali, for example, a town with 15,000 inhabitants, consists of a nuclear cluster of residential and commercial buildings, among which are markets, pharmacies, vehicle repair facilities and numerous smaller businesses. Every section of a village has a masjid and a common sitting area for the jirga's. In most settlements, one of the compounds also has a small private guest house (hujra) that is open to visitors of the clan.

Ninety-four percent of the houses are owned by the people living in them. Three percent are rented, and three per cent are provided rent-free. Due to conflict and economic problems, there has been very little new construction in the last 10 years, and around 75 per cent of the houses are at least 10 years old.

4.8.4.2 Component 2

The 1998 census suggests the same settlement patterns for the Shewa Tehsil in North Waziristan and the F.R. Bannu as outlined in 4.8.3.2. The main difference is that in the F.R. Bannu the houses are generally of higher quality (34 percent Pacca instead of 14 percent) and less fortress-like.

4.8.4.3 Component 3

In the Bannu District houses are usually rectangular in shape with one or more courtyards ("kothas") and an enclosed wall. Traditionally houses are made of hard clay with mud roofs, but these days around 26 percent are built of stone (pacca style). Nearly all houses are connected to the electric grid and around half of the houses are connected to the water system. About 20 percent of the houses only have one room, 65 percent between two and four rooms and 15 percent more than five rooms. 30 percent of the rural houses have a separate kitchen, while 40 percent have a shared one. Thirty-three percent of the rural houses have a separate bathroom, while 43 percent of them have a common one. Seventeen percent of the houses have a separate latrine and 34 percent a shared one. While in the rural areas four percent of the people rent houses, 45 percent of the houses are rented in Bannu. In both areas about 10 percent of the people are staying in the houses rent free i.e. are not the owners, but do not pay rent.

Between the houses there are small roads and in each quarter there is a chowk where the men meet in the evenings to smoke a chillum pipe. Quite some of the better off households also have a private guest house ("hujra").

In Karak District houses consist generally of two or three rooms with a verandah and host extended families of several generations. While approximately 10 percent of the houses have one room, 65 percent have between two and four rooms and 25 percent more than five rooms. The houses generally belong to those that live in them with rent and rent-free arrangements of less than two percent each. Proper houses are considered an important achievement and more than 50 percent of the houses are build out of baked bricks/blocks or stones, while the roof is mostly made out of wood or bamboo. About 20 percent of the houses have indoor water pipes, nearly all houses are connected to the electric grid and around 44 percent have a separate kitchen. Bathrooms are not very common. Only 29 percent of the houses have a separate bathroom while 34 percent have a common bathroom. More than 80 percent of the houses have neither separate nor shared latrines. But every cluster has a hujra and chowk that is used as meeting place for the men but also used as guesthouse.

In the Lakki Marwat District, the houses are commonly grouped in larger villages. Sevety-five percent of the houses are made out of unbaked bricks/earth with roofs out of kanna grass or bulrushes, while only 18 percent of the houses are made out of baked bricks, blocks or stones. About 80 percent of the houses are connected to the electric grid and around half of the houses are connected to the water system. 65 percent of the rural houses have a separate kitchen, while 10

percent have a shared one. 65 percent of the rural houses have a separate bathroom, while five percent of them have a common one. 20 percent of the houses have a separate latrine, two percent a shared one while the rest apparently uses their fields for this purpose. Hardly anybody (one percent) rents. Ninety-five per cent of the families own their house, and five per cent of the people are staying in the houses rent free i.e. are not the owners, but do not pay rent.

Between the houses there are small roads and in each quarter there is a chowk where the men meet in the evenings to smoke a chilam. Quite some of the better off households also have a private guest house ("hujra").

4.8.5 Health Conditions and Health Infrastructure

According to health officials[36], the following diseases are common in the project region:

- Heavy prevalence of cutaneous leishmaniasis (CL) subsequent to the influx of Afghan refugees to the area in the 1980ties. Leishmaniasis is a vector-borne disease caused by a species of sand fly (Phlebotomus). NGOs are involved in diagnosis and treatment of CL, but there is currently is a shortage of medication. The focus of CL seems to be North Waziristan with 1,760 cases in 2012.
- The prevalence of diphtheria in children has increased in recent years, probably due to the reduced immunization status of children resolving from the predominantly negative attitude towards health campaigns in recent years.
- Significantly high incidence rate of polio in the FATA (North Waziristan and F.R. Bannu as a result of the negative attitude towards polio oral drop campaigns in recent years that had reached a level, such that fatalities have been reported from polio teams in various parts of the FATA and KPK.
- Malaria is generally not a problem and only occurs in extremely rainy years. Malaria is not a natural disease in the dry arid project area. In 2013 there were heavy rains in all over Pakistan and chances of malaria increased nationally including the project area.
- Low personal hygiene status occurs as a result of the population's poverty and their custom of keeping their cattle in their houses. Typically, there are no indoor toilets, resulting in a high incidence rate of water-borne diseases like diarrhea, dysentery, typhoid and hepatitis A, D, and E (see specific data below).
- There is a high incidence rate of Trachoma in North Waziristan in comparison with other parts of Pakistan that might be attributable to poor hygiene and the custom of keeping cattle in their dwelling areas.
- There is an increase in number of TB cases. The interviewed health professionals attribute this to stigma and the restrictive attitude toward female patient diagnosis and treatment that prevails in the local society.
- The prevalence of HIV AIDS is low and can be attributed to the local interpretation of Islam that is not suitable for dissemination of HIV AIDS. Nevertheless, the disease flourishes in the community due to concealment as it is considered a stigma that results in social isolation. HIV AIDS is usually diagnosed when the condition is at the point of no return.

The most prevalent diseases diagnosed in the project area for the years 2011 and 2012 were:

- Diarrhea/dysentery
- Depression
- Acute upper respiratory infections
- Pneumonia
- Enteric/typhoid fever
- Peptic ulcer diseases
- Scabies

[36] FATA Secretariat (Peshawar), District Health Office (Bannu), Directorate of Malaria Control Pakistan, Chak Shehzad (Islamabad), Provincial AIDS Control Programme (Egerton Road, Lahore), District TB Coordinator (32-Cooper Road, Lahore.

Immunization Status. The immunity status against common diseases is low in the project area. In particular in the tribal area, the population has become near fanatically against all health and immunization campaigns. Due to this still growing resistance, the following diseases will increase.

- Poliomyelitis.
- Neonatal tetanus.
- Measles.
- Diphtheria.
- Pertussis (whooping cough).
- Hepatitis-B.
- Hib pneumonia and meningitis.
- Childhood tuberculosis.

The key health challenge in the project area seems to be access to purified drinking water and the chance to see a physician: While the national average is 0.6 physicians per 1,000 people, the figures in the five Districts as shown in the table below are significant lower. Access to hospital beds is with the exception of Lakki Marwat just slightly below the national average of 0.8 beds per 1,000 people. In addition, access to drinking water with the exception of Bannu is relatively low (between 60 and 75 percent).

Table 4-78: Medical Facilities in the KTMDP Areas

Category	North Waziristan	F.R. Bannu	Bannu	Lakki Marwat	Karak
Population (2013 estimate based on 1998 census)	470,048	24,775	677,346	490,025	430,796
Housing Units having Piped Water	14 %	25 %	43 %	39 %	22 %
Drinking Water Coverage	64 %	62 %	86 %	77 %	71 %
Number of physicians per 1,000 people	0.3	0.4	0.3	0.3	0.4
Number of hospital beds per 1,000 people	0.7	0.7	0.8	0.3	0.7

4.8.5.1 Component 1

In North Waziristan there are nine hospitals with 330 beds, as well as a number of health centers which offer, in total, coverage just below the national average of 0.8 beds per 1,000 peoples. The key issue here is that these government facilities are understaffed and 22 percent of the positions not filled. The situation for female medical officers is even more serious as only 21 of the 48 positions are filled.

Cultural restrictions discourage women from going out publicly and forbid consulting male doctors, even when female doctors are in short supply and the illness is serious. The same restrictions apply to female children, who are generally subject to the usual childhood ailments but may not even be allowed to be vaccinated. Therefore, preventive measures are of particular importance:
About two-thirds of the families (64 percent) have access to drinking water, which is rather low. Only 14 percent of the compounds have in-house access to water, which is an extremely low rate of coverage. In addition, there are indications that drinking water is insufficiently purified.

4.8.5.2 Component 2

The 1998 census suggests the same health situation applies for the Shewa Tehsil in North Waziristan and the F.R. Bannu. The only difference seems to be that in the F.R. Bannu more houses have indoor water pipes (25 percent instead of 14 percent).

4.8.5.3 Component 3

In the Bannu District approximately 70 percent of the houses have access to drinking water within the compounds, (43 percent through pipes, 22 percent through hand pumps and five percent through wells), in the Karak District around 26 percent (21 percent through pipes, two percent through hand pumps and three percent through wells) and in the Lakki Marwat District about 54 percent (38 percent through pipes, 12 percent through hand pumps and four percent through wells).

4.8.6 Education

The literacy level in the region is generally low, and women are significantly disadvantaged. In North Waziristan and F.R. Bannu few women are literate.

The government runs four basic levels of education: primary schools, secondary schools, high schools, and elementary colleges. Boys and girls are separated. All of the schools, but those of girls especially, suffer from difficulties of access, shortages of teachers, underpayment of teachers, absenteeism of teachers, and lack of teaching aids. The parents of girls frequently fail to send their daughters to school, for various reasons: There is an attitude that girls do not need education to be wives (and that being educated may reduce their eligibility for marriage). There is also a fear that when girls get older they will be assaulted on the road to and from school. Furthermore, corporal punishment, practiced by most teachers, deters girls from wanting to go to school. For boys, on the other hand, education is valued. A family of limited resources may have to choose between sending a son or a daughter to school and will invariably send a son.

Table 4-79: Literacy in the KTMDP Areas

Category	North Waziristan	F.R. Bannu	Bannu	Lakki Marwat	Karak
Main Ethnic Group	Wazir	Wazir	Bannuchi	Marwat	Khattak
Population (2013 estimate based on 1998 census)	470,048	24,775	677,346	490,025	430,796
Literacy Ratio (10 +)	10.6 %	9.7 %	32.1 %	29.7 %	41.9 %
Male	30%	17 %	50.8 %	50.3 %	68.2 %
Female	1.2%	0.6 %	12.2 %	8.6 %	18.1 %

4.8.7 Fuel Sources, Access to Water, Sanitation and Waste Management

As in many extremely poor regions, sanitation and waste management are not a priority and access to fuel and clean water are key challenges for everybody.

Table 4-80: Fuel Use in the KTMDP Areas

Category	North Waziristan	F.R. Bannu	Bannu	Lakki Marwat	Karak
Population (2013 estimate based on 1998 census)	470,048	24,775	677,346	490,025	430,796
Average Household Size	9.1	9.6	9.7	9.2	10
Housing Units having Electricity	60 %	28 %	94 %	87 %	81 %
Housing Units having Piped Water	14 %	25 %	43 %	39 %	22 %
Housing Units using Gas for Cooking	0.10 %	0.60 %	3.03 %	3.16 %	0.73 %
Drinking Water Coverage	64 %	61 %	86 %	77 %	71 %
No latrine	56 %	55 %	46 %	78 %	80 %

4.8.7.1 Component 1

According to the 2009 Census, 60 percent of houses possess electricity for lighting, while 40 percent rely on kerosene. Ninety-four percent of households rely on wood for cooking; hardly anybody uses gas. The reliance on open stoves causes severe indoor air pollution and the attendant respiratory problems, as well as increasing fuel wood consumption in largely deforested areas. Most wood in the area is burned without conversion to charcoal and therefore used not very efficiently.
Information on domestic water suggests that 14 percent have indoor pipes, 31 percent indoor wells (dug or drilled) and 11 percent outside wells, while the remaining 44 percent rely on "other" sources, which may be presumed to be local rivers or nullahs. Women and children of the household are responsible for obtaining water.

Thirty-seven percent of the compounds in the project region were reported to have latrines, seven percent shared latrines with other compounds, and 56 percent reports having no latrines. In those with no latrines, residents defecate and urinate in the local vegetation outside the compound. Waste management is unheard-of and waste ismostly deposited in the riverbeds in the hope that the next rain will wash it away.

4.8.7.2 Component 2

The 1998 census suggests that beside minor variations shown in the table, the same situation as outlined in 4.8.6.2 applies for the Shewa Tehsil in North Waziristan and the F.R. Bannu. The main difference is that in the F.R. Bannu the houses are less often connected to the electric grid (28 percent instead of 60 percent).

4.8.7.3 Component 3

In Bannu District about 70 percent of the houses have access to drinking water within the houses (43 percent through pipes, 22 percent through hand pumps and five percent through wells) and 94 percent are connected to the electric grid. While in the urban areas 22 percent of the households use gas, in the rural areas nearly 95 percent of the population depends on firewood for cooking. The same contrast holds for sanitation. While in the urban areas around 80 percent of the houses have a shared or separate latrine, in the rural areas separate latrines are only found in 17 percent of the houses, 34 percent use a common latrine and 49 percent no latrine.

In Karak District around 26 percent of the houses have access to drinking water within the houses (21 percent through pipes, two percent through hand pumps and three percent through wells) and 81 percent are connected to the electric grid. Less than one percent of the households use gas and the people depend in their large majority on firewood for cooking. 80 percent of the houses have no latrine.

In Lakki Marwat District around 54 percent of the houses have access to drinking water within the houses (38 percent through pipes, 12 percent through hand pumps and four percent through wells) and 87 percent of the houses are connected to the electric grid. About three percent of the households use gas, while the large majority depends on firewood for cooking. 78 percent of the houses have no latrine.

None of the three districts has an organized landfill or waste management system.

4.8.8 Physical Cultural and Historic Resources

The region is rich in cultural heritage. Research suggests that the Bannu plain as well as the Kurram and Kaitu Valleys have been inhabited since the Upper Paleolithic Period (50'000-10'000 BCE). Due to limited accessibility hardly any serious archaeological work has been conducted in the project region with three exceptions: a) Sir Aurel Stein, who conducted rapid archaeological surveys in 1904 and 1927, b) some follow up excavation by Hassan Dani in the 1960ties and c) the Bannu Archaeological Project from 1985 and 2001 focusing on the Bannu plain. While "the known antiquarian remains … are scanty, … it appears … highly probable that the route which leads

through the Kurram Valley must, owing to the great natural facilities it offers for communication between Kabul and the central part of the Indus Valley, have been one of considerable commercial and political importance in ancient times" (Stein 1905:7). For more detail please consult the standalone Cultural Heritage Preservation Plan for the KTMDP.

4.8.8.1 Component 1

There are strong indications that the area has a high potential for agricultural remains. Three "Tochi inscriptions", which are presented on display in the Peshawar Museum, have been were found near Spinwam. These stones display a combination of Arabic, Sanskrit and Bactrian texts and have been dated to the mid-9th century CE. This combination of texts can also be observed in findings from the Sheratalla and Spaira Ragha Plains. This type of findings suggests that the area of Component 1 was once the boundary between the three dominant cultures in the region and therefore might contain important cultural heritage sites.

4.8.8.2 Component 2

It is well documented that the Kurram Valley had been since time immemorial one of the easiest connections between the Indus Valley and the Afghan Highlands and therefore exposed to trade and cultural exchange. It is therefore very likely that the land along the Kurram still contains many cultural heritage sites, which might be important if they document how the conflicting cultures in the region interacted without permanent conflicts.

As far as living culture is concerned, the most important site is the Shrine of the Fakir of Shewa, who played an important role in the 1936-47 upraise against the British Colonial Rule that was led by the Fakir of Ipi. The Shrine is of large significance for the local people and Kabul Khel Clan of the Wazir tribe justifies its rejection of the Kurram Tangi Dam with the fear that the Shrine might be inundated by the reservoir.

4.8.8.3 Component 3

The Bannu Plains are well researched in its southern part. This research has resulted in a large number of excavations and the discovery of important archaeological sites and the research suggests that the land in Component 3 might be similarly rich in cultural heritage sites.

4.9 Roads and Bridges

Roads and bridges provide connections between the components of this project, resources and communities. Most roads are associated with more than one component of the project. There are some exceptions such as the roads used to construct the canals or access roads to particular components.

The majority of roads will require construction or upgrading at the start of the project to allow safe and efficient access to the construction sites. This work could be carried out as enabling work prior to the main contract being let or form part of the main contract.

Data for roads and bridges has been collected from both primary as well as secondary sources. Information regarding road lengths has been mainly extracted from the Detailed Design Report (PES et al., 2011a) and GIS images.

For acquiring primary dataIDC, a third party, was hired and trained to collect data in the AOI (Aug-Sept. 2013). However, this was mainly based on visual assessment of the area and consultations with the local residents. The field team made observations keeping in mind the type of construction activity that is proposed to take place during the construction of KTDP and location of receptors.

4.9.1 Existing Road Network

The existing road network in the AOI of the KTDP is generally in very poor condition. Very little maintenance has been carried out to preserve the assets.

Bridges show signs of structural damage to the point where three have collapsed. It has not been possible to get accurate data on the structural capacity of the existing bridges.

Roads have pot holes and failures that disrupt the smooth flow of traffic. Some of the Katcha (dirt) roads are barely wide enough to accommodate a single heavy vehicle and require a 4 wheel drive vehicle to safely traverse them. Where it is proposed to use existing roads they will require upgrading to accommodate construction traffic.

Photos of roads passing through settlements do not show clear separation between pedestrian access and vehicle access. This will create a safety issue with pedestrians in conflict with construction traffic passing through settlements.

The nomenclature for roads from A to F was decided upon in the Detailed Design Report (PES et al, 2011a) while nomenclature for H, I, J and K is proposed in this study. Roads I and J are an extension of the Mir Ali-Thal road. Road I connects Bannu to Mir Ali and Road J connects Mir Ali to Spinwam. Similarly, Road H is an extension of the Bannu-Zarwam-Thal road. On the other hand road K is a Katcha road that connects Bannu to Kurram Garhi Headworks. These roads have been marked on Maps 4-30 and 4-31.

4.9.1.1 National Road Network Linkage

Main National Highway N-55. Main National Highway N-55 passes close by Gaandi Chowk which is approximately 22 miles (length derived using Google Earth) from Bannu. So the project area is accessible to the rest of the country through the Indus Highway via Bannu. The Indus Highway then off-sets from Bannu into Bannu-Thal Road and Mir Ali-Thal Road, which is part of Miran Shah-Thal Road connecting North Waziristan Agency to F.R. Bannu and Kurram Agency. These are also the two major links to the Project site.

4.9.1.2 Component I

Bannu to Mir Ali Road, Mir Ali to Spinwam and Spinwam to Ketonaialgad Road. This is the same road but has been divided into 3 segments according to main locations. However, the entire stretch is proposed to be upgraded.

The distance along existing road from Bannu to Mir Ali is about 21.1 miles (PES et al, 2011a) and is marked as Road I on Map 4-30. This road is also known as the Bannu – Miranshah road. It is metaled but in a very poor condition. There are a number of bridges along the stretch which also need to be upgraded. The inventory of bridges along and beyond this stretch to Chashmai Nullah is presented in Table 4-81.

The distance from Mir Ali to Spinwam is about 28 miles (PES et al, 2011a) and is marked as Road J on Map 4-30. The carriageway from Bannu to Mir Ali to Spinwam is 20 ft wide metaled track with shoulders of 4.9 ft on each side. The total width of carriageway is 29.9 ft.

Table 4-81: Inventory of Bridges on Bannu – Miranshah Road

Sr. No.	Name of Bridge/Location	Year of Construction	Stream	No. of Spans	Length of Clear Span (ft)	Width of Roadway (ft)	Specification
1	Khajuri Bridge at Miles-19.3	Not known	Shah Algad	8	19.5	19.2	R.S. joist & RCC slab
2	Eidak Bridge at Miles-26.7	Not known	Chinazeb Algad	6	5.5	19.2	Stone Arched
3	Eidak Bridge at Miles-27.3	Not known	Kand Algad	21	20	18	Stone Arched

4	Bakht Jamal Bridge at Miles-28.6	Not known	B.Jamal Algad	3	15	15	Stone Arched
5	Arch Bridge at Miles-34.8	Not known	Arch Algad	2	15	15	Stone Arched
6	Laiwagai Bridge at Miles-34.8	Not known	Lewagai Algad	5	6.6	28.7	Stone Arched
7	Sarbandkai Bridge at Miles-36.7	Not known	Sarbandkai Nullah	1	16	16	Stone Arched
8	Chashmai Bridge at Miles-36.7	Not known	Chashmai Nullah	5	45	55	Steel girder RCC
9	Chashmai Bridge at Miles-36.7	1986-87	Chashmai Nullah	3	18	24	RCC stressed concrete

Source: Communication and Works Department, FATA, Peshawar, 2013

Although the road is metaled its general condition is not good. The road length from Mir Ali to Bobali is about 12.4 miles with a road width of about 24.6 ft. Similarly, the road length from Mir Ali to Spinwam is 16.8 miles while the width remained the same. About 800 vehicles were seen in a 12 hour period which included carts, trucks, motorcycles, buses and vans.

There are 5 bridges from Mir Ali to Spinwam namely, Tarkhibi Bridge, Shanal Garha Bridge, Khaesiri Bridge, Arung Bridge and Kaitu Bridge. While the first 4 are built over Nullahs (streams), the Kaitu Bridge was constructed over the Kaitu River. All of these bridges are two lane bridges made of concrete. The Mir Ali-Thal road also passes Bobali which is a major settlement in North Waziristan Agency. However, the bridges are also in a poor condition. The details of these bridges are presented in the Table 4-82.

Table 4-82: Specifications of Bridges found on Mir Ali-Thal Road (Mir Ali to Spinwam)

Sr. No.	Name of the Bridge	Location	Length of the Bridge (ft)	Width of the Bridge (ft)	Height of the Bridge (ft)
1	Shanal Garha Bridge	Mir Ali	131	16.4	19.7
2	Khaesiri Bridge	Mir Ali	32.8	16.4	19.7
3	Arung Bridge	Spinwam	32.8	16.4	13.1
4	Kaitu Bridge	Spinwam	98.4	16.4	32.8
5	Tarkhibi Bridge	Spinwam	32.8	16.4	16.4

Source: IDC Field Survey 2013

The existing Bannu-Mir Ali road further extends to the Mir Ali-Thal road crossing Spinwam and Shewa and has been marked as Road A on Map 4-30. The whole road is metaled but is not in a good condition and has patches that hinder movement of vehicles on the road. About 700 vehicles including trucks, cars, motorcycles, carts and vans were observed over a 13 hour period. The road length is approximately 7.5 miles (from Spinwam) and its width is about 16.4 ft. The two lane, concrete Kurram Bridge is situated over the Kurram River. It has an approximate length of 0.1 miles, width of 19.7 ft and height of 21.3 ft.

There are many bridges on the Mir Ali-Thal Road. According to the XEN Highway Department, Miranshah (North Waziristan Agency) in the Communication and Works Department, FATA, Peshawar; most of the bridges constructed on the Mir Ali-Thal road during the British era have been damaged. Three have already collapsed. These include Bridge at Miles-19.9 on Astar Sherman Khel Stream, Bridge at Miles-19.9 on Shermankai Nullah and Bridge at Miles-26.1 on Pastapala Nullah. There are no forests or sensitive receptors along the Mir Ali-Thal road.

There are also bridges which are not constructed to a suitable standard with the width of the RCC slab over the steel girder insufficient. These include bridges; at Miles-18 over Spinwam Nullah, at

Miles-24.9 over Amzarai Algad, at Miles-24.9 over Tarkhoba Algad, at Miles-28 over Peopali Nullah, at Miles-20 over Khuni Nullah, over Khaz Algad and Bridge at Miles-31.7 over Tauda China Nullah.

A statement confirming the inventory of bridges was also provided by the Communication and Works Department, FATA, Peshawar. The information is presented in Table 4-83.

Table 4-83: Statement Showing Inventory of Bridges on Mir Ali – Thal Road

Sr. No	Bridge Location	Year of Construction	Stream	No. of Spans	Length of Clear Span (ft)	Width of Roadway (ft)	Specification
1	Bridge at Miles-3.7	1990-91	Shah Algad	3	97	28	Pre-stressed RCC
2	Bridge at Miles-5	1997-98	Khaishora Nullah	1	97	28	Pre-stressed RCC
3	Bridge	1990-91	Tarkhoba Nullah	3	97	28	Pre-stressed RCC
4	Bridge at Mies-8.7	1990-91	Sarwakai Nullah	1	98.5	28	Pre-stressed RCC
5	Bridge at Mies-11.8	1992-93	Sangasara Nullah	2	77.6	28	Pre-stressed RCC
6	Bridge at Miles-18	1976-77	Kaitu River	3	74.5	24	Pre-stressed RCC
7	Bridge at Miles-18	Not known	Spinwam Nullah	1	30	12	RCC slab over steel girder
8	Bridge at Miles-19.3	1997-98	Kotani Nullah	2	97.1	28	Pre-stressed RCC
9	Bridge at Miles-19.9	Not known	Astar Sherman Khel	2	20	12	
10	Bridge at Miles-19.9	Not known	Shermank ai Nullah	3	24	12	
11	Bridge at Miles-23	Not known	Zakhana Nullah	6	33	12	
12	Bridge at Miles-24.2	Not known	Naripul Nullah	1	23	12	
13	Bridge at Miles-24.9	Not known	Amzarai Algad	5	33.3	12	RCC slab over steel girder
14	Bridge at Miles-24.9	Not known	Tarkhoba Algad	5	26.31	12	RCC slab over steel girder
15	Bridge at Miles-26.1	Not known	Pastapala Nullah	1	27	18	RCC slab over steel girder
16	Bridge at Miles-28	Not known	Peopali Nullah	5	24.5	12	RCC slab over steel girder
17	Bridge at Miles-20	Not known	Khuni Nullah	1	61	17.7	RCC slab over steel girder
18	Bridge	Not known	Ghaz Algad	1	28.6	17.3	RCC slab over steel girder
19	Bridge at Miles-31.9	Not known	Tauda China Nullah	5	33.6	12	RCC slab over steel girder
20	Bridge at Miles-36	1994-95	Kurram River	8	108.3	28	Pre-stressed RCC

Source: Communication and Works Department, FATA, Peshawar, 2013

Existing Road from the Dam Site to Powerhouse III on the Left Bank and the Bannu-Zarwam-Thal Road. This is the same road but has been divided into two segments according to main locations. However, the entire stretch is proposed to be upgraded. The Bannu-Zarwam-Thal

Road exists between minor settlements of Shnalura, near the proposed Dam Site and Pisi, near the proposed Powerhouse III which is 9.9 miles in length. This road has been marked as Road E on Map 4-30 and it involves construction of 1 bridge, 12 culverts and 12 causeways.

About 15.5 miles (length derived using Google Earth) of road already exists between Bannu and Pisi (near Powerhouse III) and has been marked as Road H on Map 4-30. The same road further extends about 9.9 miles to the proposed dam site (Road E), but this section will be upgraded as part of Component 2. The road is locally known as Gumatti Road and has an average length and width of about 9.3 miles and 16.4 ft respectively. However, the road passes through *Canis Lupus* (Grey Wolf), *Canis Aureus* (Golden Jackal) and bird habitats. *Acacia Nilotica* (Babul/Kikar) forest was also found in the vicinity of the road. The people living there use the forest as a source for wood fuel and fodder. The road is metaled in some segments and pacca (un-metaled) in others, but its overall condition is very poor, to the extent that the local residents were reluctant to run their vehicles on it. About 65 vehicles including cars, vans, trucks and motorcycles were seen every 24 hours. A cause way was also constructed over a nullah (stream) in Gumatti.

Both these roads are an extension of Bannu-Zarwam Road which falls between or on the Bannu to Spinwam road. The distance from Bannu to Zarwam by road is about 15.5 miles, while the distance from Zarwam to Spinwam is about 6.2 miles. The road is metaled but the condition of the black topped portion is very bad, because no maintenance has been carried out since its construction. There is only one bridge on the stretch from Shewa to Zarwam, the specifications of which are given in Table 4-84.

Table 4-84: Bridge on Shewa - Zarwam Road

Sr. No.	Bridge Location	Year of Construction	Stream	No. of Spans	Length of Clear Span (ft)	Width of Roadway (ft)	Specification
1	Shewa Bridge at Miles-1.2	1983-84	Kurram Khawar	4	101.5	24	Pre-stressed concrete

Source: Communication and Works Department, FATA, Peshawar, 2013

4.9.1.3 Component 2

Existing Road from the Dam Site to Powerhouse III on the Left Bank. This road has been described in section 4.9.1.2 above as it is part of the Bannu-Zarwam Thal road

New Access Road from Spinwam to Main Dam. This new proposed road will take off from Mir Ali-Thal Road at Spinwam near Kaitu River Bridge and follow the route along the proposed irrigation canal for Spaira Ragha Plain and subsequent periphery of the reservoir. It is 9.3 miles in length, 4.3 miles in Spaira Ragha Plain not requiring rock excavation and 5 miles through terrain requiring rock excavation. It does not involve any bridge construction. The elevation varies from 2,115 to 2,345 ft. The proposed road width is 29.9 ft with 20 ft metaled and 4.9 ft shoulders on either side. The maximum gradient will be less than 10 percent. It is designated as Road B on Map 4-30.

New Road for Powerhouse II on the Right Bank. This road will take off from the new access road to the Dam Site and follow the existing track to Powerhouse II site. It requires rock cutting but does not require any bridges. Its length will be 4.7 miles. Its width will also be 30 ft. It is designated as Road C on Map 4-30.

Construction of New Approach Road for Powerhouse III. The road involves the construction of a bridge. A road will also be constructed along the right bank from the intake tunnel to the Powerhouse. The total length of road will be 1.9 miles. It is designated as Road D on Map 4-30.

Relocation of Part of Mir Ali-Thal Road near Shewa Post. The length of the road is 5.6 miles with a 30 ft carriageway of which 20 ft is metaled. It also involves construction of two new bridges. It is designated as Road F on Map 4-30. This road will be relocated due to submergence of an existing segment of the Mir Ali-Thal road after filling of the reservoir.

4.9.1.4 Component 3

(C3) Upgrading of Existing Road from Bannu to Kurram Garhi Headworks. This is the only road specific to Component 3. The existing road from Bannu to Kurram Garhi Headworks passes through Kurram Garhi Canal and is metaled but in a very poor condition. The road passes through a densely populated suburb of Bannu and then through the built up area of Chi Garhi up to Kurram Garhi Power Station and onto the Headworks. It is designated as Road K on Map 4-30. The field survey confirmed that the road is 5 miles in length and about 16.4 ft in width. About 150 vehicles were observed with a 20 ton load limit including vans, motorcycles and cars.

Other roads in Component 3 were included in Components 1 and 2 because they provide access from Bannu to the construction sites.

4.9.1.5 List of Structures

GIS images were used to create a list of all the structures, such as bridges, culverts or causeways amongst others, that are present on the existing roads in the AOI as shown in Table 4-85. Maps 4-30 and 4-31 show roads K, I, H and J marked at different lengths which facilitates identification of the listed structures on the maps.

Table 4-85: Location of Structures

Road A (Miles)	Road E (Miles)	Road H (Miles)	Road I (Miles)	Road J (Miles)	Road K (Miles)
1.3	0.4	3.6	3.3	0.2	1.4
2.3	0.6	1.1	4.8	0.9	
4.2	0.9	6.2	9.7	3.3	
4.4	1.6	9.5	9.8	4	
	1.9	11.1	10.9	5.5	
	2.5	14	13.7	7.5	
	3.1	14.5	14.7	7.7	
	3.6		15.7	8.7	
	3.8		17.4	9.8	
	6.6			15.5	
	7.2				

4.9.1.6 Roads Proposed for Construction and Rehabilitation

Table 4-86 presents a summary of and compares the lengths of the roads in the Detailed Design Report (PES et al, 2011a) and as determined in this study.

Table 4-86: Summary of Road Lengths

Sr. No.	Road Name	Lengths (Detailed Design Report, PES at al, 2011a) Miles	Lengths (Google Earth) Miles	Remarks
1	Spinwam – Take off point of Alternate Alignment – Road - A	-	4.6	To be upgraded
2	Kaitu Weir to Dam Site Proposed Road –B	9.3	10.9	New Construction
3	Dam Site to Powerhouse 2 – Proposed Road – C	4.7	4.8	New Construction
4	Road to Proposed Weir for Powerhouse 3- Proposed Bridge and Approach Road D	1.9	1.9	New Construction
5	Dam Site to Powerhouse 3- Road E	9.9	10.5	To be upgraded
6	Alternate Alignment on left bank of Dam Lake–Road - F	5.6	7	New Construction
7	Bannu to Powerhouse #3 – Road H	-	15.7	To be upgraded
8	Bannu – Mir Ali - Road No. I	21.1	19.6	To be upgraded
9	Mir Ali – Spinwam - Road No. J	28	15.6	To be upgraded
10	Bannu – Kurram Garhi Headworks Road K	-	8.3	To be upgraded

Note: Lengths will be confirmed by topographical survey during the detailed design stage.

5 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

5.1 General Considerations

5.1.1 Approach and Methods

Depending on the rate of project development, the effects of the project may span many years. For this reason, the analysis of a project's potential impacts[37] is typically divided into two periods: the construction period and the operation period. Some potential impacts may occur in anticipation of the project during the pre-construction period (which includes activities carried out during design and planning as well as other activities that need to be carried out prior to the start of project construction. Such activities could include development of infrastructure necessary for the construction activities. For other potential impacts (use of quarries for example), potential impacts of decommissioning may need to be considered. In addition to the direct and indirect effects[38]of the project, the assessment must consider induced potential impacts and potential cumulative impacts.[39]

A zone of primary potential impact will be the construction zone of each component. In this area, the effects will be exerted on almost all human and natural resources, and the effects will be both direct, or primary, and indirect, or secondary. An example of a direct effect would be the movement of rock and soil in building a road or a dam; an indirect effect would be the interruption of drainage or changes in vegetation as a result of moving rock and soil to build a dam. Another zone of primary potential impact will be the areas affected by operation of the project, such as increased traffic on roads, changes in water flows downstream of the dam.

For each potential impact it is possible to consider whether it is positive or negative (or sometimes both). For example, the possibility of external diseases being introduced into the project area by construction workers is a negative potential impact, but the creation of a clinic that offers services locally, would be a positive potential impact. After the construction period, the roads created for the project may offer improved access for the local population.

The criteria to evaluate the significance of potential impacts and a summary of impact significance are addressed in Section 0, which presents a summary of impacts addressed in detail in the following sections of Chapter 5.

The organizational structure of this chapter parallels the organization of Chapter 4. For each component and topic, impacts are described according to project phase: pre-construction; construction, operation and decommissioning.

[37] Throughout this report "potential impacts" means "potential significant environmental and social impacts". These potential impacts can be either adverse (negative) or positive. The term "potential" is used since the identified potential impacts will not occur without the project, and most of the potential impacts will be avoided, prevented, compensated for or reduced to acceptable levels through the implementation of the EMMP.

[38] Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems (US 40 CFR 1508.8).

[39] Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (US 40 CFR 1508.7).

5.1.2 Assessment of Impact Significance

The evaluation of a potential impact is an important consideration in deciding whether to address it in terms of mitigation. There is no universal yardstick or set of criteria applicable to gauging the significance of environmental and social impacts. The evaluation of significance typically is based on a combination of expert judgment and methods of rating, ranking and scaling impacts. In a review of available literature, some common themes can be identified: (1) environmental significance is a judgment and (2) the degree of significance depends upon the (a) the nature of the impact, (b) the biophysical conditions, (c) the socio-economic values, and (d) the degree of acceptance by the community (Khadka *et al*, 2011). A common way to evaluate significance is to assess impacts according to conformity with national policies, rules/regulations or standards, based on the assumption that they reflect the public interest in various matters, e.g., requirements for preservation of wetlands or historic sites.

One approach to the evaluation of impact significance is to examine and evaluate the key project components and activities vis-a-vis each subject matter topic, such as resettlement, seismicity, water quality or the like. This type of approach is suited to a complex project, such as KTDP, encompassing a variety of activities and constructions, including dam building, irrigation development and irrigation rehabilitation.

A set of parameters for attributing significance to impacts (adopted from Lawrence, 2007) is shown in Table 5-1.

Table 5-1: Thresholds and Criteria for Impact Significance Determination

a)	Legal thresholds (e.g., regulatory standards will be contravened, likely to conflict with public policies, plans, guidelines, criteria or objectives) (Australian Government, 2006
b)	Project characteristics thresholds (e.g., high level of resource or energy consumption or waste generation, activity inherently causes significant effects)
c)	Environmental characteristics thresholds (e.g., receptors are highly sensitive or significant, resources or features are very scarce or unique) (Erickson, 1994)
d)	System function thresholds (e.g., likely to disrupt the functioning of ecological, resource, social or economic systems, carrying capacity jeopardized, establishes a precedent for future actions with significant effects) (Canter and Canty, 1993)
e)	Impact intensity thresholds (e.g., magnitude, duration or frequency of effect is great relative to ambient conditions) (Gartner Lee Limited (GLL), 2001)
f)	Impact characteristics thresholds (e.g., permanent or irreversible effects, trans-boundary effects likely, potential human health risks, major inequities in the distribution of effects are likely, high degree of uncertainty regarding impact magnitude and distribution, high cumulative effects potential) (Sadler, 1996)
g)	Preference thresholds-contrary to community norms or regional norms, likely a high level of public controversy, reflects preferences of individuals, groups or organizations) (Vanclay, 1999)
h)	Sustainability threshold-if and extent to which proposed action advances or inhibits sustainability (Sadler, 1996)

The following definitions, from Rowan (2009), are for social impact significance, but are applicable to most subject matter.

- **Major Significance:** The impact can be considered to be of major significance if the wellbeing of various social receptors, especially those who are already highly vulnerable to social exclusion, substantially deteriorates or improves compared to the pre-project scenario.

- **Moderate significance:** The impact can be considered to be of moderate significance if the wellbeing of some social receptors who may be vulnerable to social exclusion noticeably deteriorates or improves compared to the pre-project scenario.
- **Minor significance:** The impact can be considered to be of minor significance if the wellbeing of a small number of social receptors who are unlikely to suffer from social exclusion slightly deteriorates or improves compared to the pre-project scenario.
- **Neutral:** The impact can be considered to be neutral (insignificant) if there is no noticeable chance in the wellbeing and hence the level of social exclusion of social receptors.
- The criteria of significance adopted for use in this EA and the parameters to measure those criteria are described below:

Significance: The significance of something is referred to as the importance that it has because it will have effects or impacts on human or natural resources. In a similar fashion the term "significant" relates to whether there is a large enough impact to make a noticeable difference. Therefore, for the purpose of evaluating significance of impacts, a degree of significance is assigned as follows:

- **Significant or High:** an impact, which if not mitigated or not possible to be mitigated, could lead to serious negative effects and in some cases could stop the project from proceeding.
- **Less Significant or Medium**: an impact that requires effective mitigation.
- **Non-significant or Low:** an impact for which either no mitigation is necessary or will require a small effort to mitigate.

To describe high, medium and low significance, the following **five parameters** are used: extent, duration, magnitude and intensity, probability of occurrence, and legal/regulatory requirements.
Extent: geographic scale of impact based on the zone of the impact or area of influence. This parameter may be applied to different sized areas as follows: (1) a scale limited to the immediate areas of development activity or construction operations or the site; (2) limited to within 3.1 miles (5 km) or the local environs of the development; (3) affecting the region as a whole or a watershed; or (4) occurring at a national or international scale. Thus, impacts may be of local, neighborhood environs, regional, national or international scale.

Duration: Prediction of the lifetime of the impact based on how long the impact can last and is dependent on the nature of the project. This implies that a medium-term for one project may be long-term for another project. In this study, this parameter is adopted from the Environmental Impact Assessment of Indrawati-3 Hydropower Project in Nepal by Khadka Ram, as follows : (1) short-term: 0 to 5 years; (2) medium term: 5 to 15 years ; (3) long term: more than 15 years, with the impact ceasing after the operational life of the development); or (4) considered permanent.

Magnitude and Intensity: Severity, size or scale of the impact. If of high magnitude, the negative impacts may become irreversible or result in irretrievable losses; if medium and low the impacts are considered reversible. Where appropriate, MWH will use national policies and standards as a measure of the level of impact.

Probability of occurrence: Likelihood that a potential impact will occur. The probability is expressed as a percentage up to 100 percent probability (i.e. certainty). The following criteria are adopted: (1) highly probable or most likely or definite impact regardless of prevention measures; (2) probable or a distinct possibility, (3) improbable or low likelihood.

Legal and regulatory requirements: Identification of the specific legislation, regulations and permit requirements (including reference to the procedures to obtain permits) as well as relevant International Conventions and Agreements with which the proposed project is expected to comply.

Qualitative Application of the Criteria: The impact significance may be presented in both qualitative form quantitative and qualitative terms. The concept in qualitative form can be applied as follows:

High - Significant Impact: When the magnitude of an anticipated impact is high, its extent is regional, duration is long term, intensity is high, and its probability of occurrence is high and legal requirements are applicable, the impacts may be regarded as highly significant. It is quite possible, however, that in some environments one parameter is high (e.g. magnitude) and other parameters fall into low or medium categories. The impact still may be regarded as highly significant.

Medium - Less significant impact: When the magnitude of an anticipated impact is moderate, its extent is local, duration is medium-term, intensity is medium, and its probability to cause an impact is high, and legal requirements are applicable, the impact may be regarded as a less significant impact. Again, it is also possible in some cases, however, that one parameter is medium (e.g. intensity) and other parameters falls in low categories. The impact still may be regarded as medium significant.

Low - Non-significant Impact: When the magnitude of an anticipated impact is low, its extent is site specific, duration is short term, intensity is low, it is unlikely to exert more serious effects, or legal requirements are not applicable, the impact may be regarded as non-significant impact.

In summary, the ranking criteria and parameters for impact significance that MWH will apply are presented in matrix form as follows.

Table 5-2 Categorization of Impact Significance

Magnitude	Extent	Duration	Intensity	Probability	Legal
High/major (H)	Regional (R),	Long-Term	High	Highly	Applicable
Moderate (M)	Local (L)	Medium-	Medium	Probable	Applicable
Low (L)	Site Specific	Short-term	Low	Improbable or	Not applicable

Table 5-3: Summary of Significance of Potential Impacts Related to Component 1

Phase	Aspect	Potential Impact	Significance (without mitigation)
Pre-Construction[40]	Land Resources -Agriculture and Irrigation	Planning and coordination deficit delays use of irrigation systems	Significant
	Land Resources – Waste management	Inadequate waste management planning leads to poor or inappropriate disposal of waste	Significant
	Land Resources – Geology, Geotechnical and Seismicity	Inadequate geotechnical field investigations lead to poor design, siting and stability of infrastructure. Could cause cost overruns in construction	Significant
	Land Resources – Geology, Geotechnical and Seismicity	Current design earthquake ground motion parameter is too low so infrastructure may not withstand MCE	Significant
	Water Resources - Hydrology	Flow data inadequate. May affect ability to provide irrigation water and/or downstream flow releases	Significant
	Water Resources - Hydrology	No analysis of the design flood or sedimentation – could impact design and/or operating procedures	Insufficient data to assess
	Biological Resources – Aquatic Resources	Insufficient baseline data to evaluate impacts on fishery resource	Significant
	Socio-economic Environment	Land acquisition (24,000 acres), physical displacement of 6,000 people and economic displacement of 95,000 people	Significant
	Socio-economic Environment	Influx of workers and security personnel into remote tribal lands	Less Significant
	Socio-economic Environment	Conflict between tribes about territorial boundaries in the CCAs	Significant
	Socio-economic Environment	Exposure of tribal society to external influence and control	Significant
	Roads, Bridges and Traffic	Detailed design provides no road alignments, profile or cross sectional details. Could impact construction schedule	Significant
	Roads, Bridges and Traffic	Land acquisition required for new roads and road works	Significant
	Roads, Bridges and Traffic	Road requirements in new resettlement sites unknown. Will likely require land acquisition	Significant
Construction	Land Resources - Topography and Drainage	Changes to visual resources	Non-significant
	Land Resources - Topography and Drainage	Obstruction of drainage lines or irrigation systems	Non-significant
	Land Resources – Geology, Geotechnical Issues and Seismicity	No downstream cofferdam; no dewatering; lack of lining or support during tunneling; disposal of excavated material or suitability for reuse in cofferdams not known	Significant
	Land Resources - Soils	Erosion risk at construction sites and associated temporary	Non-significant

[40] The term Pre-Construction Phase as used in this report refers to tasks that are carried out during detailed design and planning as well as other activities that may be carried out prior to the start of project construction. Such activities could include development of infrastructure necessary for the construction activities.

		structures	
	Land Resources - Soils	Soil pollution	Non-Significant
	Land Resources - Soils	Soil compaction	Non-Significant
	Land Resources – Land Use	Land acquisition for Kaitu Weir, feeder tunnel, powerhouses, canal networks, roads and borrow pits	Significant
	Land Resources – Land Use	Obstruction of waterways	Non-significant
	Land Resources – Agriculture and Irrigation	Hindering of cultivation and interruption of cropping	Non-significant
	Land Resources – Agriculture and Irrigation	Shifting of labor to construction may cause labor shortage in harvesting season	Non-significant
	Land Resources – Agriculture and Irrigation	Gender issues: presence of outsiders may make women reluctant to carry out agricultural activities; contact between local women and construction personnel could lead to social conflict	Less significant
	Land Resources – Agriculture and Irrigation	Degradation of irrigation water quality downstream of construction activities	Non-significant
	Land Resources – Waste Management	High sediment loads in run off from spoil heaps affecting downstream use in Kaitu River	Significant
	Land Resources – Waste Management	Pollution of soils, surface water and ground water by contaminated run off (chemicals, fuel and oil spills, blasting residues, slurry from batching and asphalt plants, domestic waste dumps, wastewater from camps)	Significant
	Land Resources – Waste Management	Contaminated groundwater and wastewater taken up by plants and affects human health	Less significant
	Land Resources – Waste Management	Odors and other nuisances from domestic waste disposal sites	Cannot be determined with any degree of confidence
	Land Resources – Waste Management	Exposure to medical waste could impact construction personnel and local residents' health	Significant
	Land Resources – Waste Management	Exposure of sanitation workers to pathogens	Significant
	Land Resources – Waste Management	Generation of windblown dust from spoil heaps and stockpiles	Cannot be determined with any degree of confidence
	Land Resources – Waste Management	Poorly sited spoil heaps block drainage lines	Non-significant
	Land Resources – Waste Management	Run off containing high sediment loads and untreated or partially treated sewage leads to eutrophication of receiving water bodies	Non-significant
	Air Quality	Gaseous and fugitive dust emissions (vehicle and machinery emissions, dust from tunneling, dust generated by earth moving activities, excavation, haulage, movement of vehicles and machinery and road construction)	Less significant
	Air Quality	Dust emissions due to blasting (vehicle and machinery emissions, dust from tunneling, dust generated by earth moving activities, excavation, haulage, movement of vehicles and machinery and	Less significant

		road construction)	
	Air Quality	Particulate emissions from batching plants	Less significant
	Noise	High noise levels generated by construction machinery and blasting	Less significant
	Hydrology	Change in river morphology	Less significant
	Water Resources – Water Quality	Increase in TSS and turbidity due to excavation of river bed for Kaitu Weir and feeder tunnel to Kurram Tangi as well as direct deposition of dust generated by construction activities. Kaitu Weir cofferdam will alter flow regime and affect quality. Failure of the cofferdam could lead to pollution by potentially hazardous materials	Significant
	Water Resources – Water Quality	Direct dumping of debris from Powerhouse IV construction into Kaitu River. Direct deposition of dust in water bodies from Thal-Mir Ali road upgrade and borrow area activity	Less significant
	Water Resources – Water Quality	Direct dumping of debris from Powerhouse V construction into stream. Direct deposition of airborne dust from Miranshah-Thal road	Less significant
	Water Resources – Water Quality	Direct dumping of debris/spoil from Spaira Ragha canal into Kaitu River	Non-significant
	Water Resources – Water Quality	Direct dumping of debris/spoil from Sheratalla canal, excavation oat streams crossed by the canal, direct deposition of airborne dust from Mir Ali-Thal road.	Less Significant
	Biological Resources – Terrestrial Ecosystems	Disturbance of wildlife	Non-significant
	Biological Resources – Terrestrial Ecosystems	Waste dumps attract pests; predators of poultry at camps may be shot	Non-significant
	Biological Resources – Terrestrial Ecosystems	Vegetation and habitat destruction	Less significant
	Biological Resources – Aquatic Ecosystems	Permanent loss of aquatic habitat at the site occupied by the Kaitu Weir, and at borrow sites in the River. Temporary sediment load increases damage fish and benthic macroinvertebrates. Contamination by seepage water will damage fish and macroinvertebrates. Loss of riffle habitat downstream of weir	Less significant
	Socio-economic Environment	Large scale land acquisition	Significant
	Socio-economic Environment	Land allocation in CCAs	
	Socio-economic Environment	Influx of workers and security guards into remote tribal lands	Significant
	Socio-economic Environment	Conflict between tribes about territorial boundaries in the CCAs	Significant
	Socio-economic Environment	Physical and economic displacement	Significant
	Socio-economic Environment	Exposure of tribal society to external influence and control	

	Socio-economic Environment	Increase in transmittable The staff at the health unit is not up to their task leading to unreasonable high number of fatalities	Significant
	Socio-economic Environment	Increase in transmittable The staff at the health unit is not up to their task leading to unreasonable high number of fatalities	Significant
	Socio-economic Environment	Loss of cultural heritage	
	Roads and Bridges	Deterioration of air quality by fugitive dust and vehicle and machinery emissions	Less significant
	Roads and Bridges	Noise pollution by heavy machinery and equipment. Blasting noise	Less significant
	Roads and Bridges	Blasting vibrations	Significant
	Roads and Bridges	Erosion, sloughing and landsliding, particularly in hilly terrain	Significant
	Roads and Bridges	Water pollution by run off contaminated by fuel, oils, heavy metals, sediments and trash. Road works at stream crossings may increase sediment loads. Spills of concrete in waterways.	Less significant
	Roads and Bridges	Road safety impacted by increased traffic. Risk of accident	Significant
	Roads and Bridges	Travel disruption and delays	Significant
	Roads and Bridges	Gender issues due to presence of outside personnel	Less significant
Operation	Land Resources – Topography and Drainage	Changes to the visual aspect of the Kaitu Weir area	Significant
	Land Resources – Topography and Drainage	Extension of man-made drainage network	Less significant (positive)
	Land Resources – Geology, Geotechnical Issues and Seismicity	Failure of Kaitu Weir under MEC causing downstream flooding and loss of life, livestock and crops	Significant
	Land Resources – Soils	Waterlogging and salinization	Significant
	Land Resources – Land Use	Permanent inundation of area upstream of Kaitu Weir	Significant
	Land Resources – Land Use	Reduced ability to conduct gravity irrigation downstream of weir and loss of nutrients reducing soil fertility	Significant
	Land Resources – Land Use	Loss of grazing lands and access to pastures	Significant
	Land Resources – Irrigation and Agriculture	Pollution of water by excessive use of fertilizers and pesticides	Significant
	Land Resources – Irrigation and Agriculture	Waterlogging and salinization	Significant
	Land Resources – Irrigation and Agriculture	Increase agricultural development and earnings for farmers	Significant (+)
	Land Resources – Irrigation and Agriculture	Risk of electrical load shedding impacts ability to irrigate in areas where pumping is required	Significant
	Land Resources – Irrigation and Agriculture	Lack of capital to purchase inputs leads to suboptimal crop production	Less significant
	Land Resources – Waste Management	Poorly managed waste generates odors, unaesthetic conditions and breeding ground for disease vectors. Leachate can pollute groundwater	Significant

	Climate and Climate Change	Potential impacts of climate change on project and project area	Significant
	Air Quality	Increased vehicular emissions from increased traffic	Less significant
	Air Quality	Emission of methane from decay of aquatic vegetation	Not assessed as not a priority pollutant under WHO air quality standards
	Air Quality	Establishment of new industries and/or settlements could adversely affect air quality	Non-significant
	Noise	Increase in persistent noise as a result of increased traffic	Less significant
	Noise	New industries and/or settlements will be a source of noise	Non-significant
	Hydrology	Reduced downstream flows	Significant
	Water Resources – Water Quality	Reduction in assimilative capacity downstream of weir impacts Datta Khel agriculture	Significant
	Water Resources – Water Quality	Deterioration of water bodies downstream of Sheratalla and Spaira Ragha command areas by pesticides and nutrient laden water	Significant
	Water Resources – Water Quality	Minor increases in oil, grease and heavy metals in water passing through Powerhouse IV and V turbines	Non-significant
	Biological Resources – Terrestrial Ecosystems	Movement of rodents and snakes from Kaitu Weir pool area into surrounding area	Non-significant
	Biological Resources – Terrestrial Ecosystems	Extension of bird habitat and feeding grounds	Less significant (+)
	Biological Resources – Terrestrial Ecosystems	Secondary poisoning of wildlife by agrochemicals	Non-significant
	Biological Resources – Terrestrial Ecosystems	Increase in agricultural pests results in increased pesticide use and subsequent water pollution	Significant
	Biological Resources – Aquatic Ecosystems	Fragmentation of aquatic ecosystem prevents fish reaching spawning grounds in upper reaches of Kaitu River	Significant
	Biological Resources – Aquatic Ecosystems	Change in habitat from riverine to lacustrine, with change in aquatic fauna to lacustrine species. Loss of habitat for riffle spawning species. Some species' populations will increase	Non-significant (for representative important species)
	Biological Resources – Aquatic Ecosystems	Reduction in downstream flows results in severe degradation of aquatic habitat down to confluence with Kurram	Significant
	Biological Resources – Aquatic Ecosystems	Fish entrainment and turbine-induced mortality	Less significant to non-significant (in function of species)
	Socio-economic Environment	Influx of non-local populations into CCAs	Significant
	Socio-economic Environment	Change in land use pattern from transhumant to irrigated agriculture	Significant
	Socio-economic Environment	Negative perception towards project as settlements near powerhouse and transmission line don't have electricity	Significant
	Socio-economic Environment	Facilitation of vector-borne and other diseases	Significant

	Roads, Bridges and Traffic	Overloading deteriorates road surfaces	Significant
	Roads, Bridges and Traffic	Loss of aggregate sources in downstream floodplains	Non-significant
	Roads, Bridges and Traffic	Poor road maintenance results in increased accidents	Significant
	Roads, Bridges and Traffic	Water pollution by pollutant and sediment laden run off from roads	Less significant
	Roads, Bridges and Traffic	Reduced travel times. Safer roads reduce accidents. Less vehicle wear and tear	Less significant
Decommissioning	Land Resources - Waste Management	Poor disposal of demolition and other wastes	High
	Water Resources – Water Quality	Reduction in water quality	High
	Aquatic Resources	Damage to fish and macroinvertebrates	High
	Socio-economic Environment	Loss of power generation and irrigation benefits	High

Table 5-4: Summary of Significance of Potential Impacts Related to Component 2

Phase	Aspect	Potential Impact	Significance (without mitigation)
Pre-Construction[41]	Land Resources – Waste management	Inadequate waste management planning leads to poor or inappropriate disposal of waste	Significant
	Land Resources – Geology, Geotechnical and Seismicity	Inadequate geotechnical field investigations lead to poor design, siting and stability of infrastructure. Could cause cost overruns in construction	Significant
	Land Resources – Geology, Geotechnical and Seismicity	Current design earthquake ground motion parameter is too low so infrastructure may not withstand MCE	Significant
	Water Resources - Hydrology	PMP and PMF estimates too low – impacts dam safety during operations	Significant
	Water Resources - Hydrology	Uncertainty about erosion and sedimentation rates estimation – impacts dead and live storage capacity	Significant
	Biological Resources – Aquatic Resources	Insufficient baseline data to evaluate impacts on fishery resource	Significant
	Socio-economic Environment	Large scale land acquisition (14,000 acres), physical displacement of 15,000 people and economic displacement of 22,000 people. 18 settlements with more than 1,600 houses to be relocated	Significant
	Socio-economic Environment	Influx of workers and security personnel into remote tribal lands	Significant
	Socio-economic Environment	Limited chances to find suitable resettlement sites due to on-going conflicts between clans over land rights	Significant
	Socio-economic Environment	Exposure of tribal society to external influence and control	Significant
	Socio-economic Environment	Relocation of the shrine of the Fakir of Shewa	Significant
	Roads, Bridges and Traffic	Detailed design provides no road alignments, profile or cross sectional details. Could impact construction schedule	Significant
	Roads, Bridges and Traffic	Land acquisition required for new roads and road works	Significant
	Roads, Bridges and Traffic	Road requirements in new resettlement sites unknown. Will likely require land acquisition	Significant
Construction	Land Resources - Topography and Drainage	Changes to visual resources	Non-significant
	Land Resources - Topography and Drainage	Obstruction of drainage lines or irrigation systems during road upgrades	Non-significant
	Land Resources – Geology, Geotechnical Issues and Seismicity	Lack of lining or support during tunneling; disposal of excavated material or suitability for reuse not known; lack of rock cut slope stability analyses	Significant

[41] The term Pre-Construction Phase as used in this report refers to tasks that are carried out during detailed design and planning as well as other activities that may be carried out prior to the start of project construction. Such activities could include development of infrastructure necessary for the construction activities.

	Land Resources - Soils	Erosion risk at spoil heaps	Non-significant
	Land Resources - Soils	Soil pollution	Non-Significant
	Land Resources – Land Use	Land acquisition for reservoir and resettlement of built up areas in the reservoir footprint	Significant
	Land Resources – Agriculture and Irrigation	Shifting of labor to construction may cause labor shortage in harvesting season	Non-significant
	Land Resources – Agriculture and Irrigation	Degradation of irrigation water quality downstream of construction activities	Less significant
	Land Resources – Waste Management	High sediment loads in run off from spoil heaps affecting downstream use in Kurram River	Significant
	Land Resources – Waste Management	Pollution of soils, surface water and ground water by contaminated run off (chemicals, fuel and oil spills, blasting residues, slurry from batching and asphalt plants, domestic waste dumps, wastewater from camps)	Significant
	Land Resources – Waste Management	Contaminated groundwater and wastewater taken up by plants and affects human health	Less significant
	Land Resources – Waste Management	Odors and other nuisances from domestic waste disposal sites	Cannot be determined with any degree of confidence
	Land Resources – Waste Management	Exposure to medical waste could impact construction personnel and local residents' health	Significant
	Land Resources – Waste Management	Exposure of sanitation workers to pathogens	Significant
	Land Resources – Waste Management	Generation of windblown dust from spoil heaps and stockpiles	Cannot be determined with any degree of confidence
	Land Resources – Waste Management	Poorly sited spoil heaps block drainage lines	Non-significant
	Land Resources – Waste Management	Run off containing high sediment loads and untreated or partially treated sewage leads to eutrophication of receiving water bodies	Non-significant
	Air Quality	Gaseous and fugitive dust emissions (vehicle and machinery emissions, dust from tunneling, dust generated by earth moving activities, excavation, haulage, movement of vehicles and machinery and road construction)	Less significant
	Air Quality	Dust emissions due to blasting	Less significant
	Air Quality	Particulate emissions from batching plants	Less significant
	Noise	High noise levels generated by construction machinery and blasting	Less significant
	Hydrology	Change in river morphology Reduced downstream flow during impounding	Significant
	Water Resources – Water Quality	Increase in TSS and turbidity due to excavation of river bed borrow areas, high sediment loads in run off from spoil heaps or dumping of spoil in drainage lines. Pollution due to release of waste water from the construction camp. Cofferdam will reduce	Significant

		downstream assimilative capacity of the Kurram River.	
	Water Resources – Water Quality	Reduction in assimilative capacity of Kaitu River t Powerhouse II as a result of water abstraction for construction. Direct dumping of debris from Powerhouse IV construction into Kaitu River. Direct deposition of dust in water bodies from Thal-Bannu road upgrade.	Less significant
	Water Resources – Water Quality	Direct dumping of debris from Powerhouse III construction into stream. Use of water for construction could affect the Assimilative capacity of the Kurram River	Less significant
	Biological Resources – Terrestrial Ecosystems	Disturbance of wildlife	Non-significant
	Biological Resources – Terrestrial Ecosystems	Waste dumps attract pests; predators of poultry at camps may be shot	Non-significant
	Biological Resources – Terrestrial Ecosystems	Vegetation and habitat destruction	Less significant
	Biological Resources – Aquatic Ecosystems	Permanent loss of aquatic habitat at the sites occupied by the built structures, and at borrow sites in the Kurram River. Temporary sediment load increases damage fish and benthic macroinvertebrates. Contamination by seepage water will damage fish and macroinvertebrates. Loss of riffle habitat due to removal of gravels	Less significant
	Socio-economic Environment	Large scale land acquisition	Significant
	Socio-economic Environment	18 settlements with more than 1,600 houses to be relocated	Significant
	Socio-economic Environment	Influx of workers and security guards into remote tribal lands	Significant
	Socio-economic Environment	Conflict between tribes about territorial	Significant
	Socio-economic Environment	Physical and economic displacement	Significant
	Socio-economic Environment	Increase in transmittable The staff at the health unit is not up to their task leading to unreasonable high number of fatalities	Significant
	Socio-economic Environment	Loss of cultural heritage; relocation of the shrine of the Fakir of Shewa	Significant
	Roads and Bridges	Deterioration of air quality by fugitive dust and vehicle and machinery emissions	Less significant
	Roads and Bridges	Noise pollution by heavy machinery and equipment. Blasting noise	Less significant
	Roads and Bridges	Blasting vibrations	Significant
	Roads and Bridges	Erosion, sloughing and landsliding, particularly in hilly terrain	Significant
	Roads and Bridges	Water pollution by run off contaminated by fuel, oils, heavy metals, sediments and trash. Road works at stream crossings may increase sediment loads. Spills of concrete in waterways.	Less significant
	Roads and Bridges	Road safety impacted by increased traffic. Risk of accident	Significant

	Roads and Bridges	Travel disruption and delays	Significant
	Roads and Bridges	Gender issues due to presence of outside personnel	Less significant
Operation	Land Resources – Topography and Drainage	Changes to the visual aspect of the Kurram River upstream of Kurram Tangi Dam and Weirs II and III	Significant
	Land Resources – Geology, Geotechnical Issues and Seismicity	Failure of Kurram Tangi Dam or Weir II or Weir III under MEC causing downstream flooding and loss of life, livestock, built infrastructure and crops	Significant
	Land Resources – Land Use	Land acquisition for the reservoir	Significant
	Land Resources – Irrigation and Agriculture	Reduced ability to conduct gravity irrigation downstream of weir and loss of nutrients reducing soil fertility	Significant
	Land Resources – Irrigation and Agriculture	Increase agricultural development and earnings for farmers	Significant (+)
	Land Resources – Waste Management	Poorly managed waste generates odors, unaesthetic conditions and breeding ground for disease vectors. Leachate can pollute groundwater	Significant
	Climate and Climate Change	Potential impacts of climate change on project and project area	Significant
	Air Quality	Increased vehicular emissions	Less significant
	Air Quality	Emission of methane from decay of aquatic vegetation	Not assessed as not a priority pollutant under WHO air quality standards
	Noise	Persistent traffic noise from increased traffic	Less significant
	Noise	Establishment of new industries/settlements will generate noise	Non-significant
	Hydrology	Seasonal regulation of downstream flow	Significant (+)
	Hydrology	Change in soil conditions downstream of dam	Significant
	Water Resources – Water Quality	Water pollution as a result of accumulation of phosphorus in reservoir; contamination of reservoir by domestic waste; thermal stratification causes low dissolved oxygen and high turbidity levels; accumulation of salts in reservoir. Seepage from reservoir will pollute groundwater	Significant
	Water Resources – Water Quality	Minor increases in oil, grease and heavy metals in water passing through Powerhouse IV and V turbines	Non-significant
	Biological Resources – Terrestrial Ecosystems	Movement of rodents and snakes from Kurram Tangi Dam reservoir, and Weir II and III pools into surrounding area	Non-significant
	Biological Resources – Terrestrial Ecosystems	Creation of three standing water bodies could create staging posts for migratory waterfowl and waders	Significant (+)
	Biological Resources – Terrestrial Ecosystems	Waterfowl and waders using water bodies will be exposed to hunting. Migratory waterfowl include three species of concern	Significant for species of concern
	Biological Resources – Terrestrial Ecosystems	Destruction of habitat or vegetation for fuel wood	Non-significant
	Biological Resources – Aquatic Ecosystems	Fragmentation of aquatic ecosystem between the dam and Kurram	Significant

		Garhi Headworks into four segments. Dam prevent aquatic fauna in reach below dam reaching spawning grounds in upper reaches of Kurram River	
	Biological Resources – Aquatic Ecosystems	Change in habitat from riverine to lacustrine, with change in aquatic fauna to lacustrine species. Loss of habitat for riffle spawning species. Some species' populations will increase	Non-significant
	Biological Resources – Aquatic Ecosystems	Reduction in downstream flows during dam filling results in loss of aquatic habitat	Significant for species of concern
	Biological Resources – Aquatic Ecosystems	Fish entrainment and turbine-induced mortality	Non-significant for most species; significant for Golden Mahseer and other species of concern
	Biological Resources – Aquatic Ecosystems	Increase in populations of fish that adapt to lacustrine environment.	Less significant (+)
	Socio-economic Environment	Change in land use pattern from transhumant to irrigated agriculture	Significant
	Socio-economic Environment	Negative perception towards project as settlements around reservoir and near powerhouses and transmission line don't have electricity	Significant
	Socio-economic Environment	Insecurity of land rights after relocation of 1,600 households	Significant
	Socio-economic Environment	Facilitation of vector-borne and other diseases	Significant
	Socio-economic Environment	Facilitation of vector-borne and other diseases	Significant
	Roads, Bridges and Traffic	Overloading deteriorates road surfaces	Significant
	Roads, Bridges and Traffic	Loss of aggregate sources in downstream floodplains	Non-significant
	Roads, Bridges and Traffic	Poor road maintenance results in increased accidents	Significant
	Roads, Bridges and Traffic	Water pollution by pollutant and sediment laden run off from roads	Less significant
	Roads, Bridges and Traffic	Reduced travel times. Safer roads reduce accidents. Less vehicle wear and tear	Less significant
Decommissioning	Land Resources - Waste Management	Poor disposal of demolition and other wastes	High
	Water Resources – Water Quality	Reduction in water quality	High
	Aquatic Resources	Damage to fish and macroinvertebrates	High
	Socio-economic Environment	Loss of power generation and irrigation benefits	High

Table 5-5: Summary of Significance of Potential Impacts Related to Component 3

Phase	Aspect	Potential Impact	Significance Significance (without mitigation)
Pre-Construction[42]	Land Resources -Agriculture and Irrigation	Planning and coordination deficit delays use of irrigation systems	Significant
	Land Resources – Waste management	Inadequate waste management planning leads to poor or inappropriate disposal of waste	Significant
	Land Resources – Geology, Geotechnical and Seismicity	No geotechnical field investigations or laboratory testing; no geotechnical design parameters, no seepage or stability analysis. Could result in inadequate design, siting and stability of infrastructure. Could cause cost overruns in construction	Significant
	Biological Resources – Aquatic Resources	Insufficient baseline data to evaluate impacts on fishery resource	Significant
	Socio-economic Environment	Land acquisition (145,000 acres), physical displacement of 50,000 people and economic displacement of 500,000 people	Significant
Construction	Land Resources - Topography and Drainage	Changes to visual resources	Non-significant
	Land Resources – Geology, Geotechnical Issues and Seismicity	Loss of water due to seepage and its effect on surrounding areas	Significant
	Land Resources - Soils	Erosion risk at construction sites and associated temporary structures	Non-significant
	Land Resources - Soils	Soil pollution	Non-Significant
	Land Resources - Soils	Soil compaction	Non-Significant
	Land Resources – Land Use	Land acquisition for canal networks, and temporary structures	Significant
	Land Resources – Land Use	Obstruction of waterways	Non-significant
	Land Resources – Agriculture and Irrigation	Hindering of cultivation and interruption of cropping	Non-significant
	Land Resources – Agriculture and	Shifting of labor to construction may cause labor shortage	Non-significant

[42] The term Pre-Construction Phase as used in this report refers to tasks that are carried out during detailed design and planning as well as other activities that may be carried out prior to the start of project construction. Such activities could include development of infrastructure necessary for the construction activities.

	Irrigation	in harvesting season	
	Land Resources – Agriculture and Irrigation	Interruption of irrigation supply during remodeling of existing canal systems	Non-significant
	Land Resources – Agriculture and Irrigation	Gender issues: presence of outsiders may make women reluctant to carry out agricultural activities; contact between local women and construction personnel could lead to social conflict	Less significant
	Land Resources – Agriculture and Irrigation	Degradation of irrigation water quality downstream of construction activities	Non-significant
	Land Resources – Waste Management	High sediment loads in run off from spoil heaps affecting downstream use in Kurram River	Significant
	Land Resources – Waste Management	Pollution of soils, surface water and ground water by contaminated run off (chemicals, fuel and oil spills, blasting residues, slurry from batching and asphalt plants, domestic waste dumps, wastewater from camps)	Significant
	Land Resources – Waste Management	Contaminated groundwater and wastewater taken up by plants and affects human health	Less significant
	Land Resources – Waste Management	Odors and other nuisances from domestic waste disposal sites	Cannot be determined with any degree of confidence
	Land Resources – Waste Management	Exposure to medical waste could impact construction personnel and local residents' health	Significant
	Land Resources – Waste Management	Exposure of sanitation workers to pathogens	Significant
	Land Resources – Waste Management	Generation of windblown dust from spoil heaps and stockpiles	Cannot be determined with any degree of confidence
	Land Resources – Waste Management	Poorly sited spoil heaps block drainage lines	Non-significant
	Land Resources – Waste Management	Run off containing high sediment loads and untreated or partially treated sewage leads to eutrophication of receiving water bodies	Non-significant
	Air Quality	Gaseous and fugitive dust emissions (vehicle and machinery emissions, dust generated by canal construction and remodeling activities, and excavation)	Less significant
	Air Quality	Particulate emissions from batching plants	Less significant
	Noise	High noise levels generated by construction machinery	Less significant
	Hydrology	Increased downstream turbidity	Significant
	Water Resources – Water Quality	Increase in TSS and turbidity due to high sediment loads in	Significant

		run off from construction sites, direct dumping of debris and direct deposition of dust generated by construction activities.	
	Water Resources – Water Quality	Remodeling of Civil Canals and Marwat Canal can impact Kurram River water quality	Less significant
	Biological Resources – Terrestrial Ecosystems	Disturbance of wildlife	Non-significant
	Biological Resources – Terrestrial Ecosystems	Waste dumps attract pests; predators of poultry at camps may be shot	Non-significant
	Biological Resources – Terrestrial Ecosystems	Vegetation and habitat destruction	Less significant
	Biological Resources – Aquatic Ecosystems	Localized increase in turbidity during remodeling of Kurram Garhi Headworks	Non-significant
	Socio-economic Environment	Large scale land acquisition	Significant
	Socio-economic Environment	Land allocation in CCA	
	Socio-economic Environment	Influx of workers and security guards into remote tribal lands	Significant
	Socio-economic Environment	Physical and economic displacement	Significant
	Socio-economic Environment	Increase in transmittable The staff at the health unit is not up to their task leading to unreasonable high number of fatalities	Significant
	Socio-economic Environment	Increase in transmittable The staff at the health unit is not up to their task leading to unreasonable high number of fatalities	Significant
	Socio-economic Environment	Loss of cultural heritage	
	Roads and Bridges	Deterioration of air quality by fugitive dust and vehicle and machinery emissions	Less significant
	Roads and Bridges	Noise pollution by heavy machinery and equipment. Blasting noise	Less significant
	Roads and Bridges	Blasting vibrations	Significant
	Roads and Bridges	Erosion at road works sites	Significant
	Roads and Bridges	Water pollution by run off contaminated by fuel, oils, heavy metals, sediments and trash. Road works at stream crossings may increase sediment loads. Spills of concrete in waterways.	Less significant
	Roads and Bridges	Road safety impacted by increased traffic. Risk of accident	Significant
	Roads and Bridges	Travel disruption and delays	Significant

	Roads and Bridges	Gender issues due to presence of outside personnel	Less significant
Operation	Land Resources – Topography and Drainage	Extension of man-made drainage network	Less significant (+)
	Land Resources – Soils	Waterlogging and salinization	Significant
	Land Resources – Land Use	Reduced ability to conduct gravity irrigation downstream of weir and loss of nutrients reducing soil fertility	Significant
	Land Resources – Land Use	Loss of grazing lands and access to pastures	Significant
	Land Resources – Irrigation and Agriculture	Pollution of water by excessive use of fertilizers and pesticides	Significant
	Land Resources – Irrigation and Agriculture	Waterlogging and salinization	Significant
	Land Resources – Irrigation and Agriculture	Increase agricultural development and earnings for farmers	Significant (+)
	Land Resources – Irrigation and Agriculture	Lack of capital to purchase inputs leads to suboptimal crop production	Less significant
	Land Resources – Irrigation and Agriculture	Creation of conditions for improved water management in the Civil Canals command area through the creation of WUA	Significant (+)
	Land Resources – Waste Management	Poorly managed waste generates odors, unaesthetic conditions and breeding ground for disease vectors. Leachate can pollute groundwater	Significant
	Climate and Climate Change	Potential impacts of climate change on project and project area	Significant
	Air Quality	Increased vehicular emissions	Less significant
	Noise	Increased persistent noise from increased traffic	Less significant
	Noise	Noise from new industries and/or settlements	Non-significant
	Water Resources – Water Quality	Agricultural runoff and percolation degrade surface water and groundwater quality. This will impact downstream farm production	Significant
	Water Resources – Water Quality	Low riparian areas will be affected by the reduced assimilative capacity of the Kurram River. Reduced DO and increased BOD will affect cultivation reducing household income	Significant
	Biological Resources – Terrestrial Ecosystems	Extension of bird habitat and feeding grounds, and fish habitat in canals	Less significant (+)
	Biological Resources – Terrestrial Ecosystems	Secondary poisoning of wildlife by agrochemicals	Non-significant

	Biological Resources – Aquatic Ecosystems	Migration blockage by Kurram Garhi Headworks	Non-significant
	Biological Resources – Aquatic Ecosystems	Reduced flows in Kurram River will reduce habitat. Effect is more pronounced for riffle habitat	Non-significant
	Socio-economic Environment	Change in land use pattern from transhumant to irrigated agriculture	Significant
	Socio-economic Environment	Insecurity of land rights after relocation and in CCAs	Significant
	Socio-economic Environment	Facilitation of vector-borne and other diseases	Significant
	Socio-economic Environment	Facilitation of vector-borne and other diseases	Significant
	Roads, Bridges and Traffic	Overloading deteriorates road surfaces	Significant
	Roads, Bridges and Traffic	Loss of aggregate sources in downstream floodplains	Non-significant
	Roads, Bridges and Traffic	Poor road maintenance results in increased accidents	Significant
	Roads, Bridges and Traffic	Water pollution by pollutant and sediment laden run off from roads	Less significant
	Roads, Bridges and Traffic	Reduced travel times. Safer roads reduce accidents. Less vehicle wear and tear	Less significant

5.2 Potential Impacts Related to Component 1

As described in Section 3.1 and 3.2, Component 1 consists of the Kaitu Weir and associated structures, and the irrigation command areas on the Sheratalla and Spaira Ragha Plains. A low-head weir will be constructed in the Kaitu River about 400 feet upstream of the Mir Ali-Thal Road Bridge. The weir will be 18 feet high and 302 feet in length. It will have three off-takes, as follows:

- A regulator for a 16-mile canal to the Sheratalla Plain, for a new irrigation Command of 12,300 acres, with a capacity of 83 cfs. The Sheratalla Canal will contain Powerhouse V, utilizing the flow in the canal.
- A regulator for an 8-mile-long canal with full supply capacity of 29 cfs to a new command on the Spaira-Ragha Plain of 4,080 acres.
- A tunnel 14 feet in diameter and 6,100 ft long to the Kurram Tangi Reservoir. This tunnel will contain Powerhouse No. IV, and divert up to 1,200 cfs from the Kaitu River above the weir.
- A transmission line from Powerhouse IV to Powerhouse I, located at the toe of the Kurram Tangi Dam (Component 2).

The road works that have been planned for Component 1 are upgrading and strengthening of the Bannu-Mir Ali-Spinwam-Thal road, and the Bannu-Zarwam-Thal road (see Section 3.2.5.3). The part of the Bannu-Mir Ali-Spinwam-Tal road between Spinwam and Thal may only be upgraded as part of Component 2. Nevertheless, the potential impacts are described here, including those for the relocation of part of this road. Should this section only be upgraded as part of Component 2, the mitigation measures described for this upgrade will apply in Component 2.

5.2.1 Pre-Construction Phase

5.2.1.1 Land Resources

Geology, Geotechnical Issues and Seismicity.
Potential Impacts: Geology and Geotechnical: An adequate geotechnical field investigation, sufficient laboratory testing, and the selection of appropriate geotechnical design parameters play an important role during the detailed analyses and design of the project features to ensure that the project is both safe and economical. In view of the above, potential geotechnical impacts in term of magnitude, extent, duration and probability of likelihood were evaluated on the basis of insufficient geotechnical investigation, testing information available, and the design and analyses of project components (MWH, 2013a). All the information on potential geotechnical impacts is sourced from MWH (2013a). The potential geotechnical impacts for Component 1 in the Pre-construction Phase are shown in Table 5-6 below. Overall these potential impacts are assessed as significant.

Seismicity: The seismic hazard analysis (MWH, 2013b) indicates that the current ground motion parameter of 0.2g is too low. As such there is a risk of failure of the Kaitu Weir structure in the event of a Maximum Credible Earthquake (MCE) causing downstream flooding that could potentially impact agricultural activities, infrastructure and dwellings and even result in loss of human and animal life. This is a short-term, probable, high magnitude and local potential impact. It is assessed as significant.

Table 5-6: Potential Geotechnical Impacts of Component 1 during Design Phase

Sr. No.	Description	Magnitude	Extent	Duration	Probability of Likelihood
a)	**Kaitu Weir and Allied Structures**				
1	Insufficient geotechnical investigation and	High/major	Site Specific	Long-Term	Medium to High

	laboratory testing for head regulators				
2	Establishment of geotechnical design parameters	High/major	Site Specific	Long-Term	High
3	Stability and seepage analysis	High/major	Site Specific	Long-Term	Probable
4	Bearing capacity analyses for foundations	High/major	Site Specific	Long-Term	Probable
5	Stability analyses for retaining walls	High/major	Site Specific	Long-Term	Probable
b)	**Kaitu Feeder Tunnel**				
1	All laboratory test results are missing	High/major	Local	Long-Term	High
2	Inadequate Rock Mass Rating (RMR) Classification Design of Rock support system	Moderate	Site Specific	Medium-term	Probable
3	Stress analysis of tunnel not performed	High/major	Site Specific	Long-Term	Probable
c)	**Powerhouse No. IV and V**				
1	No geotechnical investigation and laboratory testing	High/major	Site Specific	Long-Term	Highly probable
2	Non-availability of geological information	High/major	Site Specific	Long-Term	Highly probable
3	No static and dynamic analyses of powerhouse foundation has been performed	High/major	Site Specific	Long-Term	Highly probable or definite
d)	**Sheratalla and Spaira Ragha Canals Systems**				
1	Non-availability of geotechnical investigation and laboratory testing	High/major	Site Specific	Long-Term	Highly probable or definite
2	Stability analyses have not been performed	High/major	Site Specific	Long-Term	Highly probable or definite

Mitigation: Further field investigations, including additional geological mapping and boreholes are needed to enable detailed design to be completed. Project designs are reasonable and appropriate for this level of study; however, as noted in MWH (2013a), design reviews, additional analyses and detailing work are still needed. Major items of work to be completed to finalize the design include the following:

- Carry out additional field investigations as described in detail in the Supplemental Report on Geotechnical Aspects (MWH, 2013a).
- Carry out additional design work as recommended in MWH, 2013a.
- Perform seismic stability analyses using the new ground motion parameter i.e. 0.8g.
- Review the foundation designs of structures which are founded on overburden material. These should be revised and rock foundations should be used wherever possible. It is expected that the weir can be placed on bedrock foundations. If still foundations are placed on overburden,

liquefaction potential of foundation strata should be assessed and the design should be revised accordingly.

Agriculture and Irrigation

Potential Impacts: Planning and coordination deficit: The planning, design and the construction of the main structures (Kaitu Weir, main canal network) is the responsibility of WAPDA while the development of the tertiary distribution networks, watercourses and on-farm development is the responsibility of the KP Agriculture and Irrigation Department. These actions are not coordinated and synchronized. This could lead to a long time lag between the construction of the main structure and the actual use of the systems for irrigated production. The magnitude of this probable potential impact is high, the extent is regional and the duration could be long. Therefore, this potential impact has been ranked as significant.

Mitigation: Strong coordination between WAPDA and the Agriculture and Irrigation Department of KP is recommended concerning the planning and design of the entire systems, particularly of the water courses and on-farm irrigation development and the surface drainage network.

Waste Management

Potential Impacts: Previous project documents do not address waste management issues adequately, nor was waste generation quantified during the design stage to date. Absence of development of an integrated waste management plan during the pre-construction phase will lead to mismanagement of waste generated during the construction and operation phases. For example, if inappropriately managed, spoil from excavations will have significant potential impacts on the surrounding environment including potential visual impacts, potential increases in sediment loads in water bodies and airborne dust generation. Moreover, there are no contractual obligations on the future Component 1 construction contractor for solid waste and wastewater management in the current contract documents.

Mitigation: This study has developed a framework Waste Management Plan (Annex III to the EMMP), however given the current data gaps, it will be necessary to develop the framework plan into a more comprehensive waste management plan during the Pre-Construction Phase. This will include quantifying all different types of waste that will be generated (to the extent possible), waste collection, storage, transport, reuse, recycling and eventual disposal. The plan will be based on the accepted waste management hierarchy, i.e. reduction at source, reuse or recycle before ultimate disposal.

In addition the following measures should be implemented during the pre-Construction Phase:

- Plan and develop appropriate training/awareness programs for construction personnel and waste management staff.
- The contractor shall be contractually obliged to provide appropriate Personal Protective Equipment (PPE) such as gloves, masks, safety shoes, jackets, goggles, etc. to all waste management personnel.
- An appropriate landfill site (s) should be selected for the ultimate disposal of the solid waste. Provision should be made for developing separate cells for disposal of domestic, inert industrial and hazardous wastes.
- U.S. EPA Regulations 40 CFR Part 258 and the IFC Environmental, Health, and Safety Guidelines for Waste Management Facilities should be consulted for guidance in the design of a landfill(s) for the project. The former require that a landfill cell include a 0.67 meter thick compacted clay liner and a 60 mil HDPE flexible membrane liner sloped to leachate collection sumps, a 0.3 meter thick leachate collection blanket with perforated leachate collection pipes, leachate sumps that are gravity drained, and are connected to the leachate collection and treatment basin.
- An inadequately designed and operated landfill has the potential to cause significant potential environmental, health and safety impacts. Therefore, design of disposal sites and provision of an

experienced waste supervisor and workers for disposal sites must be included in the design of Component 1.

- A comprehensive quarry management plan shall be developed including estimations of required material, measures to manage borrow waste and rehabilitation of the borrow sites. Where possible the latter should provide for use of excess spoil in rehabilitation efforts.
- Adequate measures, as described in the Waste Management Plan, shall be planned to protect natural water bodies (Kaitu River), especially those currently receiving wastewater.
- A proper sewerage system must be designed for the collection, conveyance and disposal of sewage generated from construction camps, staff buildings and colonies.
- The sewage must be treated prior to its disposal into the receiving natural water bodies. Septic Tanks and Soakage Pits are recommended for the treatment of sewage generated by the KTDP.
- Wastewater reuse must be considered in the final design phase.
- The construction contractor(s) must develop his (their) own site specific waste and wastewater management plans that are fully compliant with the requirements laid down for solid and liquid waste management in this EA, the EMMP, the framework waste management plan and the comprehensive waste management plan that will be developed in this phase.

5.2.1.2 Water Resources

Hydrology

Potential impacts: There are some doubts about the accuracy of the histogram Spinwam gauge flow data, as well as gaps in the data record. This is important for the estimation of total inflows available at the Kaitu Weir and their distribution between minimum downstream flow releases and flows for irrigation and power purposes. The potential impacts would become manifest at the operational stage, but are discussed here as their mitigation needs to be addressed during this phase in order to determine whether modifications to the design of Component 1 are required.

Underestimation of flows could potentially mean that insufficient flows are available to satisfy either one or both of the demands. If irrigation flows are insufficient, potential benefits of future irrigation would not be realized. This is assessed as a significant potential impact. Potential inability to ensure adequate downstream flow releases would affect both downstream irrigation at Datta Khel and riverine ecology.

In addition there is no analysis of the design flood or sedimentation for the Kaitu River. These have significant implications for design and operation of the Kaitu Weir. However, given the absence of data or analysis the significance of the impacts cannot be assessed.

Mitigation:

- The accuracy of the histogram Spinwam gauge flow data needs to be further investigated.
- Discrepancies between the sum of flow gauge data at the Thal and at Spinwam with the data at Kurram Gahri Headworks should be resolved.
- The accuracy of discharge measurement procedures and rating curves at the Spinwam stream gauging station should be checked in the field.
- Missing flow data from the Spinwam gauge should be synthesized from other flow and rainfall data.
- Once historical flow data for the Kaitu Weir have been confirmed, the Weir operation studies should be updated.
- Analysis of anticipated design floods, sedimentation in the Kaitu Wier and potential channel degradation impacts downstream of the Weir should be carried out. If necessary, the design should be updated.

5.2.1.3 Biological Resources

Aquatic Resources

No potential impacts on the aquatic resources of the Project area of influence are anticipated in the pre-construction phase. However, the aquatic resource baseline conditions in this area are presently inadequate to evaluate potential impacts on the fishery resource and determine appropriate mitigation actions. The recommended mitigation action is to conduct the Fish and Water Quality Survey described in the Fisheries Management Plan (Annex IV of the EMMP).

5.2.1.4 Socio-Economic Environment

Introduction

During the construction and operation of the KTDP, the main potential significant socio-economic impacts are (i) the large scale acquisition of land (in total 190,000 acres) resulting in the physical displacement of up to 72,000 people and the economic displacement of up to 610,000 people and (ii) the influx of security personnel and job seekers into semi-independent tribal lands. The physical and economic dislocation of the local population, in the context of significant in-migration of outsiders, exposes the tribal communities to modernization. At the same time, the KTMDP aims to transform transhumant pastoralism and rain-fed agriculture into irrigated farming.

Potential Impacts: The most significant potential impact during the pre-construction phase is the acquisition of nearly 24,000 acres of land. This amount of land acquisition would trigger the need to physically relocate up to 6,000 people and to restore the livelihoods of up to 95,000 people. Most of these people are expected to benefit in the long run from the transformation of 23,000 acres of presently rain fed agricultural land and pasture into fully irrigated canal command areas (CCA). Nevertheless, it needs to be mentioned that the period between land take and allocation of irrigated land is expected to take at least 3-4 years. The impact is considered to be of high significance.

Nearly all land to be acquired for Component 1 is tribal land. Much of it, in particular the Spaira Ragha and Sheratalla Plains, is disputed and claimed by different clans. In addition, none of the permanent user rights held by individual households for residential and agricultural lands is documented and therefore protected against misuse and/or conflicts between clans and households. Overlapping land claims may delay land acquisition and thus project implementation. This potential impact is assessed as having a high significance as such territorial conflicts have the tendency to go on forever if not addressed in a culturally appropriate way.

Another potential impact during the pre-construction period is the influx of construction workers[43] and security personnel into the project region of Component 1 in North Waziristan. Each of these two groups of in-migrants poses particular considerations for the local population.

Increased security reduces the level of autonomy of the Wazirs and exposes them to external control that they are fighting since time immemorial. Meanwhile, the influx of job seekers may create rental markets and/or shanty towns, underlie increases in cost of basic commodities, and foster locally unacceptable or even anti-social behavior. This is a potential impact of moderate significance as it limited to the construction phase.

Resettlement may result in economic, social, and psychological trauma. In the pre-construction phase, resettlement may result in psychological disorders such as anxiety, depression and suicidal thoughts that have adverse psychosomatic effects on health.

[43] It is anticipated that the number of construction personnel for the Kaitu Wier will be 400. 100 will be required for powerhouses IV and V (Section 3.2.5.6).

Mitigation: Mitigating actions for potential impacts associated with land acquisition in Component 1 are covered in detail in the Resettlement Action Plan (RAP) for Component 1. They include the following:

- Provide compensation and allowances to individuals, households and communities affected by land acquisition activities prior to impacts actually taking place.
- Identify and secure replacement land, construct resettlement housing, move PAPs into new housing, and implement the other commitments of the RAP. Alternatively PAPs may find their own housing. Construction can only start once resettlement is completed.
- Livelihood restoration will be made available to each economically displaced household. They include an irrigated agriculture enhancement package and the choice of one of four income generation packages. The RAP defines specific livelihood restoration commitments within the general framework outlined in the RPF. Livelihood restoration continues for several years to ensure that it is sustainable over the long-term.
- Ongoing monitoring and evaluation to determine the impact that land acquisition has had on individuals, households and communities as well as the relative success of livelihood restoration measures carried out after resettlement.

An outstanding task that needs to be performed during the pre-construction phase is to update/amend the RAP so that it covers (a) the temporary land needs for construction and security camps, quarries and the like, and (b) the final alignment on linear infrastructure (e.g., roads, canals and transmission lines).

Mitigation actions for potential conflicts within the tribal societies in Component 1 are discussed in detail in the Vulnerable Tribes Plan (VTP). The main approach is here to use culturally appropriate consultation and mediation methods to obtain the free, prior and informed consent of all affected clans to each subcomponent and detail mitigation measures for each intervention that creates the potential for conflict between the construction contractor and subcontractors and the tribal peoples, and/or between different clans of the Wazirs.

5.2.1.5 Roads, Bridges and Traffic

The potential impacts associated with the road and bridge infrastructure are consistent across the AOI and independent of the individual project components. The upgrading of existing roads will need to be carried out as part of Component 1 to allow safe and efficient transportation of equipment and materials. In the interests of brevity potential impacts and their mitigation have been assessed in detail for Component 1 and referred back to in Components 2 and 3.

Potential Impacts: Detailed Design: The Detailed Design Report (PES at al, 2011a) and Tender Documents (PES et al, 2011b) do not provide road alignments, profile or cross sectional details with reference to roads and bridges. The estimate for a new road is based on established rates, which varies between 4 to 5.6 Million per 0.6 miles in plain areas and hilly terrain respectively. The total cost of Preliminary Works has been kept as Rs. 196.678 Million (October 2010 revised) in the PC1 Costs reference Annexure 1. This estimate may be insufficient because rates need to be escalated from 2010 rates to those expected at the time of construction.

If the above mentioned data is not provided in time it will hamper the entire schedule for the construction of the roads which will further cause delays in construction of the project. Therefore this can be assessed as a significant potential impact with a high magnitude and a long term affect.

Land Acquisition: Land is required for the construction of new roads and the upgrading of existing roads. This may require the acquisition of some privately owned property which the people may be hesitant to give up. Land acquisition will be a serious particularly for any new roads. Therefore, this

is a high magnitude potential impact which will have permanent affects and can thus be regarded as a significant issue.

Resettlement Road Infrastructure Requirements: Currently these are unknown, but development of road infrastructure will likely involve land acquisition. As these will most probably be new roads this is a high magnitude potential impact which will have permanent affects and can thus be regarded as a significant issue.

Mitigation: Detailed Design: Road Alignments, cross sectional details/designs, ROW and topographic surveys will all be done during the detailed design stage. During this phase local communities and the highway departments of KPK and FATA need to be consulted to finalize the alignments. It is suggested that design should be carried out in accordance with the Structural Design Criteria listed in Appendix 9.5.

Land Acquisition: People whose land will be acquired for the Project will be compensated as per the terms stated in the stand alone RAP Report prepared for Component 1 of the KTDP.

Resettlement Road Infrastructure Requirements: Once the details become available for any additional road infrastructure required for resettlement the potential impacts will need to be assessed and addressed in compliance with the RAP.

5.2.2 Construction Phase

Following the signing of the contract with the Prime Contractor a period of mobilization will take place, during which the contractor will complete the development and stocking of the camps. The placement of cofferdams and work in the river will exert major changes in the topography and water quality of the river, but these potential impacts will be relatively short, a matter of weeks

In the Feasibility Report, Chapter 10 (KTDC, 2004), it is stated that WAPDA intends to undertake certain preparatory construction actions prior to letting the contract for Component 1. These are construction of the following roads:

- Mir Ali-Thal Road. This road, which is metaled for much of its length, is an important artery through the region. About six miles of this road will be relocated due to inundation by the Kurram Tangi Reservoir. The remainder of the road will be inspected for soundness, with special attention to bridges, and rehabilitated or upgraded, as necessary.
- Bannu-Shewa Road. This road is not paved, but is an important access route from Bannu to Datta Khel and the dam site. It will be graded, paved and strengthened, in order to provide an access from the dam site to Powerhouse III. This will require the construction of one bridge and two dozen culverts and causeways.
- A new road, which may be called the Spaira Ragha Road, will extend from the weir site to the Kurram Tangi Dam site. Along this metaled road, WAPDA intends to construct two camps, one to house the contractor's workforce and the other for management personnel. In the event that the contract for Component 2 is not awarded for several years after that for Component 1, this road could be built only to the site of the contractor's camp, about 500 feet from the end of the southwestern arm of the future reservoir.

WAPDA has indicated in the Feasibility Report (op. cit.) that along the Spaira Ragha two sites will be selected, of six and nine acres, to develop the camps for the project. The larger one will eventually house the workforce of 1,100 constructing the main dam. In addition to these two sites, a camp will be developed for the security force, the size of which has not yet been determined. These camps will provide all of the amenities required: residence buildings, food services, a small hospital with permanent staff, water purification and wastewater treatment, electric generation, recreation facilities, and fuel storage. A helipad will be required for emergency evacuation in the event of a serious accident.

For the construction of the weir and the canals, a major work yard will be required. The most appropriate area would be on the right bank of the Kaitu River, immediately north of the Mir Ali-Thal Road. This area of undeveloped land could provide a construction camp of about 10 acres (400 x 1,000 feet), enough for the concrete batching plant, offices, vehicle repair and storage buildings, an asphalt plant, secure storage for explosives and fuels, an electric generating plant, storage of aggregate, and all of the other necessities of the contractor. Additional land on the south side of the road could be acquired for the necessary security force. Since the site is adjacent to the river, water for construction would be readily available with little potential impact.

5.2.2.1 Land Resources

Topography and Drainage
Potential Impacts: During the construction phase there will be changes to the visual resources typical of construction activity. However these will be of low magnitude, short-term and local and will cease at the end of construction. They are assessed to be of low significance and do not require mitigation.

In addition upgrades to and/or construction of road infrastructure could affect surface and subsurface drainage (e.g. obstruction of drainage lines or irrigation systems) thereby affecting other water users and aquatic life. This is a local potential impact, of short duration and moderate magnitude. It is assigned a low significance.

Mitigation: The following measures should be implemented in order to mitigate potential impacts to drainage:

- Avoid widening of roads beyond design specifications.
- Avoid disturbance of natural drainage and construct culverts where required.
- Spoil heaps and soil stockpiles shall be located so as not to disturb natural drainage.

Geology, Geotechnical Issues and Seismicity
Potential Impacts: The potential geotechnical impacts for Component 1 are shown in Table 5-7 below. Overall these potential impacts are assessed as significant.

Table 5-7: Potential Geotechnical Impacts of Component 1 during Construction Phase

Sr. No.	Description	Magnitude	Extent	Duration	Probability of Likelihood
1	Downstream cofferdam for Kaitu Weir has not been considered	High/major	Regional	Medium-term	Highly probable or definite
2	Dewatering issues not discussed	High/major	Regional	Medium-term	Highly probable
3	Installation of tunnel lining and rock support system	High/major	Local	Short-Term	Highly probable
4	Disposal of excavated material/ suitability to be used in construction of cofferdams	Moderate	Local	Short-Term	Probable

Mitigation:

- Construct a downstream cofferdam if it is determined to be necessary.
- Ensure adequate measures are put in place for dewatering during excavation and construction.
- Install tunnel lining and rock support systems as needed.
- If suitable reuse excavated material in coffer dam construction. Excess material, if any, should be disposed of as described in the waste management section of Section 5.2.3.1 below and in compliance with measures outlined in the framework Waste Management Plan (Annex III).

Soils

Potential Impacts: Erosion Risk. The construction of the proposed Spaira Ragha and Sheratalla canal networks (main, distributaries and minors), roads and associated temporary structures (contractor camps etc.) may trigger soil erosion and landslides, particularly in bad weather conditions, due to uneven slopes, blasting, drilling, compaction improper cutting and siting/location of borrow pits and fill storage depots, or improper handling of spoils. This will be a temporary, probable potential impact. The magnitude of this potential impact is low, the extent is local and the duration is only until these construction activities have ended. Therefore, this potential impact has been ranked as of low significance.

Soil pollution. The construction of the proposed Spaira Ragha and Sheratalla canal networks (main, distributaries and minors), roads and associated temporary structures (contractor camps etc.) may lead to temporary soil degradation as a result of improper disposal of construction materials as well as soil pollution by leaks of combustibles and lubricants, disposal of wastewater etc. The magnitude of this potential impact is assigned a low value. The extent of this probable potential impact will be local and the duration will be short as it will last only during the construction activities. Therefore, this potential impact has been ranked as of low significance.

Soil Compaction. The construction of the canal networks and roads will involve the use of heavy earth moving equipment. These machines will need routes (for instance to borrow pits etc.) which are not limited to the canal or road width but will also affect neighboring areas, including cultivated land. This can lead to soil compaction which will affect soil suitability for agricultural production. The magnitude of this potential impact is foreseen to be low; the extent is local and duration is short term as it will only last for construction stage. Thus the potential impact is assessed to be of low significance.

Mitigation: Erosion risk: Good engineering practices such as appropriate siting of borrow pits and fill storage depots, keeping spoil/borrow materials covered, construction of protection structures (gabions, rip raps, stone pitching) for embankment slopes, proper cutting of slopes, plantation of trees and shrubs, and drainage management should be implemented. Further measures for mitigation of potential spoil related impacts are described under potential waste management impacts below.

Soil Pollution: Proper disposal and storage of materials and chemicals (in impervious lined pits), correct handling of chemicals and construction materials, checking for leaks and spill of oil and chemical products, proper waste management, proper training of workers for storage and handling of materials on construction sites and contractor camps.

Soil compaction:

- Restriction of machinery and vehicles to designated areas.
- Monetary compensation of affected households for foregone production during the construction phase.
- Restoration of the original soil structure of the cultivated land, which could involve ripping and deep plowing.

Land Use

Potential Impacts: Land Acquisition: Land will be needed for the construction of the Kaitu weir , feeder tunnel and Powerhouse, canal networks, associated structures, roads and borrow pits for aggregate and rocks (near Spinwam). Later, land will also be required for tertiary canals, water courses, drains, feeder roads and on-farm development. The development of new irrigation systems may also cause land fragmentation of local farms. This may lead to the need for new farm buildings and houses. In the Sheratalla command area, existing irrigation facilities (six dug wells) could also be affected. The construction of the Spaira Ragha canal will cause require displacement of built up areas in Datta Khel just 0.5 km south of the Kaitu Road bridge and again at 2.2 km south of the same bridge. The required permanent land acquisition is an irreversible, significant potential impact.
Land will also be required for temporary structures such as contractor camps, bypasses roads during construction, alternative routes and paths etc. This could affect private land. The magnitude of this potential impact is low; the extent is local and duration is short term as it will only last for the construction stage. Thus the potential impact is assessed to be of low significance.

There will also be some clearing of vegetation, trees, shrubs about 2 km from the Kaitu Weir along the main canal alignment and on various hills for the construction of upper Sheratalla Canal, and a boundary of a house about 3.5 km from the Kaitu Weir along the main canal alignment. In addition, land needs to be cleared for Powerhouse V. This potential impact will have a low magnitude as most of the land consists of barren hills. The extent of this potential impact will be local and the duration will be permanent. The potential impact is assessed to be of a low significance.

Although the temporary land acquisition and acquisition for clearance have been assigned a low significance, the overall potential impact of all land acquisition is assigned a high significance.

Obstruction of nullahs and other waterways: The Spaira Ragha canal and its left minor cross various nullahs at 1, 2, 1.8, 2.5, 3.7, 4 and 4.3 km respectively. In the Sheratalla plain the 1st, 3rd and 7th distributor and respective minors also cross nullahs. The construction of these crossings could cause inundation of cultivated land. This potential impact is of a temporary nature as it will only occur in the construction stage. The potential impact is of low significance.

Mitigation: Land acquisition:

- Prompt and full compensation in the form of alternative irrigated land or payment required for affected private property land before and during the construction phase according and/or provision of support services including timely supply of agricultural inputs and of soft loans. All mitigating measures for land acquisition should be coherent with the measures in the RAP and RPF documents.
- Restriction of machinery and vehicles to designated areas.
- Siting of temporary structures (contractor camps) and borrow areas should take into account existing land use.
- Siting borrow pits on barren land to the extent possible.
- Leasing affected private lands in exchange for financial payments.
- Plantation of trees, shrubs and other vegetation.
- Selection of the Powerhouse site away from any built up area.

Obstruction of nullahs and other waterways: Provision of temporary culverts and drains to evacuate excess water.

Agriculture and Irrigation

Potential Impacts: Hindering of cultivation and interruption of cropping: The construction of the canal networks, roads and associated structures and works (land clearance, excavation, soil fill depots, blasting etc.) may hinder access to fields and markets, disturb agricultural activities and affect cropping in the surroundings of the construction sites. Though intensive agriculture is not being

practiced in the Spaira Ragha and Sheratalla command areas, in the Rabi season some of the wheat crop which is the major crop of the command areas may be affected. The magnitude of this potential impact is low; the extent is local and duration is short term as it will only last for the construction stage. Thus the potential impact is assessed to be of low significance.

Shifting of labor to construction: During the construction phase, a labor force of approximately 500 persons (400 for construction of the weir and about 100 for the powerhouses and ancillary structures) will be required. This will provide employment opportunities to local residents. As a result there could be a shift of local labor from agriculture to construction. The wheat crop could face a labor shortage especially in the harvesting season. This potential impact is of small magnitude as it will cause some foregone production. The extent will be local and the duration will only be for the construction stage. The potential impact is of low significance.

Gender Issues: Women play an important role as labor in the agricultural sector. They help to plant, harvest and process crops, care for poultry and livestock, and help to renovate their homes at least once a year in addition to their traditionally assigned domestic roles. Tribes of FATA are very traditional and conservative. The women may be reticent to carry out their agricultural activities when laborers and project staff are in the vicinity. In addition contact (whether intentional or accidental) between women and project personnel could create social tension if they are perceived to infringe local social mores. Hence the women should be provided special consideration to avoid occurrence of any conflicts between the local residents and the workforce. The magnitude of this potential impact is assessed to be moderate, with a moderate probability and short term duration. Therefore, the potential impact can be categorized as of medium significance.

Irrigation water quality: During construction of the weir, land clearance, blasting and excavation activities could affect the quality of water used for domestic use, livestock and irrigation downstream in the Datta Khel area. The magnitude of this potential impact is low; the extent is local and duration is short term as it will only last during the construction stage. Thus the potential impact is assessed to be of low significance.

Mitigation: Hindering of cultivation and interruption of cropping:

- Restriction of machinery and vehicles to designated areas
- Monetary compensation of affected households for foregone production during the construction phase.
- Preferential hiring of affected farmers on the canal construction crews and on the larger Kaitu structures.

Shifting of labor to construction:

- As labor will be hired from the local area by the Contractor, it is important to have prior consultations with the Maliks of the area in order to make arrangements for the required labor.
- The extent of foregone production is not known. However, given the very low use of labor other than family labor as an input into agriculture it is likely to be very low. In addition earnings from construction activity will compensate for the foregone production. Therefore no additional mitigation is required.

Gender Issues: Contractors need to ensure that labor is restricted to their work areas and the construction camp and/or residential colony. The Contractor should also ensure that all personnel are aware that infringement of these requirements will result in disciplinary action.

Irrigation water quality:

- The contractor must ensure that the site specific waste management plan that will be a contractual requirement is fully compliant with the framework Waste Management Plan presented as an annex to the EMMP, and the mitigation measures for waste management described below are implemented and strictly adhered to minimize any pollution of the river.
- For drinking water, dug wells could be constructed, since groundwater is commonly safer and more hygienic than river water. However, the quality of any well that is constructed as a compensation measure must be checked for compliance with Pakistan NEQS for Drinking Water (Appendix 9.3-8) prior to its being made available to affected persons. This would be an investment in permanent structures.

Waste Management

The major types of waste generated by the KTDP will be as follows:

- Domestic and other general waste (food scraps, packaging, rags etc.).
- Waste overburden and soil spoil from excavations (including site clearance, grubbing etc.).
- Waste rock spoil from excavations.
- Construction material wastes (timber framing, concrete, rock, gravel, scrap metals, cable, wire, insulation, plastics and packaging).
- Regulated (hazardous) waste (used oils, greases and petroleum products, paints, thinners, glues, chemical resides, detergents, solvents, batteries, tires).
- Drums and containers from supply of chemicals and oils.
- Recyclable waste (aluminum cans, glass, cardboard and paper).
- Scrap metal.
- Soils contaminated by fuels, oils and other petroleum products.
- Medical waste from dispensary.
- Wastewater generated from construction activities e.g. curing etc.
- Sewage effluent and sludge.

Construction Phase Waste Quantities

(a) Domestic Waste:

Based on past experience in Pakistan, the following rates of waste generation are adopted for estimation of waste for the construction phase of the project.

Per Capita Solid Waste Generation = 0.40 Kg/Worker
Per Capita Wastewater Generation = 80 percent of Water Consumption (Water Consumption = 40 gpcd)

The domestic solid waste that will be generated by the two construction camps (one of 400 workers for the weir and one of 100 workers for the tunnel, powerhouse, and ancillary structures of Powerhouses IV; Section 3.2.5.5) are 160 kg/day and 40 kg/day respectively. Domestic waste water generation is estimated at 12,800 gpd and 3,200 gpd respectively.

(b) Construction Waste:

The bill of quantities from the tender documents for Component 1, indicate that 31,707, 685 ft^3 of overburden spoil and 23,729,530 ft^3 of rock spoil will be generated by construction activities. Total fill requirements are estimated to be 176 million ft^3, significantly more than quantities excavated. However, it is not known whether all the excavated material is of sufficient quality to be used during Component 1 construction. It is therefore possible that there could be unusable spoil requiring disposal.

There will also be waste generated from the construction materials that will be used. There is insufficient data to allow accurate determination of the amount of construction waste that will be generated. Construction waste generation rates in a recent study in Shenzen ranged from about 3.3 to 8.8 kg/m^2. Miscellaneous waste, timber for formwork and concrete were the dominant waste components (Lu et al, 2011). In the Netherlands, between one and nine percent by weight of purchased materials ends up as solid waste (Bossink and Brouwers,1996), while studies in Brazil indicated that as much as 20 percent by weight ended up as waste (Formoso et al, 1993). Estimates for concrete and steel reinforcement waste generation during construction based on generation rates of one to nine percent by weight are 5,000-45,000T and 33-300T respectively.

Construction wastewater will be generated from various sources such as curing, soaking of bricks, pilling, etc. As a general rule, water consumed in construction is equivalent to about 40 percent of the total volume of construction material (in cubic meters). Ten percent of the consumed water ends up as construction wastewater. Currently total construction material volumes have not been estimated by component, but only for all three components (891,450 m^3). This means that total volume of water consumed in construction and of construction wastewater for all three components will be about 357,000 m^3 and 35,700 m^3 (about 9,500,000 gallons) respectively
Potential Impacts: During the construction phase the waste there will be multiple sources and stages in the construction process where waste will be generated. These include, *inter alia*, procurement of materials, equipment and machinery, site/vegetation clearance, construction camps, loading and hauling, blasting, cutting and filling, borrow areas, chemicals storage and handling, use of fuel, oil lubricants and other petroleum products, construction of temporary and permanent structures and access roads.

The type of waste generated will include domestic (municipal) solid/liquid waste, runoff (from construction sites, spoil heaps), construction material spoil (excavations, borrow areas), blasting residues, rejected/unused material, wastewater, etc. as described above. The waste generated from construction activities may result in pollution of surface water, ground water, soil and air. As discussed above significant quantities of waste could be generated. Potential impacts are as follows:

- Untreated construction wastewater and runoff from spoil stockpiles entering surface waters will increase sediment loads and therefore turbidity in surface waters affecting downstream users and aquatic ecology. In the case of the Kaitu River, this would affect its designated use for the settlements of Spinwam and Roha. Moreover, natural streams and irrigation channels could become silted up as a result. This potential impact is considered to be of regional extent, highly probable and of high intensity. The potential impact would be long-term if the stockpiles remain after construction. It is assessed to be a significant potential impact.
- Pollution of soils, surface waters and groundwater. There are many possible sources of such pollution. Run-off could be contaminated by inadequately disposed of chemicals, lubricants, oils and other hazardous wastes including blasting residues, uncontained residues from sludge and slurry from batching and asphalt plants, construction wastewater, domestic wastewater from construction camps as well as poorly managed domestic waste dumps and could cause significant pollution of surrounding soil, surface water and ground water. Leachate from waste dumps or poorly managed landfills could contaminate surrounding groundwater. If uncontrolled dumping of waste occurs near surface water, the runoff may enter the water stream and result in surface water pollution. Direct dumping of wastes in surface water bodies will pollute these bodies. The eventual receiving surface water body is the Kaitu River, where degradation of water quality will affect aquatic life, the designated use of water in Spinwam and Roha villages and other downstream users. In the absence of a waste management plan and contractual enforcement of its provisions the potential impacts are considered definite, of regional extent, high magnitude and have legal requirement implications. Continued existence of dumps after construction would imply a medium to long-term duration. As such the potential impact is assigned a high significance.

- Contaminated groundwater and wastewater seeping through the soil profile may water be taken up by the vegetation affecting the health of the consumers (humans and animals). The potential impact is considered to be local, of moderate magnitude and medium term. It is assigned a medium significance.
- Domestic waste disposal sites can be the source of odors, nuisance, and unsanitary and unaesthetic conditions. They may serve as breeding grounds for disease vectors and attract vermin such as rats if not covered properly. Given that the exact siting of such sites and their proximity to inhabited settlements is not known the significance of these potential impacts cannot be assessed with any degree of confidence. However, in general, when disposal sites are close to human settlements the potential impacts are considered to be significant.
- Medical waste may cause hazardous conditions which could negatively affect the health of personnel and medical staff working at construction site and for local residents if they have access to the disposal sites. Potential impacts to construction personnel health would negatively impact worker productivity. These potential health impacts are considered to be local and potentially of high magnitude. The duration is dependent on the type of disease/germ/virus exposure undergone but could potentially be long term. The potential impact is assigned a high significance.
- Sanitation workers may be exposed to pathogens, such as hepatitis viruses, contained in the sewage, and to bacteria in bio-aerosols if they are generated by the treatment process. If members of the general public have access to the water treatment infrastructure they could also be exposed to these pathogens and bio-aerosols. Rats, insects and birds can be vectors for sewage pathogens. This potential health impact is local in extent and potentially of high intensity and magnitude. Duration will depend on the planned life and adequate decommissioning of any wastewater treatment facilities. It is assigned a high significance.
- Deposition of overburden on stockpiles and wind disturbance of the overburden will generate dust, which can be a source of nuisance or even a health hazard to workers or local residents if the stockpiles are close to human settlements. This potential impact is assessed as local and of low to moderate magnitude depending on the degree of exposure of personnel or residents to the dust. The duration of the potential impact will depend on whether stockpiles are temporary or not. Since the location of stockpiles is not currently known the significance cannot be assessed with even a moderate degree of confidence.
- Poorly sited spoil heaps could block natural drainages leading to ponding and stagnation of water and creating breeding grounds for disease vectors. This is a non-significant potential impact.
- Run off with high sediment loads combined with discharge of partially treated or untreated sewage (containing nitrates and phosphates) can cause eutrophication. Eutrophication can lead to a decrease in species diversity and changes in the dominant biota, as well as increases in plant and animal biomass, turbidity and rates of sedimentation increases, thus shortening the lifespan of Kaitu River and other water bodies in the Component 1 area. In extreme cases anoxic conditions could develop in surface water bodies. This is a local potential impact, with a low probability of occurrence and is assigned a low significance.

Mitigation:

- Complete implementation and compliance with all waste management plans shall be ensured.
- Color-coded bins for different types of waste (e.g. paper and cardboard, putrescible wastes, plastics) shall be provided at the construction camp(s) to allow segregation at source. Bins shall be equipped with lids to prevent ingress of vermin and wind-blown litter. The Contractor shall ensure regular emptying of the bins and collection of the waste by designated personnel. Recyclable waste shall be delivered to approved waste dealers (if present in the vicinity. Non-recyclable waste shall be disposed of in the project landfill.
- The project landfill shall be managed according to the following general landfill management principles:
    - Waste must be cover with at least 15 cm of earthen material at the end of each operating day or more frequently if required. Suitable excess spoil should be used for

landfill cover. If insufficient spoil is available, material excavated for a future cell should be used.
  - Routing methane monitoring to ensure methane concentrations remain at less than 25 percent of the lower explosive limit for methane within the landfill, and less than the lower explosive limit for methane at the landfill boundary.
  - No open burning of any wastes in the landfill area.
  - Landfill cells must be capped once they are no longer in use. The final cover must have a permeability less than or equal to the bottom liner or no greater than $1x10^{-5}$ cm/sec whichever is less.
  - The capped cell should be revegetated. Overburden from excavation could be used as a growth medium.
  - Capture and flaring of LFG emissions could be envisaged in function of the quantity of gas produced. However, given the waste generation rates for the project, it is considered unlikely that this will be a viable option.
- Appropriate equipment and machinery must be used by the contractor for waste storage, collection, transport and disposal as per the guidelines of the framework waste management plan proposed in the EA and any future comprehensive waste management plan. Waste transport vehicles must be covered to avoid littering during transport.
- Borrow areas must be marked on ground before commencement of construction and barricaded for restricting unauthorized entrance. The barricaded/marked boundary will help minimize chances of unnecessary/unauthorized excavation so that only required and planned quantities will be removed, thereby avoiding excess waste generation. The quarry management plan must be implemented during the construction phase of Component 1
- Where possible, spoil should be used for site reclamation of site where possible, sold/used in parallel construction activities, or temporarily stored for future use e.g. it may be possible to use overburden from excavations for daily cover and final closure of the landfill. Borrow pits shall be backfilled with unused material.
- Permanent spoil stockpiles should be sited away from natural drainage lines and be constructed in 5 m lifts with material deposited at the natural rill angle of 40°. At completion of a lift, the gradient of the lower lift shall be decreased to 18° with a step sloped at a slight angle towards the upper lift face to control erosion. The aim is to achieve an overall slope of about 16° in order to ensure slope stability. Drainage and erosion control features will be incorporated into the design to enhance slope stability. The dump slopes should be revegetated progressively (if possible) to minimize run off and dust generation. Run off control measures should be implemented. These could include directing run off into cut-off trenches and channeling of the water to silt traps prior to discharge into surface water bodies. The maximum height of spoil dumps should be determined so as to minimize the potential visual impact.
- Waste transport routes designated as such during the design phase must be followed to minimize any disturbance to sensitive receptors along the transport routes.
- Open burning of solid waste shall be prohibited.
- The suppliers of hazardous materials should be required to construct appropriate supply and waste material storage areas as a condition of contract. Alternative less toxic alternatives should be used where feasible. Suppliers should be contractually obliged to take back hazardous substance packaging and containers if feasible. Packaging that cannot be returned to the supplier should be disposed of according to the Hazardous Substances Rules of 2003.
- Oil suppliers should contractually agree to provide collection containers for used oil, develop an appropriate storage area and remove the used containers when they are full. The contract should oblige the supplier to recycle used oils where possible and to dispose of non-recyclable material in an appropriate manner.
- The toxic portions of the waste streams must be treated and disposed of separately and safely according to the Hazardous Substance Rules of 2003. If no suitable hazardous waste disposal facility exists within an economically feasible transport distance, a dedicated hazardous waste cell may have to be developed at one of the project waste disposal sites.

- Soils contaminated by fuel, oil and other petroleum products should be removed and disposed of in an appropriate landfill (or in the project hazardous waste cell should an appropriate landfill not exist).
- Proper systems must be installed for stormwater and leachate management in the vicinity of waste disposal sites to ensure pollution prevention.
- Color-coded waste skips shall be provided for different types of construction waste (e.g. concrete, timber, steel offcuts, etc.) at the construction sites. Maximum efforts shall be made to re-use or recycle such waste in the construction process. Where this is not possible, re-usable and recyclable materials should be made available to approved waste dealers.
- Residues from and/or excess sludge/slurry from batching plants shall not be disposed of directly into surface water bodies, dry river beds, ditches and small undesignated and or local disposal sites. The sludge or slurry shall be collected, and treated to NEQS effluent standards () prior to discharge of any liquid effluent into the environment. Non-reusable or recyclable solid residues should be disposed of in an appropriate landfill.
- Protection of Natural water bodies (Kaitu River) by providing devices to prevent the migration of silt must be ensured throughout the construction period;
- A wastewater treatment unit must be installed at the main construction camps. Wastewater should be treated to meet the NEQS (Appendix 9.3-1) prior to discharge into surface water bodies. Waste from temporary toilet facilities at work crew camp sites must be collected by an appropriate tanker vehicle and transported to the wastewater treatment unit.
- Camp kitchen wastewater conduits shall be fitted with grease traps to allow removal of cooking oils and fats prior to discharge of grey water. If necessary, such water will be treated to comply with NEQS effluent standards (Appendix 9.3-1) prior to discharge.
- Waste and sanitation personnel must be issued with the appropriate PPE. In addition, the Construction Contractor should ensure that these personnel are vaccinated against pathogens likely to be encountered in the waste stream.
- Medical waste should only be disposed of in special containers (such as sharps disposal containers) and transported to an appropriate facility for incineration.

5.2.2.2 Climate and Climate Change

Construction of Component 1 is not expected to bring changes to the local or regional climate.

5.2.2.3 Air Quality

Air quality is likely to be adversely affected by KTDP Component 1 construction. Several types of emissions are expected, including:

- Gaseous emissions due to movement of construction machinery;
- Fugitive dust emissions due to movement of machinery on dirt tracks, construction of roads and excavation of borrow areas;
- Dust emissions due to blasting activities during tunnel construction; and
- Particulate matter emissions during the operation of concrete batching plants and asphalt mixing plants.

These emissions are described in the following sections.

<u>Gaseous and Fugitive Dust Emissions:</u> During the construction work to be carried out in Component 1, a variety of machinery will be required. Machinery will consist of cranes, dump/haul trucks, excavators, vehicles, etc. Machinery to be used in the field, as suggested by the Construction Expert in EA team of consultants, for Component 1 is presented in the Table 5-8. It is expected that the same machinery will be used in the other two KTDP components. Since most of the machinery will use diesel as fuel, emissions will mainly consist of carbon monoxide (CO), dust, smoke, particulate matter (PM), nitrogen oxides (NO_x) and Hydrocarbons (HC).

Table 5-8: Types and Estimated Numbers of Construction Machinery – KTDP Component 1

Sr. No	Types of Vehicles	Number of Vehicles
1	Excavator	20
2	Dumper	50
3	Dozer	10
4	Batching Plant	5
5	Transit Mixer	30
6	Concrete Pump	5
7	Mobile Cranes	10
8	Loader	15
9	Shot-Crete Machine	5
10	Rock Bolter	5
11	Jack Hammer	20
12	Roller	10
13	Drill	10
14	Ventilation Blower	5
15	Grouting Machine	5
16	Aggregate Crushing and Screening Machine	5
	Total Number	**210**

Source: Construction Expert – EIA KTDP Team

Most of the above machinery (excluding the batching plants and aggregate crushing and screening machines) will move around during the construction period. The USEPA compilation of Emission Factors (AP-42) is used for estimation of CO, HC and NO_x emissions. For the KTDP, emission rates for heavy duty diesel vehicles at high altitude are used (USEPA, AP-42 Compilation of Air Pollutant Emission Factors, Appendix H of the NESPAK Supplemental Report on Air Quality**)**. Emission rates were then used to calculate an estimated value for the total emissions of HC (3.19 tons/year), CO (12.76 tons/year) and NO_x (4.41 tons/year) emitted annually for Component 1 construction.

Fugitive dust will be produced by earth moving activities, excavation, haulage, heavy machinery movement and construction of roads. The existing roads to be upgraded are Mir Ali-Thal road, and the road from Mir Ali to Spinwam. A new access road will be built from Spinwam to the main dam, and a part of the Mir Ali-Thal road near Shewa Post will be relocated. Fugitive dust emissions are a function of silt content of dirt tracks, vehicle speed and the mean annual number of days with 0.01 inches or more of rainfall. Using the empirical relationship defined by Canter (1996), the emission factor for fugitive dust comes out to be 7.21lbs/vehicle-mile (3.28kg / vehicle-mile). That is, each vehicle moving on dirt track with a speed of 30 mph will produce 7.21 lbs of fugitive dust for each mile traveled. As there are estimated to be a total of 200 pieces of construction machinery (excluding the batching and screening plants) in KTDP Component. Thus, total fugitive dust emissions are approximately 2,154 tons/year.

Gaseous and fugitive dust emissions will result in an potential impact of medium significance, due to their moderate magnitude, relatively small duration (less than five years), and localized geographic impact area. Gaseous and fugitive dust emissions will affect the people living in Bobali, a settlement about eight miles (as the crow flies) southwest of the Kaitu Weir, and the construction laborers working in the Component 1 area. Moderate levels of vehicular emissions tend to cause lung irritation, shortness of breath and increase a person's susceptibility to asthma. These emissions will also cause problems to the workers constructing the new access road from Kaitu Weir to KTDP Dam site. Potentially, the people of Spinwam and Rocha will be directly impacted by the presence of borrow areas near their settlements. Daulat Narai will be affected by construction of Powerhouse IV

and another minor settlement, Mirkhankel, will be affected by construction of the Sheratalla Canal. Adverse potential impacts will include reduction in visibility and respiratory disorders.

Dust Emissions due to Blasting: Dust emissions will result from blasting to create a tunnel that diverts water from the Kaitu River towards the Kurram Tangi Reservoir. The potential impact can be evaluated as of medium significance due to its short duration and close proximity to the settlements in Spinwam and Rocha. It will have an intense potential impact on the laborers working at the construction site.

Particulate Matter Emissions from Concrete Batching: Concrete batching plants will be a major source of particulate matter emissions. PM_{10} emissions from batching plants, calculated using the empirical approach formula provided by the National Pollutant Inventory (NPI) (Environment Australia, 1999), are about 5.87 tons/year for a single concrete batching plant. As five concrete batching plants will be required in Component 1, total PM_{10} emissions equal 29.36 tons/year.

Concrete batching plants produce particulate matter emissions that are detrimental to health. These emissions accumulate in the respiratory system and can lead to decreased lung function, respiratory disease and even death. Since five concrete batching plants are to be set-up in Component 1, the magnitude of potential impact is moderate and the duration of the potential impact is limited to the construction period. Overall, the potential impact is of medium significance. The population in Bobali and smaller populations in Spinwam and Rocha may be affected. While Spinwam and Rocha are sparsely populated, they are located very near the Kaitu Weir. Direct potential impacts would be encountered by the construction workers in close proximity to the batching plants.

Mitigation: Ambient air quality monitoring will help ensure that pollutants do not exceed NEQS limits (Appendix 9.3-3). In addition, the following mitigation measures will be implemented to minimize the release of gaseous and dust emissions associated with KTDP Component 1.

Reduction in Vehicle and Machinery Emissions: Tuning of KTDP vehicles will be mandatory to reduce the emissions of NO_x, SO_x CO, HC and PM. Tuning will be done after vehicles travel a total distance of about 1250 mi (2000 km). All vehicles will be required to carry a fitness certificate. Vehicles and machinery that use diesel will be well maintained to minimize particulate emissions. Maintenance will include changing the lubricating oil, changing the air and fuel filter, bleeding the fuel system and draining the water separators.

Reduction of Dust during Tunneling: Ventilation systems (including fans) should be used to evacuate air with potentially high dust levels. Portable dust monitors should be used to continuously monitor dust levels during tunneling. Where dust levels exceed NEQS permissible limits additional mitigation measures such as the use of respirators by workers should be implemented.

Reduction of Dust Emissions: Dust emissions will be reduced by regular sprinkling of water. Sprinkling will take place every three hours during daylight hours and every six hours during night time throughout the construction period. Sprinkling will be done on access roads, tracks frequently used by vehicles, construction zones and material storage areas. Haul trucks carrying earth, sand, aggregate and other materials will be kept covered with tarpaulins to contain the construction materials.

5.2.2.4 Noise

Potential Impacts: Use of heavy machinery (Table 5-8) and activities like blasting during construction of the tunnel that diverts water from the Kaitu River towards the Kurram Tangi Reservoir will result in high noise levels, may cause headaches, fatigue, difficulty in communication and temporary loss of hearing. High noise levels will adversely affect the onsite labor and disturb those living in Bobali, which is about eight miles (as the crow flies) southwest of the proposed Kaitu Weir. Excavation work along the Sheratalla and Spaira Ragha canals and movement of machinery will

create persistent noise along the Thal-Mir Ali road during its upgrade and during the construction of the new access road from Kaitu Weir to Kurram Tangi Dam. Potential noise impacts will be moderate in magnitude and temporary (less than five years), affecting the labor working on construction sites, people residing in Bobali (the only major settlement in the Component 1 area), Mirkhankel (a minor settlement that will be affected during construction of Sheratalla Canal), Daulat Narai (a minor settlement that will be affected during construction of Powerhouse IV), Spinwam and Rocha (minor settlements that will be affected during construction of Kaitu Weir). The overall potential impact will be of medium significance.

Mitigation: Quarterly noise level monitoring will help ensure that noise levels do not exceed NEQS limits (Appendix 9.3-9) applicable to the type of area in which mitigation is being implemented In addition; the following mitigation measures will be implemented:

- Use of machinery that complies with NEQS standards (Appendices 9.3-4 to 9.3-7);
- Standard operating procedures will be prepared and implemented by the contractor, such as public notices of date and time for blasting, the number of blasting events, announcement of blasting in the field, etc.;
- Installation of devices to reduce noise levels, such as walls or earthen walls where construction sites are near settlements;
- Limit movement of construction machinery to the day time, so that disturbance due to noise is limited to that time only;
- Construction machinery will be tuned, lubricated and maintained on a routine basis;
- Labor working on site will be provided with ear muffs/ear plugs; and
- The labor will work in 10-hour shifts to avoid permanent hearing loss.

Adopting the measures above will diminish the magnitude of potential noise impacts, making it an issue of low significance.

5.2.2.5 Water Resources

Hydrology

Potential Impacts: Construction of weir will have an unavoidable potential impact to the morphology of the river in the immediate vicinity of the Kaitu River because of the staged diversion of river during construction. Amount of river flow downstream of the weir will not change. However, excavation of river banks will potentially impact on the downstream river water quality, in the form of increased sedimentation resulting from construction activities.

Mitigation: The change in hydrology and morphology of the Kaitu reservoir area will not be mitigated and is a residual potential impact of the project. Mitigation of other potential impacts caused by the inundation of the reservoir is discussed under the land resources, biological resources, water quality and socio-economic potential impact sections of this chapter.

Water Quality

Potential Impacts of Kaitu Weir: During the construction of the Kaitu Weir, debris and activities such as excavating the river bed will result in slope instability and scouring that deteriorates the water quality of the Kaitu River. Total suspended solids (TSS) and turbidity will likely increase in the construction area and downstream.

The movement of construction machinery and vehicles will generate fugitive dust emissions (see Section 5.4, Air Quality, for additional information) that will be deposited in the Kaitu River and deteriorate water quality. Fugitive dust and erosion will also be generated by construction of new access roads, upgrading of the existing Mir Ali-Thal road and rehabilitation of the Spinwam Bridge.

According to the Detailed Design Report (KTDC, 2004; Chapter 2 related to Hydrology and Sedimentation), the Kaitu-Kurram Feeder suspended sediment load will equal 0.828 MST/yr. The

fugitive dust emissions in Component 1 and particulate matter emissions from concrete batching plants are estimated to be 2,154 tons/yr and 29.36 tons/yr respectively. The magnitude of deterioration in water quality is assessed to be high. Moreover, blasting will take place for creation of a tunnel that diverts water from the Kaitu River towards the Kurram Tangi Reservoir; nine km of the Thal-Mir Ali road will be upgraded; and a 16 km of new road will be constructed from Kaitu Weir to Kurram Tangi Dam, generating high levels of suspended particulate matter in the area. Water quality pollution due to construction materials and excavation will have long term effects on the entire region. However, since the Component 1 area is sparely populated, only the two minor settlements namely Spinwam (at a distance of 0.34 km from the Kaitu Weir) and Rocha (at a distance of 0.61 km from the Kaitu Weir) will be directly affected. Water from the Kaitu River will not be useable without treatment for several km below the weir.

For the construction of the Kaitu Weir a cofferdam is proposed. The proposed river diversion scheme is staged into two phases. A temporary embankment will act as a dam in each stage (see Section 3.2.5.4). The first stage will lead to the construction of the undersluice portion. An embankment will be constructed across the section of the river to the left of the delta. The flow would thus be diverted to the right of the delta, within the natural river. After construction of the undersluice, the temporary embankment will be reconstructed to close the natural river path, and the flow redirected through the undersluice. The temporary embankment will be demolished upon completion of the weir and a sediment excluder constructed. A permanent river training embankment joining the right guide wall of the Kaitu Weir would provide necessary river diversion during construction. This embankment would also offer road access. The cofferdam will be constructed twice and demolished twice (first right then left). This will alter the flow regime of the Kaitu River, affecting water quantity, water quality, and the river ecosystem.

Cofferdam failure could result in water coming into contact with potentially hazardous materials in the work area (e.g., fuels, oils, solvents, uncured concrete) and being transported downstream, as well as jeopardizing workplace safety.

Based on the items described above, construction of the Kaitu Weir will have a significant potential impact on water quality.

Mitigation Measures for Kaitu Weir: The following mitigation measures will be adopted to control/minimize potential water quality impacts:

- The Contractor will instruct its staff not to throw waste or scarified/scrapped materials into the Kaitu River.
- A rip-rap floor will be provided to control scouring downstream of the Kaitu Weir.
- Mitigation measures specified in control of air pollution, such as coverage of haul trucks with tarpaulins and regular sprinkling of water will keep dust settled and minimize potential impacts on water quality (see Section 5.4.1.2).
- Where dust emissions are high, katcha tracks (un-metaled) will be overlain with shingle or otherwise treated.
- Quarterly monitoring of water quality will be conducted. The locations from where surface water quality samples are to be taken during the construction stage have been marked on Map No 4-32.
- Turbidity curtains will be used just downstream from the cofferdams during construction. This will include the use of type 3 silt and turbidity curtain, which are robust floating barriers designed for fast moving water. These are apt for use in silt control during dredging activities, demolition projects and high flow construction.
- Considering the potential negative environmental impacts of a cofferdam failure, the integrity of its structure is of utmost importance therefore, a dam break study needs to be carried out before the construction of a cofferdam.
- The Contractor will ensure weather forecasts are favorable before the installation and removal of cofferdams to prevent runoff due to heavy rainfall.

- Water will be treated at Spinwam and Rocha before it gets to the end user.

Adopting the mitigation measures described above will reduce the magnitude of the potential impact and, in turn, reduce its overall significance to medium.

Potential Impacts of Powerhouse IV: The water for the construction activities for Powerhouse IV will be taken from the Kaitu River. During construction, water quality deterioration is likely if construction debris is disposed in the Kaitu River. Moreover, due to the proximity of the Thal-Mir Ali road (to be upgraded) and borrow areas, particulate matter suspension will be common. The magnitude of the potential impact is assessed to be high and duration of the potential impact short term.

Water pollution will be concentrated in and around the Powerhouse IV site during construction, affecting the water supply for the minor settlements of Daulatnarai (0.48 km from Powerhouse IV) and Spinwam (1.32 km from Powerhouse IV). Thus, based on the high magnitude of potential impacts, but small population affected, the potential water quality impacts of Powerhouse IV will have a medium significance.

Mitigation Measures for Powerhouse IV: Mitigation measures will be similar to those for the Kaitu Weir in addition to treatment of water supply at Daulatnarai and Spinwam.
Potential Impacts of Powerhouse V: During the construction of Powerhouse V, water quality deterioration is likely to result if debris is dumped into the stream. Deterioration is also likely to result from particulate matter suspension from the Miranhshah-Thal road settling into the nearby stream. This will directly affect water supply for the minor settlement of Ibrahimkhel 3.06 km downstream of Powerhouse V. This stream joins another stream and flows into the Baran Reservoir. Baran Dam, which is already adversely affected by sedimentation, could potentially be further impacted by Powerhouse V construction sediment. Overall the potential impact is assessed to be medium in significance, because it has a moderate magnitude and a local extent.

Mitigation Measures for Powerhouse V: Mitigation measures will be similar to those for the Kaitu Weir along with treatment of water supply at Ibrahimkhel.

Potential Impacts of Spaira Ragha Canal: During construction of the Spaira Ragha Canal, the potential impacts on water quality will be minimal. There are very few surface water bodies in the vicinity of the canal.

Water pollution may be generated by excavation material and concentrated on the construction site. Construction debris/spoil dumped into the Kaitu River would (if allowed) affect water quality at the point of dumping and downstream of Spaira Ragha. The overall potential impact has a low magnitude and a regional extent and is evaluated to be of low significance.

Mitigation Measures for Spaira Ragha Canal: Mitigation measures will be similar to those for the Kaitu Weir.

Potential Impacts of Sheratalla Canal: The proposed Sheratalla Canal is about 16 miles and it intercepts two streams. Construction will degrade the water quality of these two streams downstream of their junction with the canal, affecting Ibrahimkehl (minor settlement), Gharipal (minor settlement) and Bobali (major settlement). Construction could include dumping of debris in these streams (if allowed), along with particulate matter emission and suspension from upgrading the Mir Ali-Thal road that also intercepts the canal at two points. The magnitude of the potential impact can be regarded as moderate and the extent regional. Overall the potential impact is assessed to have a medium significance.

Mitigation Measures for Sheratalla Canal: Mitigation measures for the proposed Sheratalla Canal will be similar to those proposed for the Spaira Ragha Canal in addition to treatment of water supply at Gharipal, Ibrahimkhel and Bobali.

5.2.2.6 Biological Resources

Terrestrial Ecosystems

Potential Impact: Disturbance of fauna: The noise and movement of construction will effectively drive any wildlife from the area, with the possible exception of crop pests, which are accustomed to some human movements in their habitat. The larger mammals, such as foxes, jackals, porcupines, and wild boar, will probably move to other irrigated lands in the Spinwam region. The town has a large area of irrigated cropland to the north, in which some of these species are considered pests. The cropped area near the Weir is too small to support many of these mammals. Similarly, those bird species that visit croplands are likely to be scared off by the bustle of construction and will visit other agricultural areas. The potential impact on fauna is short-term, local, of low magnitude and highly probable. It is assessed as non-significant and does not require mitigation.

Pests and scavengers: The construction camp may attract rats and other scavengers, as well as their predators if kitchen waste is poorly disposed of, even if waste dumps are fenced. Since local residents consider wildlife species as game, they could hunt the predators or any larger mammals that might approach the camp. The cooks at the construction camps may keep poultry, which will attract mongooses, cats, and foxes, placing these animals at risk of being shot. This is a local, short-term, probable potential impact of low magnitude. It is non-significant.

Vegetation and Habitat Destruction: Unnecessary damage to vegetation and habitat could occur during road building, camp construction, excavations, spoiling and other construction activities. This is a local, short-term, probable potential impact of medium magnitude. It is assessed as medium significant.

There are no threats likely to any endangered, rare and threatened species and no endemic species in the Component 1 area.

Mitigation: Pests and scavengers: Despite the non-significance of the potential impact, the following measures should be implemented for the protection of wildlife during construction:

- The use and carrying of firearms shall be prohibited (except for those security personnel who are required to carry firearms). This will both protect what little wildlife is left in the area, and avoid accidents involving injury or loss of human life.
- Hunting of wildlife by personnel and in particular survey, canal and road crews shall be prohibited.
- Fence the camp and domestic waste disposal areas to exclude wildlife.
- Train all personnel including security guards to respect wildlife (snakes, mammals, birds).

Vegetation and Habitat Destruction:

- Minimize unnecessary destruction of vegetation and habitat by restricting clearance for construction areas to the minimum required to carry out the work efficiently. Areas to be cleared shall be clearly demarcated prior to the start of clearance.
- Revegetate cleared areas once they are no longer needed for construction activities.
- Store cut brush for public use (as opposed to burning)
- Prohibit cutting of fuelwood by personnel and especially canal and road crews.
- Canal and road crews shall be provided with fire wood by the Contractor.
- Prohibit the dumping of excess asphalt, fuels and solvents.
- Train supervisors and workers to respect habitat

Aquatic Resources

Potential Impacts: The construction of the off-take regulators for the irrigation canals to the Sheratalla Plain, the Spaira-Ragha Plain and Powerhouse IV will result in some temporary localized increase in turbidity in the Kaitu. However, by far the greatest potential impact will be the construction of the weir. That will result in the permanent loss of aquatic habitat in the portion of the Kaitu River occupied by the weir, itself, and potential impacts resulting from borrow area activities near, or in, the river.

Removal of borrow materials from areas on the banks of the river, and especially in the river, will result in adverse potential impacts on the aquatic biota at the site of the weir and downstream for an unknown distance. Increased sedimentation in the Kaitu River will result from removal of these materials and from the placing of cofferdams. Cofferdam placement usually takes place during a period of low flow and the project schedule is usually developed with this objective. This increase in sediment loading in the river will be temporary, but would be during the time when it would be most damaging to fish and benthic macroinvertebrates because of lack of dilution.

Additionally, in the course of working in the dewatered area, the contractor will have to pump out seepage water. Most likely this will contain various contaminants, oils and greases, sediment, and solvents, which will be pumped into the downstream flow of the river. These will adversely affect fish and macroinvertebrates on a temporary and intermittent basis.

Removal of gravels in the river bed will result in substantial long-term destruction of aquatic habitat. The loss of habitat will be more significant in riffle areas than in pools, and more significant downstream of the weir than upstream. The upstream habitat will eventually be inundated by the weir impoundment which will change the habitat from riverine to lacustrine. The loss of riffle habitat can be significant, not only because riffles are the preferred habitat of most benthic macroinvertebrates that form the base of the food chain for the fish fauna, but also because they are the preferred habitat of *Glyptothorax kashmirensis*, a Species of Concern (Section 4.7.3.2). *Garra gotyla*, a Representative Important Species in the Kaitu (Section 4.7.3.1), is also associated with riffle habitat. (The bases for designating the Species of Concern and the selection criteria for Representative Important Species are described in Section 4.7.3.) The degree of significance of this potential impact will depend on the extent of habitat loss. A small loss of riffle habitat loss downstream of the Weir will likely be of only minor significance; larger amounts may be of moderate significance.

Glyptothorax kashmirensis is usually found only in riffle areas (Kullander *et al*, 1999 and Annexure I of Annex IV in the EMMP). Although it was not collected in the Kaitu River during the 2013 fish sampling efforts (the sampling site near Spinwam was a pool), *Glyptothorax kashmirensis*is was collected in Kurram River riffle habitat near the Kurram Tangi Dam site and can be expected to be present in the riffle areas in the vicinity of the Kaitu Weir. *Garra gotyla* is reported by Baloni (1980) as dependent on a stony bottom, as occurs in riffle areas. However, it was collected in the pool habitat at Spinwam and apparently is not dependent on riffle habitat.

Assuming the extent of riffle habitat loss is small, neither *Glyptothorax kashmirensis* nor *Garra gotyla* are anticipated to be significantly adversely impacted by the construction of the Kaitu Weir. Golden Mahseer, *Tor putitora* (a Species of Concern) and *Labeo dyocheilus* (a Representative Important Species) found in the Kaitu River (Section 4.7.3.1) are also not anticipated to be adversely impacted by the construction of the Kaitu Weir. These species are found in a variety of aquatic habitats, including the pool habitat at Spinwam.

Mitigation: The logical means of mitigating the potential effects of seepage pump-out is to lagoon the water and let the sediments settle out. The lagoon need not be large, equivalent to a couple of days of seepage flow, with allowance for rainfall. It could be provided with a few baffles, so that the inflow does not disturb the sediment. The overflow would then return to the river.

The increase in sediment load to the Kaitu River can be reduced. Obtaining borrow materials from the bank areas of the river should be given priority over gravel mining in the river bed. Silt fencing can be used to reduce runoff in the areas of removal of borrow materials on the banks. When the need for in-river borrow material cannot be avoided, borrow areas upstream of the weir site should be utilized in preference to areas downstream of the weir. The use of borrow areas downstream of the weir site should be minimized, avoiding or minimizing the use of gravels in riffle areas, to the extent possible.

5.2.2.7 Socio-Economic Environment

Potential Impacts: During construction in-migration (outlined in Section 5.2.1.4) will continue, as will economic dislocation, which and may even increase in magnitude as the land earmarked for the project is finally physically taken and no longer available to the local people. One of the key challenges is that replacement land will only be available after the end of construction, which is scheduled to take three to four years, which means a food-supplement program or its cash equivalent will be required.

In addition, the presence of construction workers and security personnel, the increased level of interventions of the Pakistan security services as well as a generally increased interest in the region will reduce the level of semi-autonomy of the local tribes and might conflict with local land use patterns (poppy cultivation, informal trans-border trade, hospitality to (ex)combatants from Afghanistan etc.) and cultural norms (Pastunwalli, Sharia laws, FCR etc.) This is a significant potential impact.

The establishment of the new canal command areas (CCA) by the Department of Agriculture entails the risk that those affected by land acquisition and those living in the project area are not provided with new land and/or considered as priority beneficiaries in the land allocation process. There are numerous examples where local and/or regional elites and the military used the allocation of land to either establish large landholdings for themselves and/or to invite other populations into conflict zones to change the ethnic balance in the area and/or to extend the area controlled by the Pakistan Government into semi-autonomous regions such as the FATA. This potential impact is considered to be of high significance.

A potential impact is that some cultural heritage sites could be discovered during the construction of the weir, the roads and in particular the canals. Unmitigated this would result in the loss of cultural heritage. When mitigated, the risks could have operational impacts as rescue excavation tends to stop or slow down construction work and therefore might increase the length of time until the land in the CCAs can be allocated and used. This is a less significant potential impact.

There will be an influx of construction workers (in all a staff of about 500 is required) and security personnel, who may carry certain diseases to which the local communities are not immune. In turn, the construction workers might not be immune against certain diseases that are endemic, such as polio (FATA is a hotspot for this disease), cutaneous leishmaniasis and diphtheria.

The construction contractor is responsibility for establishing a health unit to treat minor illnesses of the construction crew with an ambulance at standby to transport medical and surgical emergencies to the relevant health care facilities. The staff at the health unit is usually not adequately trained to tackle emergencies, especially the surgical emergencies, while it is a known that efficient and timely first aid reduces fatalities. So the potential impact might be that due to insufficient preparation, the number of fatalities and injuries is unreasonably high. In the absence of mitigation this is a significant potential impact

Mitigation: The RAP provides comprehensive compensation and livelihood restoration measures to mitigate the impoverishment risks associated with the long duration between land take and provision of replacement land.

The VTP addresses issues related to the temporary influx on non-tribal people and provides a comprehensive set of mitigating measures.

To assure the priority access of project affected people and other people from the project area to the land allocation in the Spaira Ragha and Sheratalla CCAs, as early as possible a well-defined land-allocation process needs to be established in close consultation with all stakeholders to a level that it obtains the free, prior and informed consent of the tribes having or claiming ownership to the territory in and around the two CCAs.

The Cultural Heritage Preservation Plan (CHPP) outlines detailed late find procedures to assure that no valuable cultural heritage site is destroyed and all valuable sites surveyed through rescue or full blown excavations.

The construction crew shall be requested to present appropriate heath certificates before being allowed to enter the construction camp. Disease data shall be maintained centrally by the Contractor's Health, Safety and Environmental Department (as proposed in the EMMP) and should be monitored regularly in line with the Contractor's Site Specific Environmental Management Plan.

The construction workers including survey teams shall be offered the opportunity to be vaccinated against possible occurring diseases and offered free of charge other prophylactic measures to control transmission of vector-borne diseases such as malaria, dengue and cutaneous leishmaniasis. This may include bed-netting, monitoring for small impoundments in the construction worker's camps, spraying to destroy mosquitoes and other insects such as sand flies and other vectors.

Health and Safety training shall be mandatory during induction and once every four months to make the project personnel aware of the possible diseases and to educate them about the measures to control transmission of diseases such as polio, HIV/AIDS and other STDs.

5.2.2.8 Roads and Bridges

Potential Impacts: Deterioration of Air Quality: Air quality is most likely to be adversely affected during the road construction phase. Several types of emissions are expected such as fugitive dust emissions and gaseous vehicular emissions (see Section 5.2.2.3 for further details).

Fugitive dust will mainly be produced due to earth moving activities, excavation, haulage and other heavy machinery movements during the construction of roads. Fugitive dust emissions will be more of an issue if new roads are to be constructed. Some of the settlements that will be affected by construction and rehabilitation of roads will include Bobali, Spinwam, Zarwam, Mir Ali, Walikhel and Rocha, Minakot and Mirzagul.

A variety of machinery and equipment will produce vehicular emissions. Since most of the machinery and vehicles will use diesel as the basic fuel, the emissions will mainly consist of carbon monoxide (CO), dust, smoke, particulate matter (PM), nitrogen oxides (NO_x) and Hydrocarbons (HC). Vehicle emission will be a problem for all the roads especially for the Mir Ali – Thal Road since it will be used most frequently.

Air pollution can be evaluated as having a moderate magnitude for a short term, that is, it will mainly be a problem during the construction of the roads therefore on the whole it can be stated to be of medium significance.

Noise Pollution: Noise will mainly be an issue during the road construction and upgrading period. Use of heavy machinery and equipment during construction will result in high noise levels. Blasting of rock will cause sudden extreme noise levels of short duration.

Construction noise has the potential to cause headaches, fatigue, difficulty in communication and temporary loss of hearing. Persistent noise levels will adversely affect the onsite labor and will cause

disturbance to those residing in Bobali, Gumatti, Spinwam, Shewa and Bannu amongst others. Long term exposure to excessive noise levels will result in permanent hearing loss. If new roads are constructed they will cause more noise pollution because these are the new proposed roads.

Fauna may also be adversely affected by construction noise. Excessive noise levels in sensitive areas during breeding season may potentially impact on local animal populations.

Therefore, noise pollution can be regarded as having a medium significance potential impact of moderate magnitude and it will mainly be a problem during the construction period (less than 5 years). Moreover, it is considered as having a local potential impact that is, within the vicinity where construction is taking place.

Blasting Vibrations: If blasting takes place in the vicinity of residential areas and other buildings, blasting vibrations could cause damage to buildings. The potential impact is local, probable and short term, but potentially of high magnitude. For the affected households and or building owners this is a significant potential impact.

Erosion: As the soil in the Project Area is fragile and neogenic in nature, soil erosion, sloughing and land sliding may occur as a direct result of construction of new roads. This will be a major problem for road works on a hilly terrain which could involve more cutting, excavation and other civil work. The magnitude of the potential impact is assessed to be high and of long term duration. Therefore based on the recipients and above stated factors the significance of soil erosion will be high.

Water Pollution: Water pollution will result as a consequence to construction and upgrading of roads. Run-off from roads is a major source of water pollution. It tends to carry pollutants such as gasoline, motor oil, heavy metals, sediments and trash. This can affect the ground water quality as well as surface water bodies especially those underlying a bridge. Rehabilitation of Road A and will affect the Kaitu River.

Bridge construction may potentially impact on the water ways. Sediment will be stirred up when constructing abutments and piers. Culverts may require temporary nullah diversions.

There is a possibility that some rivers and nullah will need to be traversed with heavy equipment. Spinwam Bridge has been identified as one site. It has been proposed that a concrete ford will be constructed adjacent to the Spinwam Bridge. This introduces a risk of concrete spilling into the water way during construction. River crossings without a concrete ford will cause vehicles to discolor the water way with silts dislodged from the bed of the waterway and material washed off of the vehicles.

On the whole this can be regarded as being a medium significance potential impact with a moderate magnitude with regional affects but for a short duration, that is during the construction and rehabilitation of these roads.

Road Safety: The increase in traffic due to construction will be significant compared to the current traffic volumes. A detailed logistics study to determine the time, type and number of vehicles is required to quantify the potential impact of the increase in traffic. Local traffic is unlikely to be familiar with sharing the road with so many large vehicles. The problem is more significant where the roads are narrow and the modes of transport varied, i.e. horse and cart, pedestrian, motorbikes, droving of livestock, etc. Travel through villages will be one of the most critical areas.

Road condition can play a part in road safety. Poor condition roads can result in sudden direction changes from vehicles avoiding holes in the road. Where stock is kept near the roadside unfenced and untethered there will be an accident risk. The risk to road users is significant with the potential of fatal accidents.

Travel Disruption: Road construction is likely to cause disruption to local traffic through delays at construction sites and detour routes. Where the mode of travel is slow and the detour long this will have a significant potential impact on local residents affected by the detour.

Gender Issues: This is a very conservative society where women are required to be very private and have strict etiquette on any form of communication with men outside of their family. The risk is that workmen from outside the area will not understand or follow local customs and cause offense that may result in repercussions. The risk is greatest in settlements.

Mitigation: Air Pollution: Air pollution can be reduced by adopting the following mitigation measures (refer also to the measures in Section 5.2.2.3):

- Tuning of KTDP vehicles will be mandatory to reduce the emissions of NO_x, SO_x CO, (HC) and PM. Tuning will be done after the vehicle has travelled a total distance of about 1250 miles. All vehicles will be required to carry a fitness certificate.
- Equipment and vehicles that use diesel will be well maintained to minimize particulate emissions. Maintenance will include changing the lubricating oil, changing the air and fuel filter, bleeding the fuel system and draining the water separators.
- Dust emissions will be reduced by regular sprinkling of water, which will keep the dust settled. Sprinkling will take place every three (03) hours during daylight hours and every six (06) hours during night time throughout dry periods during construction. Sprinkling will be done on access roads, tracks frequently used by vehicles, construction zones and material storage areas.
- Haul trucks carrying earth, sand, aggregate and other materials will be kept covered with tarpaulins to contain the construction materials.
- The road surface will have a large potential impact on the amount of dust emissions; therefore all main roads that will carry construction traffic will be metaled.

Reduction in Noise Levels: Noise levels can be reduced by implementing the following measures:

- Reduction in noise levels can be achieved by installing noise barriers as a wall or earth wall, where the construction site is near settled areas or sensitive habitats.
- Limit movement of construction machinery and equipment to day time so that disturbance due to noise is limited to that time only.
- Construction machinery and equipment need to be tuned, lubricated and maintained on a routine basis so that noise due to wearing out can be reduced.
- Care will need to be taken when carrying out construction within sensitive habitats. The use of explosives may need to be limited.
- When blasting activities are to take place near populated areas, locals are to be notified of the activity and times to prevent anxiety or panic when the blasting occurs.
- Construction vehicles should always have appropriate exhaust systems to minimize noise. Allowable engine noise levels are set in PEPA NEQS (Appendices 9.34 to 9.3-7).
- Monitor noise levels on site.
- Long term exposure to high levels of noise will cause permanent hearing loss so workers using machinery will be required to wear hearing protection.

Blasting Vibrations:

- The contractor should carry out dilapidation surveys of houses and buildings within a radius of 500 m (or as decided upon by the supervising engineer) of blasting sites prior to blasting.
- Any buildings suffering damage due to blasting activities shall be reinstated by the contractor to the satisfaction of the building's owner and supervising engineer.

Prevention of Erosion:

- Structures such as gabions will be constructed. Their exterior is formed by modular wire mesh containing locally quarried stones. Gabion check dams are flexible structures and easy to construct, especially in catchments with difficult access and will prevent rocks and land sliding during road construction.
- All efforts should be undertaken to ensure construction and maintenance of roads in the upper watershed in accordance with erosion-control principles.
- Erosion will need to be minimized by keeping batter slopes to an appropriate grade.
- Slopes will be replanted as part of the construction program.
- Care needs to be taken when designing drainage channels to ensure water velocities are appropriate with sufficient cut off drains.
- Steep drainage channels will require rock armoring.
- Slope grades will be designed to be appropriate for the material that they are cut in.

Water Pollution:

- Rip-rap floor will be provided for controlling scouring in Kaitu and Kurram Rivers if river crossings are required.
- Quarterly monitoring of water quality parameters as stated is be carried out.
- Adopting management practices such as permanent storm water retention/detention ponds, slope protection, grass strips, sediment traps and proper drainage systems will be used. No water will be directly discharged from construction sites to any natural water course.
- Vehicles will be cleaned regularly to prevent them carrying detritus or oil into waterways
- All construction of bridge components within waterways will be carried out in a manner that isolates the construction work from flowing water to prevent concrete or silt discoloring or contaminating the water way.

Road Safety:

- The Contractor must prepare a detailed traffic management plan for approval by both the supervising engineer and XEN Highway Department, which must include measures for safety such as signs, pavement markings, flag men and lights.
- Provide traffic access through the AOI during construction, methods may include leaving one lane open, where this is not possible detour routes may be allowed if travel times are not significantly increased.
- All drivers to be suitably trained.
- Where possible avoid having construction traffic travel through villages.
- Provide separated pedestrian ways where there will be significant numbers of pedestrians.
- Narrow roads carrying multiple modes of transport need to be widened and have shoulders where slow traffic can allow heavy vehicles to pass.
- Set appropriate speed limits.
- Ensure all vehicles are in a safe condition and appropriate for their use.
- Ensure all loads are safely fixed to vehicles.
- Maintain the roads in a safe condition; this will include applying a second coat of black top to all metaled roads within 9 to 15 months of applying the first black top surface.
- Where vehicles are to travel at night on a regular basis ensure that appropriate lighting and delineation is in place on the roads to be used.
- Have a well-established accident response procedure that includes first aid training.

Travel Disruption:

- Provide traffic access through the AOI during construction, methods may include leaving one lane open, where this is not possible detour routes may be allowed if travel times are not significantly increased.
- Reroute traffic around settlements.
- Limit the time of any road closures.
- Consultation with local communities will be undertaken before closing any roads to public traffic to agree times that will minimize the potential impacts

Gender Issues:

- Reroute traffic around settlements and do not allow workmen or transporters to stop in settlements.
- Ensure foreign workers are made aware of the local culture and customs.
- Instigate a process for communities to report any contract workers not complying with the rules around access to settlements.
- Contractors' to strictly enforce compliance of their staff with local customs and remove offenders from the project site.

5.2.3 Operation Phase

5.2.3.1 Land Resources

Topography and Drainage
Potential Impacts: Water will pond behind the proposed Kaitu Weir creating a water pool of approximately 45 acres in surface area. This will result in a permanent change in the visual aspect of the Kaitu River immediately upstream of the weir, from a braided stream to a pool. This will be a permanent change to the landscape, of high magnitude but of local extent and as such is considered to be of high significance. Neither a negative or positive determination is given to this potential impact as appreciation of the aesthetic aspects of this change to the landscape is a matter of individual preference.

In addition changes to landscape will occur as a result of the presence of new and upgraded roads and the power transmission line. These potential impacts will be permanent, local and of low magnitude. They are assigned a low significance.

Construction of the Spaira Ragha and Sheratalla Canals will extend the drainage network by eight and 16 miles respectively. This is a permanent but local change of moderate magnitude and is considered to be of moderate significance. It is considered a positive potential impact in that it will increase the availability of water for agricultural activities.

Mitigation: The potential visual impacts cannot be avoided or mitigated as construction of the Kaitu Weir is an integral part of the design of Component 1. However, it is compensated for by the positive potential impact of making additional water available for agriculture and potentially contributing to increased earnings for local farmers.

Geology, Geotechnical Issues and Seismicity
Potential Impact: If the measures described in Sections 5.2.1 are not implemented there is the potential for failure of the Kaitu Weir. This would result in downstream flooding that could potentially impact agricultural activities, infrastructure and dwellings and even result in loss of human and animal life. This is a short-term, probable, high magnitude and local potential impact. It is assessed as significant.

Mitigation: Implement the measures described in Section 5.2.1 above.

Soils

Potential Impacts: Waterlogging and salinization: Potential impacts related to waterlogging and salinization and their mitigation are discussed in detail under the Agriculture and Irrigation section below.

Land Use

Potential Impacts: Permanent inundation of the area upstream of Kaitu weir: The construction of the Kaitu weir will cause permanent inundation of an upstream area with a level lower or equal to the Kaitu Weir crest (2,353 ft). This area of approximately 45 acres includes settlements, vegetation and irrigated land. The magnitude of this potential impact will be high, the extent local and its duration permanent. Therefore this will be a significant potential impact.

Gravity irrigation and soil fertility affected in areas downstream of Kaitu weir: The diversion of required irrigation flows for the Spaira Ragha and Sheratalla command areas (varying from 20cfs. in December to 110 cfs in August and September) and flows to Powerhouse IV at the Kaitu weir will diminish the downstream average yearly river flows by about 75 percent (from 361,000 Acre Feet to 88,000 Acre Feet). Daily river flows and water levels downstream of the Kaitu weir will be reduced, especially in the periods of low river flow (Rabi season). The lower riparian area's domestic uses such as washing, bathing, cleaning and livestock consumption could suffer. This will also affect the 477 acre currently under irrigation in the vicinity of Datta Khel. Irrigation of this area is by flood water or the water that diverted by temporary weirs of stones across the river bed. Lower water flow and consequently lower water levels will hamper diversion using temporary, heavily leaking structures and gravity irrigation.

In addition, soil fertility in this area will likely be affected. Currently, Kaitu River water contains nutrient-rich sediment that serves as a natural fertilizer when used on the downstream irrigated lands of Datta Khel. Once constructed, the Kaitu weir will act as a sediment trap and the downstream users will be affected. They will have to maintain the fertility of their lands by other means (fertilizers, green manure, and farm yard manure) which will involve new costs.

The magnitude of these combined potential impacts will be high, the extent is local and its duration is permanent. Therefore this will be a significant potential impact.

Loss of grazing lands and blocked access: Animal husbandry is a very important activity of the people in FATA. The magnitude of this potential impact will be high, the extent is regional and its duration is permanent. Therefore this will be a significant potential impact.

Mitigation: Permanent inundation of the area upstream of Kaitu Weir:

- Full compensation to the affected households is needed, in the form of alternative irrigated fields in one of the command areas or in cash, according to market rates and/or provision of support services including timely supply of agricultural inputs and of soft loans. All mitigating measures for land acquisition should be coherent with the measures in the RAP and RPF documents.
- Land acquisition and construction activities will be scheduled in such a way that there will be a minimum effect on the standing crops. Where permitted by the construction schedule, farmers will be allowed to harvest crops. Where this is not possible, cash compensation will be paid. Cash compensation will also be paid for loss of fruit and other trees based on market value. Mitigation could also include establishment of small fruit nurseries by local farmers with expert advice from the Provincial Agriculture Department.

Gravity irrigation and soil fertility affected in areas downstream of Kaitu weir: While mitigation needs further study (hydrology, topography), three possible alternatives are mentioned below.

- The replacement of the temporary stone weirs by low permanent weirs.
- The possibility of these areas receiving water directly from the Kaitu weir through new small, (lined) canals diverting water from the main canals of Spaira Ragha and Sheratalla should be investigated.
- Another alternative is to pump water; however, this will be very expensive and potentially unreliable should the current electrical load shedding continue. That means that downstream users will definitely be worse off and need to be compensated for the increase in irrigation costs.
- For the other downstream riparian water users other water resources could be tapped such as ground water from dug wells. Additional measures could include construction of platforms for drinking water and washing clothes, pools for animals (cattle/ livestock) and steps for fetching water.
- Compensation for loss of natural nutrients in river water sediments, could take the form of input subsidies for fertilizer.

Loss of grazing lands and blocked access:

- Provide alternative routes to grazing lands. These should include all needed facilities such as canal, nullah and road crossings, drinking pools supplied by canal water, fences etc.
- Promoting the cultivation of fodder crops (alfalfa, berseem) to compensate for the loss of grazing lands. At the same time this would have additional benefits as fodder crops are very suitable for a sound crop rotation system and for improving soil structure and fertility (N-fixation).

Agriculture and Irrigation

Potential Impacts: Pollution of water by excessive use of fertilizers and pesticides: There is currently almost no use of pesticides and fertilizers in the command areas of Component 1. With the project interventions the use of pesticide and fertilizers may increase. However, hazardous effects are not anticipated as the cropping intensity is only 100 percent in the calendar year. Furthermore, the anticipated cropping pattern the area under vegetables and orchards is also low. Nevertheless irrigation could be accompanied by excessive use of fertilizers and/or pesticides by farmers. This will result in pollution of groundwater and surface water by leaching of nutrients and pesticide residues, particularly where marginal and moderate suitable agricultural land is irrigated. This concerns about 1,510 acre of sandy texture or 29 percent (Land capability class IV-s3) in Spaira Ragha CCA and 2,200 acre or 14 percent of gravelly profile (Land capability class III-g2) in Sheratalla CCA. It can also lead to illness related to exposure to high levels of nitrates and pesticide residues in the groundwater and surface water. The magnitude of this potential impact is rated high, the extent will be local and the likelihood is medium. Hence this is a significant potential impact.

Waterlogging and Salinization risks: The risk of waterlogging and secondary salinization in the command areas of Component 1 will increase with time. Currently, the only salt affected area of Component 1 is localized in the Sheratalla plain and covers 53 acres. The nullahs crossing the command areas form natural drainage channels which mainly get rid of excess precipitation. With the project interventions, new canal irrigation systems will be constructed to meet the irrigation requirements of these command areas. The proposed irrigation systems have been designed with an overall irrigation efficiency of about 60 percent. This means that 40 percent of the irrigation supply will be lost, mainly by infiltration losses due to surface irrigation applications and earth canal/watercourse infiltration. Due to these large infiltration losses the recharge rate of the groundwater will be high and it is likely that groundwater levels will rise if there is insufficient natural groundwater drainage to the nullahs.

In an agrohydrological scenario/simulation study of the Spaira Ragha command area, salinization risks in the Spaira Ragha command area under irrigation have been analysed. The most important conclusions of this study (Rehman et al, 2005) are:

- Owing to irrigation application losses, limited soil depth and low (horizontal) hydraulic conductivity groundwater levels will rise rapidly and consequently secondary salinization risk will emerge.
- Since natural groundwater drainage is deficient, deepening of the natural drainage network (nullahs) will not resolve the drainage problem.
- After some years the installation and construction of an artificial drainage system (horizontal porous pipelines and/or tubewells) will be necessary.
- Further drainage studies will be necessary.
- Monitoring of groundwater levels before and after the irrigation intervention will be crucial.

The simulation results indicate that a large part of the area is liable to become water logged and salinity build up within five years of the project operation. So, it can be expected that gradually more area may be threatened in the future by water logging and subsequently secondary salinization. Waterlogging and salinization are very important impacts of irrigation development in semi-arid Pakistan. The magnitude of this potential impact is rated high, the extent will be local, the duration is long-term and the likelihood is high. Hence this is a significant potential impact.

Agricultural development: In the Component 1 command areas about 16,320 acres will be brought under canal irrigation. Cropping intensity will increase up to 100 percent in the Spaira Ragha and 110 percent in the Sheratalla command areas while the current cropping intensity (baseline) is 23 percent for the Spaira Ragha and 33 percent for the Sheratalla plain. Cropping patterns will change. Farmers will have the opportunity to grow cash crops and increase their earnings considerably. All these factors will have a tremendous positive potential impact, namely a large increase in farm production and farmers' incomes. The magnitude of this potential impact is rated high, the extent will be regional, the duration is long-term and the likelihood is high. Hence this is a significant positive potential impact. This potential impact could be further enhanced if water allocation (water rights) promotes fair water distribution between head and tail ends of the systems. However in many irrigation systems unequal distribution is a persistent problem. In some traditional law systems in Pakistan and PK/ North Waziristan it is even defined that the users at the head end have the right to take the water when they want and as much as they want. The Irrigation Department has a very important role to play in ensuring rational water management and a fair water distribution.
Risk of electrical load shedding: In the Spaira Ragha Command Area 2,720 acres will be supplied irrigation water by gravity flow and 1,300 acres under a canal lift system (i.e. pumped). Electrical load shedding might affect the smooth running of pump units. This will affect agricultural production and deregulate water management. The magnitude of this potential impact is rated high, the extent will be local, the duration is long-term and the likelihood is medium. Hence this is a significant potential impact.

Lack of capital: With the conversion from rainfed to irrigated agriculture, implying a more intensive agriculture, the demand for agricultural inputs will increase. However, most farmers are small land owners, with few resources. Under such circumstances, local farmers may have insufficient capital to purchase these inputs and agricultural production will be suboptimal. The magnitude of this probable potential impact is rated moderate, the extent will be local and the duration is medium-term. Hence this is an potential impact of medium significance.

Mitigation: Pollution of water by excessive use of fertilizers and pesticides: The mitigation measures will be crop rotation (hindering pest proliferation), mechanical weed destruction (instead of herbicide applications), green manuring (legumes) and addition of farmyard manure to improve the structure of the soils, light (small water applications) but frequent irrigation and split doses of fertilizer application. Farmers should also be trained in the safe use of pesticides/ fertilizers. It is recommended that integrated pest management pilot projects be started within the project command areas to create awareness among local farmers through farmer field schools. The four possible insect control tools (cultural, mechanical, biological and chemical) should be synchronized in an integrated way to control and keep the insects below economic threshold levels.

Growing pest resistant varieties, clean cultivation, crop rotation, destroying of eggs and larvae through tillage and hoeing and growing of trap crops are effective ways to minimize harmful insects' populations. The use of pheromones to trap adults is also relatively effective. Biological control involves the use of beneficial insects that prey on the eggs and larvae of target insects. Lady bird beetles, *Trichograma* and *Chrysopa* are the best insect tools to control some target insects naturally. The establishment of laboratories at the Government level to promote the propagation and growth of beneficial insects and then free insemination within fields is recommended. Integrated Pest Management (IPM) should be adopted to keep the pest population below harmful levels.

According to the FAO, IPM is the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. While designing and adopting an efficient IPM Module, all the four possible pest control mechanisms, i.e. cultural, mechanical, biological and chemical, are utilized in an integrated way to keep the pest population below economic threshold level. The first three mechanisms have the least potential environmental impacts so should be adopted preferentially. Chemical control is recommended only when it is considered necessary. The chemicals used should be environment friendly with minimal residual effects. The only drawback to biological control is the possible misbalancing of the natural population intensity of local fauna.

Any pesticides used shall comply with Pakistan legal requirements and USAID 22CFR 216.3 and the PERSUAP and 2013 PPERSUAP.

Waterlogging and Salinization risks:

- Reducing the groundwater recharge rate by effective water management. This involves minimizing conveyance losses through lining of the main and secondary canal networks and watercourses, and minimizing of field application losses through precision land leveling and appropriate planting geometry.
- Another way to reduce the recharge rate of the groundwater and at the same time increasing irrigation efficiencies and cropping intensities is the introduction of drip and/or micro sprinkler irrigation methods. This could be promoted by subsidies to individual farmers or groups of interested farmers for drip or micro-sprinkler systems. Investment for drip irrigation at the farm level includes connection to tertiary canal networks or a tubewell, a farm reservoir, pump and diesel engine or electrical motor, filters, main and secondary pipelines, drip or micro-sprinkler lines, emitters/drippers or micro-sprinklers. In other semi-arid countries such as Morocco, drip irrigation systems are spreading quickly but nearly always on an individual farm basis and with very high government subsidies (70-100 percent of the capital cost).
- A complementary network for the drainage of excess rainfall that links to the natural drainage channels (nullahs) needs to be planned in advance (i.e. in the design phase). Subsurface drainage should be provided in a timely manner. However, assuming that the pre-project groundwater levels are deeper than 3 m beneath ground surface, there is no immediate threat of water logging or salinization. Nevertheless with time, because of potentially considerable water losses it can be foreseen that groundwater levels will rise and that water logging and secondary salinization will become increasingly problematic. When the groundwater is about 2-3 m below the ground surface it will be crucial to construct a groundwater drainage system using tubewells and/or horizontal pipe systems. This requires drainage studies and the design of a groundwater drainage system in the command areas.
- Monitoring of groundwater levels and salinity spots will be crucial.
- Biological phyto-reclamation of the saline soil areas in Sheratalla by planting site specific salt tolerant species of trees, shrubs, and grasses should be carried out. A package is available from the Pakistan Forest Institute in Peshawar and National Agriculture Research Council in

Islamabad. Alternatively, initiation of saline-agriculture by growing salt-tolerant crops, vegetables and fruit-trees should be conducted. This package is available from the Pakistan Council for Research in Water Resources, Islamabad.

Agricultural development: Formation of Water Users Associations (WUA) in the command areas to encourage the farmers in equitable water use for irrigation. Water rights must be clearly defined and agreed upon by both upstream and downstream farmers.

Risk of electrical load shedding: Stabilization measures of electricity supply to the Spaira Ragha pumping station. Under the proposed project a new 11-kV transmission line will connect the Powerhouse V to the Spaira Ragha Pumping Station which should stabilize the supply.

Lack of capital: Farmers should be provided with financial assistance through credit facilities and input subsidies.

Waste Management

Potential Impacts: The waste generated in operation phase will be mainly municipal solid and liquid waste as well as waste (e.g. used parts) resulting from maintenance of the weir, gates, spill ways etc. It is estimated that there will be 400 staff during operations (all components) and offices and colonies will generate 160 kg/day of solid waste and 12,800 gpd wastewater.

The solid waste generated from staff offices/colonies if not properly collected, transported and disposed of may cause odors and visually unaesthetic conditions for the nearby residents as well as for staff and will serve as breeding ground for disease vectors. The organic portion may produce leachate which may percolate into the soil and groundwater. The potential impact is local, potentially long term and likely to be considered high magnitude by the affected staff and residents. It is therefore assigned a high significance.

The wastewater generated from staff working at Component 1, will be ultimately discharged into the surface water bodies e.g. Kaitu River, Spaira Ragha Canal and Sheratalla Canal thus polluting the river water and degrading the water quality for the designated uses including agricultural use of water in the downstream villages (Spinwam and Rocha).

Mitigation:

- The implementation of the waste management plan for Component 1 must be monitored by a Sanitary Supervisor to ensure proper operation and maintenance of equipment and machinery for waste storage, collection, transport and disposal.
- Monitoring of Natural water bodies (Kaitu River) must be conducted.
- The transport routes for disposal of solid waste followed during the operation phase of Component 1 shall be limited to the routes identified in design phase to minimize any disturbance to the local communities.
- If WAPDA retains the construction period landfill for final disposal, it shall manage it according to the procedures defined for the construction phase
- Regular maintenance of wastewater treatment units must be ensured for efficient operation.
- Monitoring of water bodies (Kaitu River, Spaira Ragha and Sheratalla canal) and treatment units must be conducted and additional unit shall be installed when the inflow of existing unit exceeds its design capacity.

5.2.3.2 Climate and Climate Change

Potential Impacts: Operation of Component 1 is not expected to bring changes to the local or regional climate, and the size of the pool upstream of Kaitu Weir is such that it will not induce detectable microclimatic changes.

However, the potential impacts of climate change are considered to be a more critical concern. These are discussed under Component 2 in Section 5.2.3.2 below. However as hydroelectric power will be generated by Powerhouses IV there is the potential for GHG emissions offsets as discussed below.

GHG Emissions Offset: The calculation of GHG emissions reductions involves first setting a baseline, and then calculating the reduction in emissions against that baseline. In this case, the power provided by Component 1 will be going to the national grid. This means that the hydropower would be displacing other potential sources of power which might have been built instead. In the case of Pakistan, most of the current power generation comes from natural gas (48 percent), imported fuel oil (32 percent), or distributed non-grid connected diesel gen sets. All three of these sources are very carbon intensive, varying from 0.5 kgCO_2/kWh for natural gas to 0.75 kg CO_2/kWh for diesel and fuel oil (UNEP/OECD/IEA/IPCC,1995). It is reasonable to expect that any alternative power would likely be some combination of these more conventional power sources.

The International Energy Agency (IEA) produces an average carbon emissions factor for every country in the world. This emissions factor is based on the mix of energy sources currently in use by that country. For Pakistan that emissions factor is 0.451 kgCO_2/kWh. This reflects the fact that the remaining portion of Pakistan's power comes from lower carbon intensity sources such as hydropower and nuclear.

For the purposes of this analysis it was conservatively assumed that the baseline power displaced by the KTMD project would be some mix of the current grid, and therefore utilize the IEA value for carbon intensity. Since this value is lower than the value for the more likely natural gas or diesel sources of generation, it represents a more conservative calculation. The carbon baseline is then calculated for each year of operation over the anticipated life of the project, as follows:

(kWh displaced by the Component 1 for each year) * (0.451 kgCO_2/kWh) = kgCO_2/year

The projected power production is 15,000 MWh/year, based on an installed capacity of 18.4 MW capacity and 45.5 percent capacity factor.

This then results in a possible carbon offset of 6,765 metric tons of carbon dioxide per year (MT CO_2/year). Assuming a valuation of $5/MT CO_2, the annual value of that carbon offset would be $33,825. This is the equivalent of taking over 1,395 motor vehicles off the road for a year.

5.2.3.3 Air Quality

Potential Impacts: KTDP Component 1 operations related potential impacts on air quality will be related to vehicular emissions, greenhouse gas emissions and industrial development, as discussed in the following sections.

Vehicular Emissions: Once the Mir Ali-Thal road is upgraded and the new road built from the Kaitu Weir to Kurram Tangi Dam, the vehicular load will increase and result in higher levels of vehicular emissions such NO_x, SO_x, CO_2, CO etc. The potential adverse impacts of vehicular emissions will be of medium significance. Increased air pollution will negatively affect the expanding population near Bobali.

Emissions of Greenhouse Gases: Aquatic vegetation may result from impoundment of water behind the Kaitu Weir. This aquatic vegetation may periodically die and decay, causing buildup and release of methane (a potent greenhouse gas). According to WHO standards for air quality, methane is not a priority pollutant. Therefore, the significance of this methane release is not estimated.

Industrial Development: Availability of water in the area may encourage settlements and development of industries in the area that may adversely affect air quality. The magnitude of the

potential impact will depend on the number of industries, which in turn will not only be conditioned by potential agricultural intensification, but other factors such as the security situation, labor availability, skills and education of available labor and access to markets amongst others. While the magnitude of this potential impact would be high and the duration long term if many industries developed, it is currently considered to have a low likelihood of occurring on a large scale. Should such development occur, the population in Bobali, which will likely increase, could be exposed to potential industrial air emissions, if the industries are situated close to residential and commercial areas. However, this potential impact is considered to have a low likelihood and is evaluated as non-significant

Mitigation: Intelligent Transport System: Measures to tackle vehicular emissions include traffic control measures and mode of transport. An "Intelligent Transport System" includes many steps for traffic management. Those that might be practical in this particular area include implementation of effective signal timings and parking guidance systems where applicable. This will reduce vehicle idle time and increase average speeds, reducing fuel consumption and vehicular emissions. Moreover, public transport should be encouraged, which will minimize vehicular emissions, benefit the general public, and benefit KTDP operators.

Greenhouse Gas Emissions: Aquatic vegetation in the reservoir should be properly managed to minimize the release of methane.

Emission Control Technology: Industrial development should be planned properly by establishing industrial zones. New industries and emissions (SO_x, NO_x and PM) should comply with the NEQS (Appendix 9.3-2). This can be done by employing emission control technologies such as gravitational settling chambers, electrostatic precipitators, cyclones or fabric filters, depending on the removal efficiency and economic viability of each technology.

5.2.3.4 Noise

Potential Impacts: Increase in Vehicular Traffic. Once Component 1 engineering features are constructed, traffic on the newly upgraded Thal-Mir Ali road and on the newly constructed Kaitu Weir to Kurram Tangi Dam road will increase, causing a rise in persistent noise levels.

The potential impact will remain of medium significance, because there is only one major settlement (Bobali) in the Sheratalla Plains. An increase in vehicular traffic will affect the people living near the main roads. Noise produced by these vehicles will be of a persistent (as opposed to irregular) nature.

Establishment of New Industries/ Settlements: Development in the Component 1 area may increase once operation of the Kaitu Weir begins. This could encourage the establishment of new small industries and settlements. New industries will create noise pollution and disturb those living nearby. The magnitude of the potential impact will depend on the number of industries, which in turn will not only be conditioned by potential agricultural intensification, but other factors such as the security situation, labor availability, skills and education of available labor and access to markets amongst others. While the magnitude of this potential impact would be high and the duration long term if many industries developed, it is currently considered to have a low likelihood of occurring on a large scale. Noise from any such industry could potentially be a source of nuisance if there are nearby residential areas. The potential impact is considered non-significant.

Mitigation: Mitigation measures will consist of the following:

- Trees form natural barriers to noise. Therefore, trees will be planted parallel to the roads, especially those roads that pass through residential areas;
- Limit movement of large vehicles and equipment for KTDP operations to day time, so that disturbance due to noise is limited to that time only; and

- Industries should have their noise levels monitored frequently. Noise barriers should be installed if levels exceed permissible NEQS limits (Appendix 9.3-9).

Adopting the mitigation measures described above will reduce the potential impact to low significance by limiting the adverse effects of vehicular and industrial noise on settlements and people.

5.2.3.5 Water Resources

Hydrology

Potential Impacts: The main potential impact during operation will be the diversion on Kaitu River flow to the Sheratalla and Spaira Ragha canals and to the Kurram River via the feeder tunnel resulting in drier conditions on the Kaitu River section downstream of the weir and upstream of its confluence with the Kurram River.

Mitigation: Environmental flows varying from at least 145 cfs in low flow months (September to June) to a high of 217 cfs in July and 218 cfs in August (Table 5-9) are proposed to maintain the wet channel in the Kaitu River downstream of the Kaitu weir Section (see Aquatic Resources below). This flow is envisaged to keep the river hydrology and morphology live to its minimum level required for aquatic ecology in the most dewatered section of Kaitu River. Besides, it will also provide general water requirements needed for economic and social purpose. The released environmental flow will also be sufficient for other terrestrial wild life. Such an environmental flow release when augmented with the ground water seepage and tributary flow from streams present downstream of the weir is envisaged to further enhance the river hydrology and morphology downstream.

The minimum flow releases will need to be revised when studies recommended in the Pre-Construction Phase (Section 5.2.1.2) have been carried out and the Ecological Flow Requirements are finalized.

Final flows and the schedule of their release need to be included as part of the dam/reservoir operating procedures for the Kaitu Weir and coordinated with the irrigation demand operations of Component I.

Water Quality

Potential Impacts of Kaitu Weir: During operation of the Kaitu Weir, water quality may improve in the immediate vicinity through aeration of the flow as it cascades over the structure. However, water will be diverted into three channels resulting in low flow conditions in the Kaitu River and a reduction in its assimilative capacity. A reduction in the assimilative capacity of the Kaitu River will adversely affect the cultivated area in Datta Khel. If the cultivated area is negatively affected, the economic conditions of those who solely depend on agricultural activities as the earning source for their households will also be adversely affected.

Water quality issues associated with operation of the Kaitu Weir will result in significant potential impacts, due to their high magnitude and long term duration.

Mitigation: The following mitigation measures will be adopted:

- Bi-annual monitoring of water quality will be conducted. The locations where water quality samples are to be taken in the operational stage have been marked on Map 4-33 (Operational Phase Sampling Points).Reduction in the assimilative capacity of the Kaitu River and adverse effect on Datta Khel will be mitigated by releasing a downstream minimum flows varying from at least 145 cfs in low flow months (September to June) to a high of 217 cfs in July and 218 cfs in August (Table 5-9).This flow will meet Kaitu River ecological requirements and Data Khel drinking water demands. The Kaitu Weir will be designed to accommodate the downstream minimum flow.

The mitigation measures described above will reduce the magnitude of the potential impact and result in overall potential impacts with medium significance.

Potential Impacts of Spaira Ragha Canal and Sheratalla Canal: The existing cropping intensity (33 percent in the case of Spaira Ragha Plains and 23 percent in the case of Sheratalla Plains) will increase to 100 percent in the Spaira Ragha and 110 percent in the Sheratalla Command Areas respectively due to the operation of the proposed canals and the use of fertilizers in the new command areas (see Section 5.2.3.1). The major crops cultivated after the construction of the proposed canals will be wheat and maize. Fertilizers and pesticide usage may increase during the operation phase of the proposed canals. Phosphorous and nitrogen may be used as fertilizers, along with pesticides, to increase the crop yield of both wheat and maize. Potassium may also be used as an additional fertilizer for increasing the maize yield.

The agricultural runoff of nutrient laden water will deteriorate water quality downstream. This effect may be more pronounced in low flow conditions when nutrients accumulate in water bodies and can result in eutrophication. Moreover, seepage of nutrient laden water will deteriorate ground water quality. Waterlogging can lead to concentration of salts and potentially result in arsenic contamination off shallow groundwater as has been the case in Sindh (Baig, 2011). No settlements in the Spaira Ragha Canal Command Area will be affected. Bobali, a major settlement in the Sheratalla Command Area, will be adversely affected, since the canal passes directly through its command area. Overall potential water quality impacts will be significant, having a high magnitude and a long duration.

Mitigation Measures for Spaira Ragha and Sheratalla Canal: The following mitigation measures will be adopted:

- Farmers will be properly trained in the use of fertilizers and pesticides. This training should be presented by the Agricultural Department of Miranshah, FATA who should recommend the dose, type, amount and economic feasibility of different fertilizers, suggesting those that are environmentally friendly and have minimal residual effects.Organic fertilizers will be promoted. It is strongly recommended that a Pest Management Plan be prepared before the start of the operation of these canals and a pilot study to be carried out on small plots in the Datta Khel area using IPM. Pesticides used shall comply with Pakistan legal requirements and USAID 22CFR 216.3 and the PERSUAP and 2013 PPERSUAP.
- Bi-annual monitoring of water quality parameters will be done. The locations where water quality samples are to be taken in the operational stage have been marked on Map 4-33. The parameters that shall be analyzed are listed in Chapter 8 of the EMMP and include arsenic.

The mitigation measures described above will reduce the magnitude of the potential impact, resulting in an overall potential impact of low significance.

Potential Impacts of Powerhouse IV and Powerhouse V: No significant potential operational impacts of Powerhouse IV and Powerhouse V on water quality have been identified. However, minor increases in oil, grease, and heavy metals may result from water passing through the turbines.

Mitigation of Potential Impacts of Powerhouse IV and Powerhouse V: Powerhouse discharges will be monitored and treated, if required. Water used in powerhouse maintenance will not be disposed of in the canals.

5.2.3.6 Biological Resources

Terrestrial Ecosystems

Potential Impacts: Displacement of wildlife: Flooding of about 12 acres of irrigated cropland by the Kaitu Weir pool will force crop pests and their predators to move upward into the town of Spinwam and into other cultivated areas. These pests consist mostly of rodents (rats and mice) and their predators are mostly snakes (venomous and nonvenomous). The two species of wild cats, although scarce in the area, may also prey on the pest rodents. The rodents will not be so numerous

as to cause problems in stored grains or residences and the snakes will be killed by the local people. The movement of fauna is a short-term, local and probable potential impact of low magnitude. It is assessed as non-significant.

Increase in agricultural pests: As described in Section 3.2.2, the Sheratalla Canal will irrigate a Command Area of 12,300 acres, while the Spaira Ragha Canal will irrigate 4,080 acres. Increased agricultural activity in these areas could result in an increase in agricultural pests end result in increased use of pesticides. The potential impacts of increased pesticide use are discussed in detail in Section 5.2.3.1 above. Pesticides used shall comply with Pakistan legal requirements and USAID 22CFR 216.3 and the PERSUAP and 2013 PPERSUAP.

Habitat creation: The cropland resulting from development of the Sheratalla and Spaira Ragha Command Areas will provide a habitat for resident and migratory wildlife as discussed in more detail in Section 5.4.3.6 below. The expansion of habitat can be further enhanced by planting of trees along canal banks, as these will provide nesting and roosting sites to birds, and may also serve as food sources.

While the potential expansion of bird habitat and feeding grounds is positive, the application of pesticides to their crops by farmers could result in occasional secondary poisoning of wildlife. This negative potential impact is local, potentially long term and of low magnitude. It is assessed as non-significant and does not require mitigation.

There are no threats likely to any endangered, rare and threatened species and no endemic species in the Component 1 area.
Mitigation: Displacement of wildlife: Residents of villages bordering the weir pool should be informed that they may expect an invasion of crop pests and snakes. If venomous snakes are expected to flee the reservoir filling, local clinics should be provided with antivenins.

Increase in agricultural pests: Mitigation of increased pesticide use to control agricultural pests is described involves training of farmers, the implementation of IMP as discussed in detail in Section 5.2.3.1 above. Pesticides used shall comply with Pakistan legal requirements and USAID 22CFR 216.3 and the PERSUAP and 2013 PPERSUAP.

Aquatic Resources

Potential Impacts: The Kaitu Weir will fragment the aquatic ecosystem of the river, dividing it into two reaches. The extensive reach above the weir (some 70 miles in length, based on the Feasibility Report, KTDC 2004) will be isolated from the 17.5-mile reach that extends downstream of the weir to the confluence with the Kurram (Section 4.2.1.1). The weir will prohibit the fauna in the downstream reach from moving into the upper reach. This potential impact will be of major significance for species that utilize the upper reach during part of their lifecycle. Spawning migrations of the population of Golden Mahseer, *Tor putitora*, residing downstream of the weir, as well as other species (including fish populations in the Kurram River) to breeding habitat in the upper reach, will be blocked by the weir. Baloni (1980) reported that Golden Mahseer in the Mandakini River (India), a river similar in character to the Kaitu River and upper Kurram River, begin their spawning migration in March in response to increasing water temperature, then descend downstream after the monsoon season when water temperature begins to decline. The loss of spawning habitat for Golden Mahseer will result in a decline in the population in the Kurram River system. IUCN listed this species as "Endangered" because such migration blockages are causing a serious decline in its populations throughout its range of distribution.

The Kaitu Weir will form an impoundment that extends 0.5 miles (Section 3.2.1) in the river upstream of the weir. The impoundment will have a surface area of 45 acres and a maximum depth of 18 feet (Section 3.2.1). The impoundment will change the aquatic habitat from riverine to lacustrine, resulting in a change in water quality characteristics and aquatic fauna. Water

temperatures in the impoundment will be warmer than the ambient temperatures of the river coming into the impoundment; levels of dissolved oxygen (DO) will be somewhat reduced in the impoundment. The aquatic fauna will change from predominantly riverine species to those that can adapt to a lacustrine environment.

The aquatic fauna most likely to be impacted by the formation of the impoundment will be species inhabiting inundated riffle areas. Most of these species, especially some rheophilic species of benthic macroinvertebrates and, possibly, *Glyptothorax kashmirensis*is (if present), will leave the impounded reach for suitable habitats upstream. Golden Mahseer will lose potential spawning habitat as a result of the formation of the impoundment. The Representative Important Species, *Labeo dyocheilus* and *Garra gotyla*, found in the Kaitu River are not anticipated to be adversely impacted by the formation of the impoundment. These species were collected in the pool habitat at Spinwam (Section 4.7.3.1) and will likely adapt to the impoundment. Because the biological productivity of the impoundment will be higher than that of the river, the populations of these species, and others that adapt to the impoundment, are likely to be larger in the impoundment than in the riverine habitats of the Kaitu. However, it is unlikely that a commercial fishery could be established in the impoundment because of its relatively small size.

The flows of the Kaitu River downstream of the weir will be reduced by the operation of Component 1. Based on information derived from the Feasibility Report (KDTC, 2004), a downstream release of 10 cfs from the weir is assumed to be planned for domestic and environmental use during the filling of the impoundment and operation of Component 1. This flow will undoubtedly be less than the flow needed to maintain the aquatic ecosystem in the reach of river between the weir and the confluence of the Kaitu with the Kurram. Additionally, the temperature and DO of water released from the weir will also often be lower than ambient conditions upstream of the weir impoundment. The resulting severe degradation in aquatic habitat can be expected to result in most of the fauna in the 17.5-mile reach of the Kaitu downstream of the weir moving into the Kurram River.

The loss of aquatic habitat in the 17.5-mile reach of the Kaitu River between the weir and confluence with the Kurram will have a significant potential adverse impact on the populations of the Species of Concern (*Tor putitora* and *Glyptothorax kashmirensis*) in the Kurram River system. This loss, when combined with the loss of access to the reach of the Kaitu above the weir, will eliminate the use of the Kaitu River in its entirety for fish populations in the Kurram River. When Powerhouse II (Component 11) becomes operational, only the 0.17-mile reach below the powerhouse discharge (Section 3.3.7) will be available as habitat for these species.

Fish upstream of the Kaitu Weir will move into the irrigation canals and the intake canal to Powerhouse IV. Those entrained into the intake of Powerhouse IV and Powerhouse V will be subject to turbine-induced mortality. Fish entrainment and turbine-induced mortality has been extensively studied at numerous hydropower sites in the US (EPRI, 1992; and Winchell and Amaral, 1997). Most (over 90 percent) of the fish entrained were small (less than 4 inches in length), and experienced 5 percent to 6 percent mortality. Tests with larger fish (8 inches or longer) passing the turbines experienced 10 percent to 30 percent mortality. This potential impact will be of minor significance for most species in the Kaitu River, but can be of moderate significance to significant for the Golden Mahseer (*Tor putitora*) because of its migratory habits. Golden Mahseer can be expected to attempt to migrate downstream if water temperatures in the Kaitu become lower than the zone of thermal preference for this species.

Mitigation: There are three aspects to mitigating the potential adverse impacts of the operational phase of Component 1; one addressing flows downstream of the weir; a second, addressing the blockage of fish movements by the weir; and third, addressing fish entrained into Powerhouse IV and Powerhouse V. The flows downstream of the weir must be sufficient to maintain the aquatic ecosystem in the Kaitu to its confluence with the Kurram, including the use of the reach for seasonal

movements of Kurram River fish populations into the Kaitu. This will require the release of an Ecological Flow (the flow needed to maintain the biological components of the aquatic ecosystem) from the Kaitu Weir, which is a prerequisite to addressing the blockage of fish movements at the weir.

There are numerous methods to determine an Ecological Flow for the Kaitu River downstream of the weir. The methods have been categorized by Dyson (2008) as: "Look-up tables; Desk top analysis; Functional analysis; and Habitat modeling," and no one method is universally the best. However, on the basis of existing information, only "Look-up tables" can be used at this time. Of these, the most appropriate is the Tennant Method (Tennant 1976). This method utilizes the hydrological record for a site. It was developed based on studies on hundreds of rivers and streams in the United States between the Atlantic Ocean and the Rocky Mountains, including rivers similar in character to the Kaitu and Kurram. Because the method addresses flows on the basis of flow in channels of a river, which are universal, it is considered applicable to the Kurram River system and is considered appropriate as an initial estimate for an Ecological Flow.

The Tennant Method requires only the annual mean flow at a site, and estimates an Ecological Flow on the basis of percentages of that flow on a seasonal basis. During low flow months, 20 percent of the annual mean flow is considered "Good." During high flow months, 40 percent of the annual mean flow is needed to maintain "Good" conditions; 30 percent of the annual mean flow is considered only "Fair." Based on the hydrological period of record from 1980-2011, the annual mean flow of the Kaitu River at Spinwam (the site of the Kaitu Weir) was 718 cfs (Sections 4.6.1.1 and 4.7.3.1). An Ecological Flow for the Kaitu downstream of the weir would then be about 144 cfs during the low flow months (September to June, on average), and at least 215 cfs during July and August.
The above Ecological Flows based on the Tennant Method are to be considered initial estimates. The method is not biologically based and will need to be adjusted based on additional studies that should begin with a year-long comprehensive survey of the fisheries resources in the reach of the Kaitu River below the weir. When the biological uses of the reach are known, the final Ecological Flow should be determined using a habitat modeling method, such as Physical Habitat Simulation (Bovee 1982). The Physical Habitat Simulation Model (PHABSIM) has been used in several countries around the world (Ataberk *et al* 2002 and Dyson 2008), and successfully applied on the Platt River in the US (a river very similar to the Kurram and Kaitu rivers) by the US Fish and Wildlife Service (Locke, et al 2008). The habitat modeling study should be conducted by an experienced team of fisheries biologists, hydrologists and hydraulic engineers (see Dyson 2008), and focus on the fish species in the Kaitu River, as well as the flows needed to permit upstream migration of species (especially the Golden Mahseer) from the Kurram.

Environmental Flows need to be considered in addition to the Ecological Flows discussed in the previous paragraphs. Environmental Flows consider flow needed to address potential human impacts – primarily water withdrawal, wastewater discharge and irrigation. No information is available on any existing piped water supply or wastewater collection systems in the region. Water generally is supplied from wells or by carrying from local rivers of Nullahs, while sanitation is provided by latrines or by open defecation. As a result, true water and wastewater requirements probably are negligible. However, without a water balance study that assesses the hydraulic relationship between stream flow and groundwater flow, it is difficult to know for sure what impacts human activity actually have on surface water quality and therefore what minimum releases are appropriate for the water/wastewater components of the Environmental Flows. Streams that are “losing” will need sufficient flow to meet adjacent groundwater withdrawals, and streams that are “gaining” will need sufficient flow to dilute contaminated groundwater inflow to maintain adequate water quality. Nevertheless, assumptions can be made in order to provide an indication of relative impacts and rough estimates the water/wastewater components of the of Environmental Flow requirements. IFC Environmental Health and Safety Guidelines establish an overall target of 100 liters/capita/day (L/c/d) for water supply, while 25 L/c/d is considered a minimum subsistence level of water supply; for estimating purposes, we have assumed a water demand of 100 L/c/d in urban areas and 50 L/c/d in

rural areas. Typically, 80% of household water supply is discharged as wastewater, while the remaining 20% is consumed. There are no known industrial or institutional water demands or wastewater dischargers in the region. Pakistan's National Environmental Quality Standards require a minimum receiving stream dilution ratio of 10:1 for discharge of partly treated wastewater; while this is intended to apply to wastewater treatment plants, it also may be assumed relevant to naturally-occurring degradation of septage to groundwater. Applying these assumptions to the population of Component 1 results in an estimated water requirement of 0.6 cfs (consumptive use), and a wastewater requirement of approximately 5 cfs (non-consumptive use). . . These represent initial estimates based on information currently available; they should be re-examined if additional information becomes available in the future.

Component I will impact the irrigation requirement for Datta Kehl. An additional 1 to 3 cfs are required for Datta Kehl irrigation. These flows are diverted from the Kaitu River and are considered a consumptive use. The non-consumptive wastewater use (5 cfs) is accommodated by the much higher Ecological Flow. Therefore, the total minimum flow released from the Kaitu Weir needs to include the Ecological Flow requirement plus the consumptive water and irrigation requirements. These total minimum flow releases are shown by month in Table 5-9. As such, these flows and the schedule of their release need to be included as part of the dam/reservoir operating procedures for the Kaitu Weir and coordinated with the irrigation demand operations of Component I.

The total minimum flow releases will need to be revised when the Ecological Flow Requirements are finalized. This revision must be based on the PHABSIM study that as described in the Fisheries` Management Plan uses Riverine Habitat Simulation (RHABSIM 3.0), an extensive conversion of PHABSIM (Thomas R. Payne and Associates Software, http://trpafishbiologists.com).

Assuming a suitable flow is maintained in the reach of the Kaitu downstream of the weir, the blockage of upstream fish migrations by the weir can be addressed by the use of a fishway. Wickstrom (1999) observed the use of two fishways (a Denil and a "pool type with orifices and notched overflow") on the Jhelum River by a fish fauna that include species occurring in the Kurram River. Of the species in common, *Schizothorax plagiostomus*, a Representative Important Species in the Kurram River (Section 4.7.3.2), and two species of *Glyptothorax* were found using the fishways. Wickstrom concluded, however, that a vertical slot fishway would be better than either type of fishway studied because of the fluctuations in Jhelum River flows. Kullander et al (1999), studying fish populations in the Jhelum, observed that *Glyptothorax kashmirensis* would also be likely to utilize a fishway. (Information on the design and operation of Denil, "pool type with orifices and notched overflow," and vertical slot fishways is provided in Katapodis, 1992; and Lay, 2009. Internet web sites for these sources are provided in the reference section.)

However, a year-long comprehensive survey of the fish species and aquatic habitats upstream of the Kaitu Weir is needed before a fishway is built at the weir. The seasonal movements of the Kaitu River fish fauna need to be known, and the characteristics of aquatic habitats in the reach above the weir need to be determined. At this time, only a conceptual design of a fishway at the Kaitu Weir is warranted. The fishway can be built later, if needed. That need will also depend on the presence of the Kurram Tangi Dam (which is too high for a conventional fish ladder). Until that dam is operational, fish can freely move upstream into the upper reaches of the Kurram River.

The loss of fish as a result of turbine-induced mortality at Powerhouse IV and Powerhouse V can be mitigated by maintaining a low approach velocity to their respective canal intakes, and by placing a trashrack parallel to river flow at the entrances of these canals. The trashrack clear spacing should be designed to allow only small fish to pass through. Based on the extensive studies of fish entrainment at hydropower projects cited above, fishery agencies in the US recommend an approach velocity to the trashrack of 0.5 fps, and a trashrack clear spacing of 2 inches as mitigation. That recommendation is expected to be valid for the Kaitu and Kurram River fish fauna.

Table 5-9: Minimum Ecological and Environmental Release Flows (cfs) for the Kaitu Weir

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Water (consumptive)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Wastewater (non-consumptive)	5	5	5	5	5	5	5	5	5	5	5	5
Ecological (non-consumptive)	144	144	144	144	144	144	215	215	144	144	144	144
Irrigation - Datta Khel (consumptive)	1.1	1.4	1.2	1.4	1.4	1.5	1.4	2.2	3.3	2.3	1.1	0.7
Total Min Release (1)	146	146	146	146	146	146	217	218	148	147	146	145

Irrigation water for Sheratalla & Spaira Ragha diverted upstream of Kaitu Weir, while Datta Khel Irrigation is diverted downstream. Wastewater requirements are non-consumptive so are met by Ecological flows. Therefore, Minimum Release = Water + Ecological + Datta Khel Irrigation.

5.2.3.7 Socio-Economic Environment

Potential Impacts: During operation the main potential impacts are changes in land use patterns. At present hardly any of the people in the Component 1 project area have access to irrigated land. Consequently, very few people are familiar with the challenges and potentials of irrigated intense agriculture. They mostly practice some form of transhumant pastoralism at this point in time. In order to take good advantage of the benefits offered by the CCAs, the local population will need to change these livelihood patterns. This commonly results in situations where the local people become frustrated with the new land and lease it out to agro-industries and/or agriculturalists from other areas below market rates and gradually lose control over their territory and lands. This potential impact is assessed as having a high significance. During operation, downstream populations will experience changes in water availability and flow levels in the Kaitu. Potential impacts to the people of Datta Khel who rely on Kaitu River water for irrigation could be significant.

During operation, population in the footprint of Component 1 will realize that the Kaitu Weir through Powerhouse Four generates quite some electricity which is evacuated to the national grid near Bannu, but that none of this electricity is made available to the local people. In particular the people living around Powerhouse Four and along the transmission line have presently no access to the grid and therefore might be quite unhappy about the limited magnitude and coverage of benefit sharing schemes. This is a significant potential impact is considered as such outstanding grievances can undermine the success of the overall project.

The post-construction effects on health are generated by changes in geography and climate with the potential for negative impacts on the population. Owing to the presence of the Kaitu Weir and the expansion of irrigation areas there could be increases in diseases such as malaria, schistosomiasis, dengue, chikungunya, onchocerciasis, and dracunculiasis. There may also be increased water-borne diseases like cholera, typhoid, dysentery, diarrhea, hepatitis A and E, and intestinal parasites like roundworm, tapeworm, and threadworm.

The establishment of a water bodies in a dry arid area may facilitate vector-borne diseases such as malaria, leishmaniasis, Japanese encephalitis, dengue and dracunculiasis (Dracunculiasis or guinea-worm disease is caused by water fleas and was endemic in Pakistan but was eradicated in 1993. Nevertheless, chances for occurrence still exist, so this disease should be considered as a possible future threat). This change to the environment could increase health related issues.

At the intake point of the channel supplying water to turbines, there is normally an accumulation of all types of trash, both biodegradable and non-biodegradable. Commonly, this is removed and spread in the vicinity of the dam/weir to decompose. This is a source of air pollution and could also affect the population located near to the project site. The polluted air could be deleterious effects to human health by triggering or causing asthma, chronic obstructive pulmonary disease, and other non-infectious respiratory ailments.

Potential health impacts are assessed as significant.

Mitigation: To utilize the potentials of the CCA and to maximize the benefits of Component 1, the people in Component 1 will need to be provided with effective training, capability enhancement and support during the first five to six years of perimeter management in order to transition from transhumant productive systems to irrigated agricultural livelihoods. This will need to include the establishment of Water Users Associations and Agricultural Extension Services, credit associations, input supply mechanisms, and storage depots and marketing arrangements. While the RAP provides guidance on such mitigating measures in the context of the livelihood restoration measures for the affected people, similar measures need to be established for the otherwise unaffected population in the footprint of the Component 1 project area.

Environmental Flow Releases, as discussed in Section 5.2.3.6 above, shall be form part of the operating procedures for the Kaitu Weir. Downstream flows and and water availability of downstream water need to be monitored closely and additional mitigation measures (minimum flow rates, feeder canals etc.) might need to be established if the expected availability of downstream water is lower than expected.

It is highly recommended and best practice to establish a rural electrification project in the footprint of Component 1 to share benefits with those in the vicinity of the power generation and exportation.

Precautions should be taken to prevent increases in diseases such as malaria, schistosomiasis, dengue, chikungunya, onchocerciasis, and dracunculiasis as well as the water-borne diseases.

Attention should also be paid to limiting residential use underneath the transmission line to Domail.

Proper prophylactic arrangements shall be offered to the local communities:

- Health education for making them aware of the impending threats and prophylactic techniques for avoiding these vectors such as mosquitoes, and snails etc., such as bed-netting, weekly chloroquin, repellent creams, removal of small impoundments in the dwelling places.
- Offering free vaccinations to the population for vaccine-preventable diseases.

5.2.3.8 Roads, Bridges and Traffic

Once the existing roads are upgraded and access roads are constructed they will be used for transporting material, workers and passengers during the construction and operation of the KTDP.

Potential Impacts: Overloading: Overloading heavy vehicles damages road pavements. A truck overloaded by 10 percent causes 40 percent more wear on a pavement than a truck loaded to the legal limit. This in turn reduces the life of the road to a greater extent, which will require constant maintenance. Based on the existing trend Mir Ali-Thal Roads and the Bannu-Zarwam Roads and existing road from the dam to Powerhouse III can be predicted to have overloading issues.

Overall this is assessed being a significant potential impact with a moderate magnitude but with a regional extent for a long duration.

Aggregate Sources: Material for road maintenance is usually extracted from river flood plains. However, the weir will prevent gravel being replenished and could potentially impact on availability of gravel for future maintenance and construction. There are various other nullahs and the upstream reaches of the Kaitu River, as well as other rivers that will not be impacted by the dam where gravel can be extracted. This can be assessed as a low magnitude impact of long duration. Therefore on the whole the potential impact can be regarded as having a low significance.

Road Safety: The potential impacts during the operation will be similar to those applicable to traffic travelling between sites during the construction phase. Regular maintenance of the roads will be required to keep them safe. This will require an appropriate budget allocated for maintenance activities which does not appear to have been available in the past.

Water Pollution: There will be an ongoing requirement to maintain the drainage systems so they function appropriately. This will include ensuring all sediment trap facilities are functional and drains are cleaned to prevent blockages and water discharging directly into natural waterways.

Benefits: Improved road infrastructure will improve the ability of people to travel and encourage commerce between settlements. Safer roads will reduce accidents. Better maintained roads will reduce vehicle wear and tear. Travel times will be reduced.

Mitigation: Overloading: The following steps can be adopted to reduce the wear and tear of roads and bridges during the operation stage.

- Comply with all legal load restrictions when hauling material and equipment on public roads to and from the project. A special permit does not relieve the Contractor of liability for damage resulting from the moving of material or equipment.
- Unless otherwise permitted, do not operate equipment or vehicles that exceed the legal load limits over new or existing structures, or pavements within the project except those pavements intended to be removed.
- Truck Weighing Strips should be installed at the beginning of each stretch of road to ensure that the vehicle does not surpass the standardized loading limits.
- Proper operation and maintenance of roads need to take place complying with limits set by KPK and FATA Highway Departments.

Availability of Aggregate: Many nullahs (streams) are found to be present in the AOI that can provide for material needed for maintenance of roads and bridges. Moreover, gravel from upstream reaches of the Kaitu River or the Indus River can also be utilized since River Indus already confluences within the AOI. No material is to be sourced from sensitive habitats.

Road Safety:

- All drivers to be suitably trained.
- Where possible avoid having traffic travel through villages.
- Set appropriate speed limits.
- Ensure all vehicles are in a safe condition and appropriate for their use.
- Ensure all loads are safely fixed to vehicles.
- Carry out regular inspections and maintain all roads and bridges in a safe condition, this will include applying additional coats of black top to all metaled roads every 12 to 16 years as required.
- Where vehicles are to travel at night on a regular basis maintain appropriate lighting and delineation on the roads to be used.

Water Pollution: Maintain road side drainage and associated structures.

5.2.4 Decommissioning

5.2.4.1 Operational Life of the Kaitu Weir

It is anticipated that the Kaitu Weir will have an economic life of 60 to 100 years. Except for the small pool behind the weir, there is no seasonal or daily storage of inflows. There will be regular flushing and if needed, dredging and removal of sand and gravels that will deposit behind the weir. The weir will also require regular maintenance but no major rehabilitation or repairs unless the weir is damaged during major floods.

As future plans for the power and irrigation sectors in the Component 1 area outside of this particular project development are unknown and/or cannot be predicted, it is assumed that once the weir reaches the term of its economic life, it will be most likely fully rehabilitated and upgraded so that power generation and irrigation can continue.

5.2.4.2 Operational Life of the Powerhouses

Civil works associated with powerhouses have generally an economic life of 50 years. The electro-mechanical equipment typically has an economic life of 25 to 30 years. Both civil works and equipment can however be easily rehabilitated and upgraded so that power plants have indefinite life.

5.2.4.3 Closure/Decommissioning Plan

Plans for closure and/or decommissioning depend on whether a decision is made to interrupt power generation and irrigation. In such a case, it is likely that the weir would be removed in its entirety. In such a case, complete removal will require a process that is essentially the reverse of the construction process. It would likely be necessary to construct an upstream and downstream cofferdam to divert flow away from the weir pool and then empty the weir pool. After emptying the pool, the weir itself would be dismantled and removed entirely. The entrance and outlet of the tunnel diverting water towards the powerhouse would need to be plugged as well. The last stage would involve removal of the cofferdams so that the Kaitu River would return to its natural state

Powerhouses could also be decommissioned. Once water stopped flowing into the powerhouse intake structures, it is relatively easy to dismantle equipment inside a powerhouse and remove the civil works.

In the unlikely event that part or all of the proposed project features would be shut down, a formal decommissioning and abandonment plan would need to be prepared. At a minimum it would include the following:

- Removal of all structures and equipment.
- Removal of all associated infrastructure specifically required for operation of the built. infrastructures – e.g. access roads, transmission lines.
- Removal and safe disposal of demolition waste and any hazardous wastes.
- Occupational health and safety.
- Community safety during decommissioning.
- Reclamation of disturbed land.
- Plans for future land use.
- Redistribution of reclaimed land.
- Management of socioeconomic impacts.
- Socio-economic and land redistribution.
- Restoration of river flows, aquatic riverine habitats and ecological condition of the River.

Potential impacts: Decommissioning and closure would potentially have severe economic consequences due to the loss of power generation and irrigation benefits. It would then be very difficult for the population involved with the irrigated land to maintain a livelihood.

Construction of cofferdams and removal of the weir could also be the source of potential adverse impacts on the river ecology and water quality during the construction and demolition period.

In addition there would be potential adverse impacts related to disposal of demolition and other waste materials.

Mitigation: The potential impacts of decommissioning could be avoided by maintenance and upgrade of Component 1 infrastructures and electromechanical systems to ensure perennity of irrigation water supply and power generation.

However, if the decision is made to decommission, alternative livelihood strategies would have to be developed as part of a decommissioning and closure plan to mitigate potential socio-economic impacts.

While the mitigation measures for potential impacts to water quality and the river ecology, and related to waste management proposed for the construction phase could be implemented, the actual measures would have to be developed in a decommissioning and closure plan. Since this would only

be developed some 50 to 60 years after commissioning at the earliest, it is considered likely that a new suite of potential mitigation measures would be available.

5.3 Potential Impacts Related to Component 2

As described in Section 3.1 and 3.3, Component 2 consists of the Kurram Tangi Main Dam, its reservoir and Powerhouse I; Weir II, its impoundment and Powerhouse II; Weir III, its impoundment and Powerhouse III and a transmission line to the Domail Substation. The Kurram Tangi Dam (located at Kurram RM 67) will be 322 feet high and 1,035 feet long. At full pool, its reservoir will store 1.2 million acre-feet of water, have an average depth of 117 feet (Section 3.3.3), and a surface area of 10,939 acres (17.1 square miles). At full pool, the reservoir will extend 8 miles upstream of the Dam (Section 3.3.3). Powerhouse I will be located at the toe of the dam, 1.5 river miles above the Weir II and three miles above the confluence of the Kurram and Kaitu rivers (about Kurram RM 64).

Weir II will be located upstream of the confluence of the Kurram River and Kaitu River (about Kurram RM 64) at Kurram RM 65.5, be 20 feet high and 418 feet long (Section 3.3.6). Its impoundment will have a surface area of 10.1 acres (Section 3.3.6). At full pool, the reservoir will extend 0.3 miles upstream of Weir II (Section 3.3.6). This weir will divert water from the Kurram River to Powerhouse II, located on the Kaitu River, about 0.17 miles upstream of the confluence of the Kaitu with the Kurram (Section 3.3.7).

The weir for Powerhouse III will be located downstream of the confluence of the Kurram River and Kaitu River at Kurram RM 61, be 75 feet high and 1,190 feet long (Section 3.3.6). Its impoundment (considered a reservoir), have an average depth of 57 feet, and a surface area of 730 acres (Section 3.3.6). At full pool, the reservoir will extend 3.5 miles upstream of Weir III to the confluence of the Kurram and Kaitu rivers (Section 3.3.6). Weir III will divert water to Powerhouse III located at about Kurram RM 60, bypassing an estimated 6,560-ft long reach of the river. Powerhouse III will be about five river miles upstream of the Kurram Garhi Headworks (located at Kurram RM 56).

5.3.1 Pre-Construction Phase

5.3.1.1 Land Resources

Geology, Geotechnical Issues and Seismicity
Potential Impacts: The potential geotechnical impacts for Component 2 are shown in Table 5-10 below. Overall these potential impacts are assessed as significant.

Table 5-10: Geotechnical Potential Impacts of Component 2 during Design Phase

Sr. No.	Description	Magnitude	Extent	Duration	Probability of Likelihood
a)	**Main Dam and Spillway**				
1	Consolidation Grouting	High/major	Regional	Long-Term	Highly probable or definite
2	Establishment of geotechnical design parameters	Moderate	Site Specific	Long-Term	Probable
3	Stability and seepage analysis	Moderate	Site Specific	Long-Term	Probable
4	Bearing capacity analyses for foundations	Moderate	Site Specific	Long-Term	Probable
5	Design of filters	Moderate	Site Specific	Long-Term	Probable
b)	**Diversion and Power Tunnel**				

1	Insufficient laboratory test results	High/major	Local	Long-Term	Highly probable or definite
2	Design of Rock support system	Moderate	Site Specific	Medium-term	Probable
3	Development of design parameters	Moderate	Site Specific	Medium-term	Probable
4	Stress analysis of tunnel	High/major	Site Specific	Long-Term	Probable
c)	**Powerhouses**				
1	Insufficient geotechnical investigation and laboratory testing	High/major	Site Specific	Long-Term	Highly probable
2	Stability and seepage analysis for weirs	Moderate	Site Specific	Long-Term	Probable
3	Static and dynamic analyses of powerhouse foundation	High/major	Site Specific	Long-Term	Highly probable or definite

Seismicity: The seismic hazard analysis (MWH, 2013b) indicates that the current ground motion parameter of 0.2g is too low. As such there is a risk of failure of the Kurram Tangi Dam structure in the event of a MCE causing major downstream flooding that could potentially impact agricultural activities, infrastructure and dwellings and result in loss of human and animal life. This is a regional, short-term, high magnitude and probable potential impact and is assessed as significant.

Mitigation: Major items of work that must be completed to finalize the design include the following (MWH 2013a):

- Carry out additional field investigations recommended in MWH, 2013a.
- Carry out additional design work as recommended in MWH, 2013a.
- Perform seismic stability analyses using the new ground motion parameter i.e. 0.8g.
- Review the foundation designs of structures which are founded on overburden material. These should be revised and rock foundations should be used wherever possible. In general, it is expected that the dam and major weirs and other water retaining structures can be placed on bedrock foundations. If still foundations are placed on overburden, liquefaction potential of foundation strata should be assessed and the design should be revised accordingly.
- Assess the reservoir geology using published geological maps, topographic plans and satellite imagery. This task will establish the principal geology units and define major structure in the area to be flooded. Reservoir assessments will include the classification of lands to be flooded, landslide hazard assessment and confirmation that the reservoir will be acceptably watertight.
- Assemble and assess the various missing data items that are noted in this report. This includes feasibility study borehole logs and laboratory testing data and all other geotechnical information noted herein in previous sections. This information should be incorporated into the existing database and assessed in light of the current geotechnical designs. Design revisions should be made if warranted by the new information.

- The saddle dam, cofferdams and diversion system need to be planned and designed.

Waste Management
Potential Impacts: The potential impacts identified for Component 2 are the same as for Component 1.

Mitigation: The mitigation measures for the potential impacts identified for Component 2 are the same as for Component 1.

5.3.1.2 Water Resources

Hydrology

The Supplemental Report on Hydrology (MWH, 2013d) indicates that the PMP and PMF used for the design are too low. This means that the proposed spillway design may be inadequate and that the dam could potentially overtop during a maximum flood event. Overtopping could lead to erosion of the downstream face of the dam with concomitant weakening of the structure and risk of dam failure. Potential impacts of dam failure include major flooding and even loss of property and human and animal life. This is considered a significant impact.

In addition, MWH (2013d) indicates that published annual sediment yields are approximately half of those determined in the MWH review. The higher sediment ingress into the Kurram Tangi Dam reservoir would reduce the time required to fill the reservoir dead storage and thereby impacting live storage as well. This potentially impacts the ability to regulate water distribution and availability of water for irrigated agriculture during the dry season. This is considered a significant potential impact.

While the potential impacts would occur at the operational stage, they are discussed here as their mitigation needs to be addressed during the Pre-Construction Phase in order to determine whether modifications to the design of the Kurram Tangi Dam needs to be updated.

Mitigation: The following studies are recommended:

- The peak and volume of the PMF should be reviewed and recalculated after revising the PMP. Once a new PMP and PMF are calculated, the adequacy of the proposed spillway should be re-evaluated and revised.
- To quantify the channel degradation downstream of the dam, there is a need to develop a numerical model covering the reservoir extent and the river stretch downstream of the dam and duly capable of simulating the envisaged reservoir operation on long-term basis.
- Furthermore, given the host of uncertainties present in the previous and current sedimentation studies, a vigilant discharge and sediment measurement program at Thal should be implemented as soon as possible in order to help verify previous and current estimates.
- Once the above have been carried out, dam design and operational procedures should be updated.

5.3.1.3 Biological Resources

Aquatic Resources

No potential impacts on the aquatic resources of the Project area of influence are anticipated in the pre-construction phase. However, the aquatic resource baseline conditions in this area are presently inadequate to evaluate potential impacts on the fishery resource and determine appropriate mitigation actions. The recommended mitigation action is to conduct the Fish and Water Quality Survey described in the Fisheries Management Plan (Annex IV of the EMMP).

5.3.1.4 Socio-Economic Environment

Potential Impacts: The most significant potential impact during the pre-construction phase of Component 2 is the acquisition of land with a total surface area of up to 14,000 acres. This would trigger the need to physically relocate up to 15,000 people and restore the livelihoods of up to 22,000 people. As the affected tribal people are in conflict since time immemorial with those people living within the footprint of Component 1, the ostensible "logic" of the solution to relocate them into the Spaira Ragha and Sheratalla CCAs is likely to exacerbate conflicts and therefore is unlikely to work. Therefore additional replacement land for housing and livelihoods will need to be made available for them. See the RPF for more details. This potential impact has a high significance.

Nearly all land to be acquired for Component 2 is tribal land. A great deal of this land is disputed and claimed by different clans. In addition, none of the permanent user rights held by individual households for residential and agricultural lands is documented and therefore protected against misuse and/or conflicts between clans and households. The people on the left and right bank of the Kurram have been in conflict since time immemorial and it will be therefore challenging to find solutions that find acceptance among all affected people. This potential impact has a high significance.

Another potential impact during the pre-construction period is the influx of construction workers[44] and security personnel into the project region of Component 2 in North Waziristan. This reduces the level of autonomy of the Wazirs and exposes them to modernization and external control that they are fighting since time immemorial. This is a less significant as it is limited to the construction phase.

Mitigation: Mitigating actions for potential impacts associated to land acquisition in Component 2 are covered in detail in RPF. As is the case for Component 1 they will include payment of compensation and allowances, replacement of land/resettlement of PAPs, livelihood restoration and monitoring and evaluation. The main task here is to establish a RAP for Component 2 and find sufficient replacement residential and agricultural land for the affected households in areas that are culturally acceptable to the affected peoples.

Mitigation actions for potential conflicts within the tribal societies in Component 2 are discussed in detail in the VTP. The main approach is here to use culturally appropriate consultation and mediation methods to obtain the free, prior and informed consent of all affected clans to the relocation process and establish detailed mitigation measures for each intervention that is considered to entail potential conflicts between the construction contractor and the tribal people and/or between different clans of the Wazirs.

5.3.1.5 Roads, Bridges and Traffic

Road works envisaged under this Component may include the upgrade of the Bannu-Mir Ali-Spinwam-Thal road between Spinwam and Thal. This has been discussed in Section 5.2.1.8 above. Other planned roadworks include relocation of part of the Mir-Ali Thal road and of the Bannu-Zarwam-Thal road, including the left bank access to Powerhouse III, as well as upgrading the remaining portions, new access roads to Powerhouses II and III and upgrading the road

Potential Impacts: Relocation of part of Mir Ali-Thal Road near Shewa post (Road F): A detailed study of the proposed alignment is required. However, a tentative line was drawn for Road F and was put on the Google map to visualize the alignment. This can be seen on Map4-30. The alignment generally appears appropriate but may need to be adjusted or moved at certain locations to achieve an acceptable vertical profile. The gradient is less than 10 percent at all locations but one.

Submergence of Bannu-Zarwam-Thal Road: About 3.7 miles of metaled and 14.3 miles of un-metaled Bannu-Zarwam-Thal will be submerged due to the construction of the dam. Submergence of the road will hamper movement of the local residents and will require acquisition of land. About 10 minor settlements will be directly affected due to relocation because of their proximity with the road. Some of these settlements include Madikhel, Chamakanni, Shawa and Zund.

No design details of the road have been provided along with no alternative route suggested considering that the road facilitates many villages. Therefore the potential impact is of high magnitude with a permanent affect but within the locality. Based on these factors and the recipients of the potential impact it can be regarded as significant.

[44] At peak construiction the labor force will number about 1,100 workers and 200 engineers/highly qualified staff (Section 3.3.8.5).

Land Acquisition: Land is required for the construction of new roads and the upgrading of existing roads. This may require the acquisition of some privately owned property which the people may be hesitant to give up. Land acquisition will be a major issue for the proposed new roads. Therefore, this is a high magnitude potential impact which will have permanent affects and can thus be regarded as a significant issue.

Mitigation:

Mitigation of potential pre-construction impacts will be as for Component 1.

5.3.2 Construction Phase

5.3.2.1 Land Resources

Topography and Drainage

Potential Impacts: Upgrading roads prior to the start of the main phase of construction of Component 2 could cause potential impacts such as the obstruction of drainage lines and associated potential impacts on other water users and aquatic life. This is a local potential impact, of short duration and moderate magnitude. It is assigned a moderate significance.

The upgraded and/or new roads will affect visual resources. These potential impacts will be permanent, local and of low magnitude. They are assigned a low significance.

In addition, there will be changes to the visual resources typical of construction activity. Although the scale of works envisaged in this Component is greater than in Component 1, the potential impact is still considered to be of low magnitude. This potential visual impact is also short-term and local and will cease at the end of construction. The potential impact is therefore assessed to be of low significance and does not require mitigation.

Mitigation: The following measures should be implemented in order to mitigate potential impacts to drainage:

- Avoid widening of roads beyond design specifications.
- Avoid disturbance of natural drainage and construct culverts where required.
- Spoil heaps and soil stockpiles shall be located so as not to disturb natural drainage.

The potential visual impact of roads can be mitigated by vegetation strips along the roadsides to render the roads more aesthetically pleasing. This would neutralize the potential impact.

Geology, Geotechnical Issues and Seismicity

Potential Impacts: The geotechnical issues listed in Table 5-11 could lead to potential impacts that are assessed as significant.

Table 5-11: Potential Geotechnical Impacts of Component 2 during Construction Phase

Sr. No.	Description	Magnitude	Extent	Duration	Probability of Likelihood
1	Installation of tunnel lining and rock support system	High/major	Local	Short-Term	Highly probable
2	Disposal of excavated material/suitability to be used in construction of cofferdams	Moderate	Local	Short-Term	Probable
3	Rock cut slope stability analyses	Moderate	Local	Short-Term	Probable

Mitigation:

- Ensure tunnel lining and rock support systems are put in place as required.
- If suitable reuse excavated material in coffer dam construction. Excess material, if any, should be disposed of as described in the waste management section of Section 5.2.3.1 below and in compliance with measures outlined in the framework Waste Management Plan (Annex III).

Soils

Potential Impacts: Erosion Risk. During the construction stage borrow material will be required for construction of the main dam and appurtenant structures, tunnels, Powerhouses and associated temporary structures (contractor camps etc.). This will be taken from the reservoir area, the surroundings of the dam as well as from the stretch of land between the dam and Kurram Garhi Headworks. This will generate spoil which may trigger soil erosion and landslides, particularly in bad weather conditions, due to uneven slopes, blasting, drilling, compaction, improper cutting and siting of borrow pits and fill storage depots, the excavation and collection of borrow material exposed to water and/or wind, the movement of heavy equipment, or improper handling of spoil. If the spoil heaps are only temporary, the potential impact will be short term. However, should there be excess spoil, there will be permanent heaps and therefore the potential impact could be permanent. This is a probable potential impact of low magnitude and local extent, limited to the surroundings of the. This potential impact has been ranked as of low significance.

Soil pollution: The construction of the dam and appurtenant structures, Powerhouses and associated temporary structures (e.g. contractor camps) may lead to temporary soil degradation by improper disposal of construction materials as well as soil pollution as a result leaks of combustibles and lubricants, disposal of wastewater etc. The magnitude of this potential impact is assigned a low value. The extent of this probable potential impact will be local and the duration will be short term as it will last only during the construction activities. Therefore, this potential impact has been ranked as having a low significance.

Mitigation: Erosion Risk:

- Good engineering practices such as appropriate siting/location of borrow pits and fill storage depots, keeping spoil/borrow materials covered, construction of protection structures (gabions, rip raps, stone pitching) for embankment slopes, proper cutting of slopes, plantation of trees and shrubs on the spoil depots and drainage management should be implemented. Further measures for mitigation of potential spoil-related impacts are described under waste management below
- Borrow areas should be sited away from settlements and agricultural lands.
- Affected areas should be restored to their original conditions after construction.

Soil pollution:

- Proper disposal and storage of materials and chemicals (in impervious lined pits), correct handling of chemicals and construction materials, checking for leaks and spill of oil and chemical products, proper waste management, proper training of workers for storage and handling of materials on construction sites and contractor camps.

Land Use

Potential Impacts: Land Acquisition: The proposed Main Dam Reservoir (10,939 acres) area will cause the inundation of pastures, barani and irrigated land (1,495 acre), houses and other constructions and existing vegetation (1,416 fruit trees). Moreover, the existing built up areas (Shewa and other small settlements) will have to be relocated. This is irreversible and therefore a significant potential impact.

Mitigation:

- Prompt and full compensation in the form of alternative irrigated land or payment required for affected private property land before and during the construction phase according and/or provision of support services including timely supply of agricultural inputs and of soft loans. All mitigating measures for land acquisition should be coherent with the measures in the RAP and RPF documents.
- Land acquisition and construction activities will be scheduled in such a way as to have a minimum effect on standing crops. Where permitted by the construction schedule, farmers will be allowed to harvest crops. Where this is not possible, cash compensation will be paid. Cash compensation will also be paid for loss of fruit and other trees based and/or establishment of small fruit nurseries by local farmers with expert advice from the Provincial Agriculture Department.

Agriculture and Irrigation

Potential Impacts: Shifting of labor to construction. During the construction phase, a labor force of about 1,100 persons will be required. This will provide employment opportunities to local residents. This will result in a shift of local labor from agriculture to construction. This potential impact is of small magnitude as it will cause some foregone production. The extent will be local and the duration will only be for the construction stage. The potential impact is of low significance.

Water quality: Construction activities such as excavation, storing of rock, blasting, clearing of land etc. and the waste generated from contractor camps will generate a large increase in sediment loads in run-off. This can directly affect the river water quality and hence the downstream water users and irrigation. The magnitude of the potential impact is low; the extent is regional and duration is short term as it will only last during the construction stage. Thus the potential impact is assessed to be of medium significance.

Mitigation:

- As labor will be hired from the local area by the Contractor, it is important to have prior consultations with the Maliks of the area in order to make arrangements for the required labor.
- The extent of foregone production is not known. However, given the very low use of labor other than family labor as an input into agriculture it is likely to be very low. In addition earnings from construction activity will compensate for the foregone production. Therefore mitigation is not required.

Water quality: The Contractor must implement and strictly adhere to its site specific waste management plan based upon the waste management measures defined below and in the accompanying framework waste management plan (Annex III). In addition measures for protection of water quality as described in Section 5.3.2.5 must be implemented.

Waste Management

It is estimated that the full staff complement for Component 2 construction (1,1000 workers and 200 engineers) will generate 520 kg/day of solid waste and 41,600 gpd of wastewater.

As far as construction wastes are concerned, total excavations will amount to 250 million ft^3. Currently it is planned to use most if not all of the rock excavated at the dam site for construction of the dam. Appropriate overburden spoil will also be used where possible. As discussed in Section 3.3.8.5 approximately 4.5 million cft of fill material area required for Component 2 construction. Some of the excess excavated material may be used for backfill of Component 1 borrow areas. However, the quantities that will be used have yet to be determined therefore no estimation is made of the amount of residual waste material that will have to be permanently stored.

Estimates for concrete and steel reinforcement waste generation during construction based on generation rates of one to nine percent by weight are 5,900 – 53,000 t and 180 – 1,600T respectively.

Potential Impacts: The potential impacts identified for construction stage of Component 2 would be the same as for Component 1. However, the main receiving water body would be the Kurram River. The aquatic life and designated use of downstream river water and irrigation canals for the settlements of Bannu, Ghoriwala, Sada Khel, Naurang Sarai, Lakki Marwat, Wandha Khajjar, etc. will also be affected.

Mitigation: The mitigation measures for the potential impacts identified for Component 2 would be identical to those suggested for Component 1.

5.3.2.2 Climate and Climate Change

Construction of Component 2 is not expected to bring changes to the local or regional climate.

5.3.2.3 Air Quality

Potential impacts on air quality during the construction of Component 2 will be similar to those for Component 1 (see Section 5.2.2.3). However, as described below, the areas affected will be different.

Gaseous and Fugitive Dust Emissions: Since the machinery used in Component 2 is the same as in Component 1 (as suggested by the Construction Expert-EIA, KTDP), the estimated emissions will also be the same. Though the main route for the movement of equipment and machinery will remain via Mir Ali-Thal road to the newly constructed road from Kaitu Weir to Kurram Tangi Dam, several other roads will be upgraded. Roads to be upgraded include the road from the dam site to Powerhouse III (Thal – Bannu Road) and the road from Powerhouse III to Bannu. New roads will also be constructed on the left bank of the reservoir and from the dam site to Powerhouse II. The Upgrading of the Bannu-Thal road will affect the three major settlements of Gumbatai, Shashogai and Zawakhwara. Another cause of fugitive dust emissions will be the excavations done in the reservoir area (also a potential borrow area) and in the borrow area extending from Powerhouse II to Powerhouse III. Overall the potential impact is of medium significance. Recipients of the potential impact will include the above mentioned settlements, laborers in the contractor's camp and those working at the construction sites.

Dust Emissions due to Blasting: Dust emissions will result from blasting to create tunnels associated with Powerhouse 1, II and III. The intensity of the potential impact is evaluated to be high although it is of temporary duration. It will have an intense potential impact on laborers at the construction site, and those using the Bannu-Thal road. However, this potential impact will occur only when the blasting activity takes place. It will have no impact on the major settlements in the Component 2 area that include Gumbatai, Shashogai and Zawakhwara. Overall the potential impact will be of medium significance.

Particulate Matter Emissions from Concrete Batching: Since the type and number of concrete batch plants in Component 2 is the same as in Component 1 (as suggested by the Construction Expert-EIA, KTDP), the estimated emissions will also be the same. The magnitude of the potential impact is taken to be moderate and the nature of the potential impact is temporary. Those affected include the construction workers near the dam site and Powerhouse 1, II and III. Gumbatai, Shashogai and Zawakhwara are the only major settlements that will be affected by these particulate emissions. Overall the potential impact is of medium significance.

Mitigation: The mitigation measures adopted for Component 2 will be the same as for Component 1.

5.3.2.4 Noise

Potential Impacts: Since the heavy machinery used in Component 2 is the same as in Component 1 (as suggested by the Construction Expert-EIA, KTDP), the noise pollution in Component 2 will be similar to that described for Component 1 (see Section 5.4.1.2). However, as described below, the areas affected will be different. Blasting will be undertaken to create tunnels associated with Powerhouse I, II and III. Persistent noise will be generated by the upgrades to the road from the dam site to Powerhouse III (Thal – Bannu Road), the road from Powerhouse III to Bannu and another road from the dam site to Powerhouse II. The only major settlement that will be affected is Gumatti, which is about 4 mi (as the crow flies) southeast of Powerhouse III. Construction workers onsite and residing in the contractor's camp will also be adversely affected by the persistent noise generated by machinery. The magnitude of the potential impact will be moderate and the duration temporary (less than 5 years). Overall potential noise impacts will be of medium significance.

Mitigation: Mitigation measures for Component 2 construction will be similar to those described for Component 1 construction.

5.3.2.5 Water Resources

Hydrology

Potential Impacts: Construction of the Kurram Tangi dam will potentially have an unavoidable impact to the morphology of the river in the immediate vicinity of the Kurram River because of the diversion of river during construction. Amount of river flow further downstream of the dam will not change during the construction of the dam. However, during initial impounding of the reservoir, the water flow will be reduced in the river section downstream of the dam. In addition, excavation of river banks during construction will potentially have impact on the downstream river water quality, in the form of increased sedimentation resulting from construction activities.

Mitigation: The minimum Ecological and Environmental Flow requirements described for the potential impacts during the Operation phase will be applicable during the initial impounding of the reservoir. The change in hydrology and morphology of the Kurram Tangi reservoir area will not be mitigated and is a potential residual impact of the project. Mitigation of other potential impacts caused by the inundation of the reservoir is discussed under the land resources, biological resources, water quality and socio-economic impact sections of this chapter.

Water Quality

Potential Impacts of Main Dam, Powerhouse I, Diversion Tunnels 1 and 2 and the Construction Camp: As described in Section 3.3.8.4 the construction camp for Component 2 will accommodate 1,100 laborers. Accommodation will also be required for about 200 engineers and specialists. Currently the actual location of the camp is not known, but it is likely that it will be situated near the dam. The laborers will consume water and discharge wastewater. The total water demand for the construction camp is calculated as 52,000 gpd (40 gpcd x 1,300 persons). It is estimated that about 80 percent of this water demand (41,600 gpd) will be discharged as wastewater, requiring proper treatment and disposal.

Wastewater produced by the construction camp will be largely organic in nature and is likely to have characteristics similar to those shown in Table 5-12Table 5-12**.**

Table 5-12: Anticipated Composition of Wastewater from Construction Camps

Sr. No.	Constituent	Unit	Range
1	Total Dissolved Solids	mg/l	350-1200
2	Total Suspended Solids	mg/l	100-350
3	BOD_5	mg/l	110-400
4	COD	mg/l	250-1000
5	Total Nitrogen	mg/l	20-85

6	Total Phosphorous	mg/l	4-15
7	Chloride	mg/l	30-100
8	Sulfate	mg/l	20-50
9	Alkalinity as $CaCO_3$	mg/l	50-200
10	Total Coliforms	colonies/100 ml	10^6-10^9
11	Grease	mg/l	50-150
12	VOCs	mg/l	100-400

Source: Adapted from Metcalf and Eddy, (1991), Wastewater Engineering Treatment and Reuse, 4th Edition

Potential impacts associated with construction of the Main Dam and PH1 will be similar to those described for the Kaitu Weir in Section 5.6.2.1. The machinery used in Component 2 will be the same as in Component 1.

Main Dam construction activities will include diverting the flow of the Kurram River by building a cofferdam. Moreover, the borrow area for the construction of the dam lies within the proposed Kurram Tangi Reservoir. As a result, the water pollution will be concentrated at the Main Dam site and in the downstream stretch (several km) of the Kurram River. Since a cofferdam is proposed and flows will be diminished, and as a result the assimilative capacity of the Kurram River will be reduced. As described in Section 3.3.8.2, the first major construction act will be the excavation of the two diversion tunnels for the Main Dam, generating 165,000 cy of overburden material (requiring about 1.5 acres of storage area, assuming a stockpile height of 30 yards) and approximately 290,000 cy of rock material (requiring about 3 acres of storage area, assuming a stockpile height of 30 yards). This rock will be stored for use in the concrete-faced rock-filled dam.

Total excavation in Component 2 is about 9,260,000 cy, with fill requirements of about 170,000 cy. Some of the excess excavated material may be used for backfill of Component 1 borrow areas or for rehabilitation efforts post-construction. However, the quantities that will be used have yet to be determined therefore it is not possible to estimate the quantity of residual spoil requiring permanent storage.

Although the available reports do not indicate precisely where excavated material is to be stored, there is plenty of unused land near the dam site that could be utilized for this purpose.
Heavy rain could cause substantial rock dust and spoil to run off into the river. Depending on the chemical properties of the rock and spoil, this runoff could seriously pollute the Kurram River.

While no major settlements use water from the downstream reach (to the Kurram Garhi Headworks) of the Kurram River, two minor settlements (Palowanakats and Kaitu) do. These minor settlements will be adversely affected by the construction and spoil that may be dumped along with the wastewater that will be released from the construction camp. Therefore, the magnitude of the potential impacts is assessed to be high and the duration long term. On the whole, the potential impact is evaluated to be significant.

Potential Impacts of Powerhouse II: Powerhouse II will be constructed upstream of the confluence of the Kaitu and Kurram rivers. A 16 ft diameter tunnel 5,400 ft in length will be constructed as an appurtenant structure for the powerhouse. The water for the construction activities and the construction camp for Powerhouse II will be taken from the Kaitu River. The assimilative capacity of the Kaitu River and the Kurram River will be affected by this taking of water. Moreover, the Thal-Bannu road will also be upgraded, creating particulate matter emissions that may be deposited in the river and areas downstream of Powerhouse II.

Construction will mainly affect water quality at the Powerhouse II site and at minor settlements downstream (Tojizhawarkhandal, Aghzepoya, Poya, Zarwam and Tangai). The magnitude of the potential impact is assessed to be high, because construction activities will take place simultaneously

with upgrading of 15 km of the Bannu-Thal road and excavation for the powerhouse tunnel. Overall, these potential impacts are assessed to be of medium significance.

Potential Impacts of Powerhouse III: Powerhouse III will be constructed along with a tunnel on the Kurram River. Water from Kurram River will be used for construction activities and the Kurram River downstream of Powerhouse III could receive construction debris.

Construction will mainly affect water quality at the Powerhouse III site and at downstream areas utilizing water from the Kurram River. These affected areas will include four minor settlements (Pisi, Talaum, Tarnao and Wamaqazikhel) just upstream of the Kurram Garhi Headworks. The potential impact is assessed to be high in magnitude and long term. On the whole, the potential impact is regarded as having a medium significance.

Mitigation:
The following mitigation measures will be adopted:

- Quarterly monitoring of water quality will be conducted. The locations from where water quality samples are to be taken during the construction stage have been marked on Map 4-32**.**
- The proposed WAPDA Land Acquisition Unit proposed in the RAP and EMMP will negotiate the transfer of land for spoil heaps and the use of the excavated rock and spoil from the tunnels with tribal leaders and land owners. The amount of land required is not great. Stormwater and erosion control measures such as a dike will be added around the spoil area to control run-off, preventing potential water quality impacts to the Kurram River from heavy rainfall. Run-off will be diverted through retention basins to settle out sediment prior to release into natural drainages.
- As discussed in Section 3.3.8.5, approximately 250 million cft of material will be excavated, while fill requirements are 4.5 million cft. Most if not all of the rock excavated at the dam site will be used for construction of the dam. Appropriate overburden spoil will also be used for reinstatement where possible. In addition, excess excavated material may be used for backfill of Component 1 borrow areas. As quantities have yet to be determined, estimates of the residual spoil requiring permanent storage cannot be made.
- The contractor will devise a suitable mechanism for the discharge of wastewater. The recommended option in the Waste Management Plan (Annex III to the EMP) is a sewage collection system with disposal in a septic tank/soakage pit combination. Options include the disposal of sewage in a soakage pit constructed near the camp area. The contractor would ensure that the depth of the soakage pit is such that it does not contaminate groundwater. That is, the contractor would ensure that bottom of the soakage pit is above groundwater level. The waste management plan presents guidelines for siting septic tanks and soakage pits including minimum separation from the top of the water table.
- Oil-water separators and grease traps will be installed and maintained at appropriate refueling facilities, workshops, parking areas, washbays, and fuel storage areas.
- Surface runoff from potential sources of contamination will be prevented. Particular attention will be paid to vehicle washbays where detergents and other chemicals will be used. Washing of vehicles in natural drainages will be prohibited. Only dedicated washbays equipped with water collection and treatment systems will be used. It is further recommended that drivers dust off their vehicles before washing and do not use pressure washers, which tend to waste water.
- The contractor will develop standard operating procedures based on the pertinent IFC Environmental, Health and Safety guidelines.
- Treatment of the water supply at Pisi, Talaum, Tarnao and Wamaqazikhel settlements.

The mitigation measures described above will reduce potential impacts to medium significance.

5.3.2.6 Biological Resources

Terrestrial Ecosystems

Potential Impacts: Disturbance of wildlife: Owing to the impoverished condition of terrestrial habitat, there are few mammals and birds in the Main Dam area to be affected by the noise and dust of construction. The same may be said for the construction areas of the two downstream weir/tunnel/powerhouse areas.

Pests and scavengers: The construction camp may attract rats and other scavengers, as well as their predators if kitchen waste is poorly disposed of, even if waste dumps are fenced. Since local residents consider wildlife species as game, they could hunt the predators or any larger mammals that might approach the camp. The cooks at the construction camps may keep poultry, which will attract mongooses, cats, and foxes, placing these animals at risk of being shot. This is a local, short-term, probable potential impact of low magnitude. It is non-significant.

Vegetation and Habitat Destruction: Unnecessary damage to vegetation and habitat could occur during road building, camp construction, excavations, spoiling and other construction activities. This is a local, short-term, probable potential impact of medium magnitude. It is assessed as medium significant.

There are no threats likely to any endangered, rare and threatened species and no endemic species in the Component 2 area.

Mitigation: The measures identified for mitigation of potential construction related impacts in Component 1 will be implemented for Component 2.

Aquatic Resources

Potential Impacts: The potential impacts of the construction of Component 2 will be similar to those for Component 1. The greatest potential impact will be the construction of the Kurram Tangi Dam, weirs and powerhouses that will result in the permanent loss of aquatic habitat in the portion of the Kurram River (and Kaitu River for Powerhouse II) occupied by the structures. Additionally, potential impacts will result from borrow area activities near, or in, the river.

As with Component 1, removal of borrow materials from areas on the banks of the river, and especially in the river, will result in potential adverse impacts on the aquatic biota of the rivers at the sites of the Dam, weirs and powerhouses, as well as downstream for an unknown distance. Increased sedimentation in the rivers will result from removal of borrow materials on the banks of the river and from the placing of cofferdams. This increase in sediment loading in the river will be temporary, but would likely be during the time when it would be most damaging to fish and benthic macroinvertebrates because of lack of dilution.

Additionally, in the course of working in the dewatered area, the contractor will have to pump out seepage water. Most likely this will contain various contaminants, oils and greases, sediment, solvents, which will be pumped into the downstream flow of the river. These will adversely affect fish and macroinvertebrates on a temporary and intermittent basis.

As previously noted, removal of gravels in the river bed will result in substantial long-term destruction of aquatic habitat. The loss of habitat will be more significant in riffle areas than in pools, and more significant downstream of the Dam and weirs than upstream. The loss of riffle habitat can be significant, not only because riffles are the preferred habitat of most benthic macroinvertebrates that form the base of the food chain for the fish fauna, but also because they are the preferred habitat of *Glyptothorax kashmirensis*. This species was found in Kurram River riffle habitats at Bagan (27 river miles upstream of the Kurram Tangi Dam site) and can be expected to be present in the riffle areas in the reaches of that river well downstream of that site. Because *Glyptothorax kashmirensis* was found in the Kurram near Bannu (see Table 7.1 in Annexure I of Annex IV of the

EMMP), it can be expected to be present in riffle areas from the Kurram Garhi Headworks to well above the Kurram Tangi Dam site. The Representative Important Species, *Glyptothorax naziri* and *Garra gotyla* found in this reach of the Kurram (Section 4.7.3.2), also prefer gravel bottom habitat in runs and riffles, but apparently are not dependent on riffle habitat. The degree of significance of this potential impact will depend on the extent of habitat loss. A small loss of riffle habitat loss downstream of the Weir will likely be of only minor significance; larger amounts may be of moderate significance

Assuming the extent of riffle habitat loss is small, the potential adverse construction impacts of the Kurram Dam, weirs and powerhouses on *Glyptothorax kashmirensis*, *Glyptothorax naziri* and *Garra gotyla* are not anticipated to be significant. *Tor putitora* and the Representative Important Species, *Salmophasia punjabensis*, *Barilius pakistanicus*, *Racoma labiata*, *Schizothorax plagiostomus*, *Schistura curtistigma* and *Mastacembelus armatus*, found in the this reach of the Kurram River are also not anticipated to be adversely impacted by the construction of the dam, weirs and powerhouses. These species are found in a variety of aquatic habitats and are not dependent on riffle areas.

Mitigation: The logical means of mitigating the potential effects of seepage pump-out is to lagoon the water and let the sediments settle out. The lagoon need not be large, equivalent to a couple of days of seepage flow, with allowance for rainfall. It could be given a few baffles, so that the inflow does not disturb the sediment. The overflow would then return to the river.

The increase in sediment load to the Kurram River can be reduced. Obtaining borrow materials from the bank areas of the river should be given priority over gravel mining in the river bed. Silt fencing can be used to reduce runoff in the areas of removal of borrow materials on the banks. When the need for in-river borrow material cannot be avoided, borrow areas upstream of the dam and weir sites should be utilized in preference to areas that will not be impounded downstream of these sites. The use of borrow areas downstream of these sites should be minimized, avoiding or minimizing the use of gravels in riffle areas, to the extent possible.

5.3.2.7 Socio-Economic Environment

Potential Impacts: As was the case for the Component 1 project area, the potential impacts of land abstraction and security and labor in-migration, outlined in Section 5.3.1.4 will continue and may even increase in magnitude as the land required for project infrastructure is actually taken out of production. One of the key challenges will be to have the replacement land developed (finalized housing schemes and agricultural land ready for utilization) before closing the flood gates and filling the reservoir.

In addition, the presence of construction workers (up to 1,100) and security personnel, the increased level of interventions of the Pakistan security services, as well as a generally increased interest in the region, will reduce the level of semi-autonomy of the local tribes and might conflict with local land use patterns, as was earlier the case in the Component 1 project area (poppy cultivation, informal trans-border trade, hospitality to (ex)combatants from Afghanistan etc.) and cultural norms (Pastunwalli, Sharia laws, FCR etc.). This is a significant potential impact.

Another potential impact is that an important cultural site (the shrine of the Fakir of Shewa) will need to be relocated to the resettlement area. In addition cultural heritage sites may be discovered during construction. Unmitigated this would result in the loss of cultural heritage., Mitigation , however, creates the risk of operational delay as rescue excavation tend to suspend or slow down construction activities at least until the importance of the chance discovery is assessed professionally. This potential impact is of moderate significance.

There will be an influx of construction workers (up to 1,100) and security personnel, who may carry certain diseases to which the local communities are not immune. In turn, the construction

workers might not be immune against certain diseases that are endemic, such as polio (FATA is a hotspot for this disease), cutaneous leishmaniasis and diphtheria.

The construction contractor is responsibility for establishing a health unit to treat minor illnesses of the construction crew with an ambulance at standby to transport medical and surgical emergencies to the relevant health care facilities. The staff at the health unit is usually not adequately trained to tackle emergencies, especially the surgical emergencies, while it is a known that efficient and timely first aid reduces fatalities. So the potential impact might be that due to insufficient preparation, the number of fatalities and injuries is unreasonably high. In the absence of mitigation this is a significant potential impact

Mitigation: The RPF provides an outline on how to establish a RAP and contains comprehensive compensation and livelihood restoration measures to mitigate the impoverishment risks associated with the physical and economical relocation of the populations in the footprint of Component 2.

The VTP addresses issues related to the temporary influx on non-tribal people and provides a comprehensive set of mitigating measures.

The RPF outlines a process of how to relocate cultural and communal infrastructure and the CHPP outlines detailed late find procedures to assure that no valuable cultural heritage site is destroyed and all valuable sites surveyed through rescue or full blown excavations.

The construction crew shall be requested to present appropriate heath certificates before being allowed to enter the construction camp. Disease data shall be maintained centrally by the Contractor's Health, Safety and Environmental Department (as proposed in the EMMP) and should be monitored regularly in line with the Contractor's Site Specific Environmental Management Plan.

The construction workers including survey teams shall be offered the opportunity to be vaccinated against possible occurring diseases and offered free of charge other prophylactic measures to control transmission of vector-borne diseases such as malaria, dengue and cutaneous leishmaniasis. This may include bed-netting, monitoring for small impoundments in the construction worker's camps, spraying to destroy mosquitoes and other insects such as sand flies and other vectors.

Health and Safety training shall be mandatory during induction and once every four months to make the project personnel aware of the possible diseases and to educate them about the measures to control transmission of diseases such as polio, HIV/AIDS and other STDs.

5.3.2.8 Roads, Bridges and Traffic

Potential Impacts: Deterioration of Air Quality: Potential impacts are the same as those identified for Component 1. However, fugitive dust emissions will be more of an issue for Roads B, C, D and F, since these are new roads that are to be constructed.

Noise Pollution: Potential impacts are the same as those identified for Component 1, but Roads B, C, D and F will cause more noise pollution because these are the new proposed roads.

Blasting Vibrations: Potential impacts are the same as those identified for Component 1.

Erosion: Potential impacts are the same as those identified for Component 1; however they are considered as having a higher probability of occurrence for new roads. This will be a major problem for Roads B, C and F since these are proposed to be constructed on a hilly terrain which will involve more cutting, excavation and other civil work. Road B will directly affect minor settlements like Spaira Ragha, Bobarbarai, Datta Khel, Spinwam and Shanalura. Similarly Road F will affect Shewa, Mirzagul, Nurshah and Zund Road C will affect Shanalura and Zarwam.

Water Pollution: Potential impacts are the same as those identified for Component 1. Construction of Road B will affect the Kaitu River while Roads C, D, and E will affect the Kurram River.

The other potential impacts (road safety, travel disruption and gender issues) are the same as those identified for Component 1.

Mitigation: The mitigation measures identified for the potential impacts in Component 1 will be implemented for the potential impacts in Component 2.

5.3.3 Operation Phase

During project operation, flow downstream of each of the three powerhouses of Component 2 will be maintained through generation, but in the absence of minimum releases at the weirs the intervening channels would be dewatered without minimum releases at the weirs.

Each of the Powerhouses II and III will require a round-the-clock operating force of about three engineers and supporting staff, totaling perhaps 20 individuals, plus service personnel. Similarly, each weir will require a supervising engineer, who will monitor the flow to the tunnel and the downstream release. These men, with their security force, are expected to occupy a small colony near the powerhouse. Collectively, this colony may be expected to house about 60 individuals. The operating force of the Weir/Powerhouse II may occupy the residence camp along the Spaira Ragha Road, but that of Weir/Powerhouse III will be too far away to expect them to drive back and forth from that camp. The closest market center for the operators of Powerhouse III will be Gumatti, about two miles away on the Bannu-Thal Road.

5.3.3.1 Land Resources

Topography and Drainage

Potential Impacts: Water will pond behind the proposed Kurram Tangi Dam wall creating a reservoir of 10,939 acres in surface area. This will result in a permanent change in the visual aspect of the Kurram River upstream of the dam wall from the current braided stream. In addition, water will also pond behind Weir II and Weir III, inducing a similar change in the aspect of Kurram River at these points. These will be permanent changes to the landscape, of high magnitude but of local extent and as such is considered to be of high significance. For the same reason given for Component 1 neither a negative or positive determination has been given to the potential visual impact of these infrastructures.

New roads and powerhouse buildings could also impact visual resources locally. These potential impacts will be of low magnitude and permanent, and are assigned a low significance.

Mitigation: The potential visual impacts cannot be avoided as the purpose of Component 2 is to construct the Kurram Tangi Dam and the other infrastructure. While the potential visual impact of smaller structures such as powerhouses can be partially mitigated by designing the buildings to blend in with their surroundings, the potential visual impacts will be compensated for by the potential positive socio-economic impacts that should be derived from increased water availability for irrigation and during low flow periods as well as increased power generation.

Geology, Geotechnical Issues and Seismicity

Potential Impacts: Reservoir-triggered seismicity (RTS): is described as earthquake events that are triggered by the filling of a reservoir, or by water-level changes or fluctuations during operation of the reservoir. Throughout the world, several thousand dams have been constructed and are impounding reservoirs which are operating without any observed RTS. Compared to the large number of operating reservoirs, there are only a very few instances of possible RTS cases. The KTDP will have a shallow and small reservoir, which puts the likelihood of RTS occurring as very low. The resulting magnitude from RTS is estimated to be less than M 5.0. In the context of the

design event (M>7.4) used in the DSHA, this is thought to pose little additional hazard to the project.

Available geologic data and geological studies carried out on satellite imagery suggest that there is no likelihood of rock slides around the dam and on the reservoir rims. Therefore, the hazard of rockslides during a strong earthquake is assessed as non-significant.

Dam failure: If the measures described in Sections 5.2.1 are not implemented there is a risk of failure of the Kurram Tangi Dam structure in the event of a MCE causing major downstream flooding that would potentially impact agricultural activities, infrastructure and dwellings and result in loss of human and animal life. This is a regional, short-term, high magnitude and probable potential impact and is assessed as significant.

Mitigation: The risk of dam failure can be mitigated by implementation of the measures described in Sections 5.3.1 above.

Agriculture and Irrigation

Potential Impacts: Changed river regime downstream of Kurram Tangi Dam: The water supply to areas downstream of the dam will be affected by construction of the dam and inundation of the reservoir area, especially the riparian areas (floodplains outside the Civil Canals and Marwat Command Areas) which depend upon the pre-project natural Kurram River regime (water levels, flows and sediment). This needs further study. Satellite imagery suggests that these areas are large but their actual extent is currently not known. In these dominantly gravity-fed irrigated areas, cropland and orchards amount to about 27,280 and 275 acres respectively. Temporary structures in the river for gravity irrigation can be observed but the exact number and type are not known. Irrigation of these areas is most likely by flood water or the water that is diverted by temporary weirs of stones across the river bed (comparable with the leaky stone dams in Datta Khel). If water flow in the river is less and consequently water levels are lower it will be more difficult to lift and divert the water in the river using these temporary, heavily leaking structures so as to irrigate by gravity. The flow of nutrient-carrying sediment load to the downstream riparian areas will be disrupted because the sediments will be trapped in the reservoir of the Kurram Tangi Dam. This will increase the cost of maintaining soil fertility in these areas. All these complex, interlinked factors make the magnitude of this potential impact high. Its extent is regional and its duration is permanent. Therefore this will be a significant potential impact.

Agricultural development: The benefits of the Kurram dam are many. About 69,000 acres of the Thal plain will be brought under irrigated agriculture resulting in higher cropping intensities, and increased per acre yields and agricultural production. Similarly, an increased water supply will be ensured to 170,000 acres of Marwat and a more efficient supply to 107,000 acres of Civil Canals Command Areas. The magnitude of this potential impact is high; the extent will be regional, the duration long-term and the likelihood high. Hence this is a significant potential positive impact. This potential impact could be further enhanced if water allocation (water rights) promotes fair water distribution between the head and tail ends of the systems.

However in many irrigation systems unequal distribution is a persistent problem. In some traditional law systems in Pakistan and PK/ North Waziristan it is even defined that the users at the head end have the right to take the water when they want and as much as they want. The Irrigation Department has a very important role to play in ensuring rational water management and a fair water distribution.

Mitigation: Reduced water supply and nutrient-carrying sediment to downstream riparian areas Mitigation measures can only be established after thorough study of these riparian areas. The required studies include the following:

- Identification of all irrigation schemes (constructed and managed by farmers and/or communities) in the riparian areas, their water sources and extraction/derivation means (e.g. temporary weirs).
- Water allocation (water rights) and distribution.
- Actual irrigation practices during Rabi (dry and low flow) and Kharif (wet and high flows/floods) season.
- Actual agricultural practices (particularly about maintaining soil fertility).
- Replacement of the temporary stone weirs by low permanent weirs and compensation to users of the downstream riparian areas of the Kurram Tangi Dam for the loss of nutrients in the river water, possibly in the form of input subsidies for fertilizers.

Agricultural development: Formation of Water Users Associations (WUA) in the command areas to encourage the farmers in equitable water use for irrigation. Water rights must be clearly defined and agreed upon by both upstream and downstream farmers.

Waste Management
Estimates of waste generation during operations have not been broken down by component as only a global estimate of the project operations staff has been made. The generation rates for solid waste and wastewater are 160 kg/day and 12,800 gpd respectively (Section 5.2.3.1).

Potential Impacts: The potential impacts identified for operation stage of Component 2 are the same as for Component 1. However, the water bodies receiving the potential impacts of Component 2 will be the Kurram River, Thal Canal and Marwat Canal. The aquatic life and designated use of downstream river water and irrigation canals for the settlements of Bannu, Ghoriwala, Sada Khel, Naurang Sarai, Lakki Marwat, Wandha Khajjar, etc. will also be affected.

Mitigation: The mitigation measures for the potential impacts identified for Component 2 operations are the same as those for Component 1 operations.

5.3.3.2 Climate and Climate Change

Potential Impacts: Operation of Component 2 is not expected to bring changes to the local or regional climate.
However, some microclimatic changes of lesser significance may be noticed. Formation of a storage reservoir in the Kurram River area covering an area of about 10,939 acres has potential to bring some microclimatic changes in the adjoining areas, especially the dry period. The daytime temperatures may be lowered by a degree or two and locally the weather may be humid with foggy mornings.

The potential impact of climate change is deemed to be a more critical concern. The potential local socio-economic impacts of climate change are likely to be around adjusting to longer summers, higher summer temperatures, and an earlier spring melt of the snow packs. If water resources are not properly managed, this could result in a decrease in summer productivity through the hottest months. However, a longer summer season, if coupled with well managed irrigation waters, could actually extend the growing season and result in higher agricultural productivity and a boost to the local economy. If not managed properly, it is likely that climate change will result in a decrease in the overall agricultural productivity, and a potential negative socio-economic impact on the region.

The potential national impact of increasing temperatures will be an increase in summer demand of power for cooling needs. Since the Kurram Tangi Dam operation would likely peak in the spring months, it is likely that the summer production will only make a marginal impact on the increased summer power needs nationwide. Unless significant storage capacity was built to allow for longer retention of the spring snow melt behind the dam. It is also likely that Pakistan will need to turn to other, non-hydro sources of power to meet increasing summer power demands, which could have negative economic impacts given the fact that much of the fuel to run Pakistan's non-hydro fossil fuel

units is imported. Additionally, the combustion of those fossil fuels will produce additional GHGs, further exacerbating the climate change problems.

Mitigation: Following are the recommendations for managing the anticipated climate changes at the KTDMP and the region potentially impacted by the project:

- Assess possible shifts in hydrology by the 2040-2065 time period. Based on outcomes account for increased siltation in reservoir management planning, and assess the possible changes in the power curves to account for any reduction in power output during peak summer months.
- Assess possible shifts in future hydrology on the river flood plain levels. Based on outcomes assess any resultant resettlement needs, crop pattern considerations, livestock grazing patterns, and education campaigns about flash flooding.
- Ensure that irrigation planning accounts for possible future decreases in summer water availability, drier soils, and shifts in agricultural practices.
- Assess existing crop and livestock tolerances to increased temperatures and any necessary changes in future management practices. Conduct agricultural outreach to assist in adaptive changes which may be necessary in the future.
- Assess whether agricultural outreach may offset possible human induced stresses to the natural rangeland habitats.
- Assess local health practices and needs to determine if climate induced human illnesses are likely, and if measures can be taken to counteract these.
- Prepare emergency plans for extreme climate events.

GHG Emissions Offset: The calculation of GHG emissions is described in Section 5.2.3.2 above. The carbon baseline for the dam calculated for each year of operation over the anticipated life of the project, as follows:

$$(\text{kWh displaced by Component 2 for each year}) * (0.451\ \text{kgCO}_2/\text{kWh}) = \text{kgCO}_2/\text{year}$$

The projected power production is 317,000 MWh/year, based on an installed capacity of 64.9 MW capacity and 45.5 percent capacity factor.

This then results in a possible carbon offset of 142,967 metric tons of carbon dioxide per year (MT CO_2/year). Assume valuation of \$5/MT CO_2, the annual value of that carbon offset would be \$14,835. This is the equivalent of taking over 29,475 motor vehicles off the road for a year.

5.3.3.3 Air Quality

The potential impacts during the operation stage of Component 2 are described below.

Vehicular Emissions: Traffic on the new and upgraded roads will affect air quality in adjacent settlements (see Section 5.3.2.3). Vehicular emissions will have a medium significance potential impact.

Emissions of Greenhouse Gases: A large amount of aquatic vegetation may result from the impoundment of water behind Kurram Tangi Dam. This aquatic vegetation may periodically die and decay, causing buildup and release of methane. According to WHO standards for air quality, methane is not a priority pollutant. Therefore, the significance of methane release is not estimated.

Industrial Development: Availability of water and a proper road network in the area may encourage development of industries that could potentially adversely affect air quality. The magnitude of the potential impact will depend on the number of industries, which in turn will not only be conditioned by potential agricultural intensification, but other factors such as the security situation, labor availability, skills and education of available labor and access to markets amongst others. While the magnitude of this potential impact would be high and the duration long term if many industries developed, it is currently considered to have a low likelihood of occurring on a large scale. Should such development occur, the population in the areas near Gumbatai, Shashogai and Zawakhwara, which will likely increase, could be exposed to potential industrial air emissions, if the industries are situated close to residential and commercial areas. However, this potential impact is considered to have a low likelihood and is evaluated as non-significant.

Mitigation: The mitigation measures adopted for Component 2 will be the same as those for Component 1.

5.3.3.4 Noise

Potential Impacts: Roadworks: Roads upgraded during construction of Component 2 include the road leading from the dam site to Powerhouse III (Thal-Bannu Road) and the road from Powerhouse III to Bannu. A new road will be built from the dam site to Powerhouse II. These roads, along with the operational Kurram Tangi Dam, will encourage vehicular traffic and settlement (new settlement and growth in existing settlements) in the area near Gumatti, which is currently the only major settlement in the Component 2 area.

The magnitude of the potential impact is assessed to be moderate, because the noise will be of a persistent nature (as opposed to irregular). The potential impact will be long term in duration. Therefore, the overall significance will be of medium significance.

Establishment of New Industries/ Settlements: Development of the Kurram Tangi Dam and other Component 2 elements may encourage the establishment of new small industries and settlements. . The magnitude of the potential impact will depend on the number of industries, which in turn will not only be conditioned by potential agricultural intensification and increased water availability, but other factors such as the security situation, labor availability, skills and education of available labor and access to markets. While the magnitude of this potential impact would be high and the duration long term if many industries developed, it is currently considered to have a low likelihood of occurring on a large scale. Noise from any such industry could potentially be a source of nuisance if there are nearby residential areas. The potential impact is considered non-significant.

Mitigation: Mitigation measures for Component 2 operation will be similar to those described for Component 1 operation.

5.3.3.5 Water Resources

Hydrology

Potential Impacts: The main potential impact during operation will be the seasonal regulation of the water flow by the Kurram Tangi dam and reservoir. Avoidance of the frequent heavy flooding land and habitat downstream of the dam will be a potential positive impact. On the other hand, dry period will experience a higher than historical flow and wet period will experience a lower than historical flow on the section downstream of the Kurram Tangi dam. As the river flows downstream and mixes with other rivulets and streams, the potential impact will be less severe.

Kurram Tangi dam will trap a large amount of silt and cause the trapped silt to settle down in the dead storage portion of the Kurram Tangi reservoir resulting in the less amount of silt in the river downstream of the dam. Decrease of silt will have a potential negative impact on the morphology of the river. Decreased amount of silt in river water and drastic decrease in the frequency of heavy flooding conditions will cause the soil conditions to change in the land downstream of the dam and has the potential to cause the agricultural productivity to decrease. The potential agricultural impact and its mitigation are discussed separately in Section 5.3.3.1.

Mitigation: Envisaged discharges from the Kurram Tangi Dam and Weir II are sufficient to meet ecological and environmental flow requirements downstream of these structures. However, a 6,560-ft long reach of the Kurram below Weir III will be dewatered when the Powerhouse III hydro is in operation. Envisaged flow releases from the Dam and Weir II and Weir III (See Section 5.3.3.6 Aquatic Resources) will maintain the wet channel in the river downstream of the dam during the operation phase (apart from the dewatered reach). These flows are envisaged to keep the river hydrology and morphology live to its minimum level required for aquatic ecology in the most dewatered section of Kurram River. Besides, they will also provide general water requirements needed for economic and social purposes. The released environmental flows will also be sufficient for other terrestrial wild life. Such environmental flow releases when augmented with the ground water seepage and tributary flow from streams present downstream of the dam is envisaged to further enhance the river hydrology and morphology downstream.

Water Quality

Potential Impacts of Main Dam: Phosphorous is currently used as fertilizer in the proposed reservoir area. Impounding water will result in the accumulation of phosphorous in the reservoir. Water will also percolate into the soil and groundwater. Domestic waste will contaminate the reservoir from nearby areas as they develop. Thermal stratification of the reservoir will take place during the summers, restraining mixing of the water column and resulting in low dissolved oxygen levels and high turbidity.

Impoundment of water in the reservoir will result in an accumulation of salts and subsequent seepage and percolation into groundwater. Salt accumulation could potentially result in arsenic contamination of groundwater. Water pollution is regarded as a significant issue for the operation phase of the Main Dam and reservoir. Mitigation measures described below will reduce the significance of this issue.

Potential Impacts of Powerhouse I, II and III: The potential operational stage impacts of Powerhouse I, II and III will be similar to those described for Powerhouse IV and V in Component 1.

Mitigation:

- Monitoring of water quality will be conducted once every six months. The locations where water quality samples are to be taken in the operational stage have been marked on Map 4-32. The parameters that shall be analyzed are listed in Chapter 8 of the EMMP and include arsenic.
- Temperature and dissolved oxygen will be monitored. If analysis of the monitoring data indicates the need for corrective action, mixing of surface water with hypolimnial water could be undertaken to minimize shifts in water regime.
- In areas surrounding the reservoir, farmers will be properly trained in the use of fertilizers and pesticides. The Agricultural Department of Miranshah, FATA should carry out the training which should include recommendations as to the dose, type, amount and economic feasibility of different fertilizers, suggesting those which are environmentally friendly with minimum residual effects.
- Organic fertilizers will be promoted and it is strongly recommended that a pest management plan be implemented.

The mitigation measures described above will reduce the overall significance of potential water quality impacts to medium.

5.3.3.6 Biological Resources

Terrestrial Ecosystems

Potential Impacts: Displacement of wildlife: As in the case of Component 1, filling the reservoir will cause fleeing movements of pest mammals in the flooding zone, along with their predators. Because the reservoir is expected to take several years to fill to its full supply level, these movements of wildlife will not be especially noticeable, but during the spring high flows, the villages

bordering the reservoir may experience more rodents and snakes. The croplands in the reservoir will be inundated early in the filling period, so the crop pests will probably be seen in the first season. The few large mammals (e.g. wild boar, red fox, and porcupine) will also seek higher ground. Residents of areas that will be inundated in the subsequent years will already have been resettled during the last year of construction and the razing of villages will have taken place. Livestock that is normally allowed to graze freely along the river will be moved by its owners, while any feral animals will be forced into drier areas. This is a local, short-term, definite potential impact of low magnitude. It is of low significance and does not require mitigation.

The weir pools of Powerhouses II and III will see different potential inundation impacts from those at the Main Dam. Weir II would not inundate any cropland, but would submerge a peninsula of scrubby woodland, which may be assumed to support some animals. The weir pool would come within about 100 horizontal feet of the Bannu-Thal Road. Across the road from the woodland are several residential compounds, which may find their livestock slightly affected by predators from the woodland. There is no information available on wildlife use of this woodland. However, it may be assumed that wildlife would migrate away from the area as it is being inundated. This is a local, short-term, definite potential impact of low magnitude. It is non-significant and does not require mitigation.

In the case of Weir III, the pool will be much larger than that of Weir II. In the 1.8-mile length of this pool, the only significant area of irrigated agriculture, about 15 acres, lies along the left bank of the river immediately downstream of Zarwam. There is another area of about an acre on the left bank, about 4,500 feet downstream of the town, but that will not hold enough pest rodents to cause problems. The larger area will produce rodents and snakes, but there is no reason to believe that they will enter the village. The potential impact to wildlife is non-significant.
Increased bird feeding areas: The creation of standing water bodies at all three sites could provide staging posts for migratory waterfowl and waders. This is a highly probable and long-term, potential positive impact of local extent and high magnitude. It is assessed as significant. However, waterfowl and waders that use the water bodies created by the dam and weirs will be exposed to hunting by local residents. The impact on species of concern such as the Marbled Teal, (vulnerable), White-headed Duck (endangered), and Sociable Plover (critically endangered) the impact could be significant.

Destruction of habitat or vegetation: Operating staff could cut vegetation for fuelwood. This is a local, long term, probable potential impact of low magnitude. It is assigned a low significance.

There are no endemic species in the Component 1 area.

Mitigation: Displacement of wildlife: Residents of villages bordering the reservoir should be informed that they may expect an invasion of crop pests and snakes. If venomous snakes are expected to flee the reservoir filling, local clinics should be provided with antivenins.

Destruction of habitat or vegetation: Operating staff will be provided with heat and cooking fuel, rendering the use of fuel wood unnecessary.

Aquatic Resources

Potential Impacts: There are three major sub-components of Component 2 that affect the aquatic ecosystem: 1) Kurram Tangi Dam, its reservoir and Powerhouse I; 2) Weir II, its impoundment and Powerhouse II; and 3) Weir III, its impoundment and Powerhouse III. Although the potential impacts of these sub-components are similar, they differ in magnitude. Recognizing the complex and cumulative interaction of these sub-components (the distance between the Kurram Tangi Dam and Powerhouse III is only seven river miles), they are, nonetheless, addressed separately for clarity. The cumulative interactions are described as needed. Collectively, they will fragment the Kurram River upstream of the Kurram Garhi Headworks into four segments: 1) the reach of the Kurram River from its headwaters to the Kurram Tangi Dam; 2) the reach between the Kurram Tangi Dam and Powerhouse Weir II; 3) the reach between Powerhouse Weir II and Powerhouse Weir III (which includes the confluence of the Kurram and Kaitu rivers); and 4) the reach from Powerhouse Weir III to the Kurram Garhi Headworks. In all cases, it is assumed that the hydropower facilities will be operated in a "run-of-river" mode.

Sub-Component 1): Kurram Tangi Dam, Reservoir and Powerhouse I. The Kurram Tangi Dam (RM 67) will isolate some 120 miles of the Kurram River above the dam (KTDC 2004) from the 11-mile reach between the Dam and the Kurram Garhi Headworks (RM 56), and will prohibit the fauna in that reach below the dam from moving upstream into the upper reaches of the river. Given the extent of aquatic habitat upstream of the dam that is suitable for most of the fish species in the Kurram, this potential impact will be significant. Some of these species (including the Golden Mahseer, *Tor putitora*, listed by IUCN as endangered) are undoubtedly presently migrating upstream from reach between the Dam and the Headworks to the upper reaches of the river for spawning. The loss of spawning habitat in the upper Kurram can be expected to reduce the populations of these species, especially that of the Golden Mahseer. The potential adverse impact resulting from this blockage will be exacerbated if most of the Kaitu River is eliminated as an alternative to the upper reach of the Kurram. The habitat in the Kaitu will be unavailable if the potential adverse impacts of Component 1 are not mitigated.

The Kurram Tangi Reservoir will inundate 8 miles of river habitat (Section 3.3.3), changing it to a lacustrine habitat. The riffle/rapid habitats (such as those near Thal) in the inundated reach will be lost. Based on images in Google Earth, there numerous riffle/rapids (some extensive in length) in the Kurram from the Dam site to Thal. The change from riverine to lacustrine habitat will also result in changes in water quality characteristics and aquatic fauna in the reservoir.
Water temperatures and levels of DO in the reservoir will be different than the ambient conditions of the river coming into the reservoir. During the summer months, the reservoir will thermally stratify because of its depth. Bottom waters will be substantially colder than those in the surface layer, and levels of DO in the bottom waters will be substantially lower than those in the surface layer. Depending on the amount of organic matter that settles on the bottom of the reservoir, the level of DO in the bottom water could approach anoxic conditions during the period of thermal stratification.

The aquatic fauna in the reservoir will change from predominantly riverine species to those that can adapt to a lacustrine environment. The aquatic fauna most likely to be impacted by the formation of the impoundment would be species inhabiting riffle areas inundated by the impoundment. Most of these species, especially some rheophilic species of benthic macroinvertebrates and *Glyptothorax kashmirensis*is, will likely leave the impounded reach for suitable habitats upstream. Golden Mahseer may spend part of its lifecycle in the reservoir, but will leave it to migrate upstream to spawn. *Salmophasia punjabensis*, *Barilius pakistanicus*, *Garra gotyla*, *Racoma labiata*, *Schizothorax plagiostomus*, *Schistura curtistigma*, *Glyptothorax naziri* and *Mastacembelus armatus* found in this reach of the Kurram River are not anticipated to be adversely impacted and will likely adapt to the reservoir.

Because the biological productivity of the reservoir will be higher than that of the river, the populations of many species that adapt to the impoundment will be larger in the impoundment than

in the riverine habitats of the Kurram. Additionally, it is anticipated that a commercial fishery can be established in the reservoir.

Fish entrained into the intake of Powerhouse I will be subject to turbine-induced mortality. Most of the fish entrained will likely be small (less than 4 inches in length), and experience 5 percent to 6 percent mortality. Larger fish (8 inches or longer) passing the turbines are likely to experience 10 percent to 30 percent mortality. The likelihood of entrainment will depend on the distribution and movements of the species in the reservoir. Fish not in the vicinity of the hydropower intakes will not be entrained. Thus, the potential impact of fish entrainment will be of minor significance for most species in the Kurram Tangi Reservoir. However, it can be expected to be significant for the Golden Mahseer (*Tor putitora*) because of its migratory habits. Golden Mahseer can be expected to attempt to migrate downstream if water temperatures in the reservoir become lower than the zone of thermal preference for this species.

The flows in the Kurram River downstream of the Dam will be reduced during filling the reservoir and changed by the operation of the hydropower units in Powerhouse I. During reservoir filling, it is assumed that only the flow required for downstream irrigation demands will be released from the Dam. Such flows may periodically be less than needed to maintain the aquatic ecosystem in the downstream reach of river. The resulting degradation in aquatic habitat can be expected to result in most of the fauna in the reach between the Dam and the impoundment formed by Weir II moving into the Weir II impoundment (if present). Some of the fauna will be lost. The loss of habitat will be significant for the Species of Concern because they are considered Endangered at the international level on the basis of habitat loss.

When the turbines in Powerhouse I are in operation, the flows will be sufficient to maintain the aquatic ecosystem in the downstream reach between the Dam and Weir II. However, when the reservoir is thermally stratified, the discharged water will be cold and likely have low DO. Those water quality conditions will make the affected portion of the downstream reach unsuitable for most of the fish fauna.

Sub-Component 2) Weir II, its impoundment and Powerhouse II. Weir II will further fragment the aquatic ecosystem of the Kurram River. It will isolate the portion of the river between the Weir and the Kurram Tangi Dam from the reaches downstream and will prohibit the fauna below the weir from moving upstream. The presently available aquatic habitat upstream of Weir II to the Dam totals 1.5 river miles. However, because it is a short distance, the potential impact of this lack of access by downstream fauna to the reach between the weir and the dam will only be of minor significance.

Nonetheless, the cumulative effect is to further reduce the availability of suitable habitat for migratory species downstream of the weir. As previously noted, *Tor putitora* is assumed to presently migrate upstream from the reach below the weir to the upper reaches of the river for spawning. The additional loss of habitat can be expected to further reduce the populations of these species in the reach below Weir II. The potential adverse impact resulting from the blockage by Weir II will be exacerbated if the Kaitu River is eliminated as alternative habitat to the upper reach of the Kurram. Even with the operation of Powerhouse II, most of the habitat in the Kaitu will be unavailable if the potential adverse impacts of Component 1 are not mitigated.

Weir II will form an impoundment that extends 0.3 miles (Section 3.3.6) in the river upstream of the weir. The impoundment will change the aquatic habitat from riverine to lacustrine, resulting in a change in water quality characteristics and aquatic fauna. Water temperatures in the impoundment will be slightly warmer than the ambient temperatures of the river coming into the impoundment; levels of dissolved oxygen (DO) will be somewhat reduced in the impoundment. The aquatic fauna will change from predominantly riverine species to those that can adapt to a lacustrine environment.

The aquatic fauna likely to be the most impacted by the formation of the impoundment will be species inhabiting riffle areas inundated by the impoundment. Most of these species, especially some rheophilic species of benthic macroinvertebrates and *Glyptothorax kashmirensis*is, will likely leave the impounded reach for suitable habitats upstream. *Tor putitora* will lose spawning habitat as a result of the formation of the impoundment. *Salmophasia punjabensis*, *Barilius pakistanicus*, *Garra gotyla*, *Racoma labiata*, *Schizothorax plagiostomus*, *Schistura curtistigma*, *Glyptothorax naziri* and *Mastacembelus armatus* found in this reach of the Kurram River are not anticipated to be adversely impacted and will likely adapt to the impoundment.

Because the biological productivity of the impoundment will be somewhat higher than that of the river, the populations of many species that adapt to the impoundment will likely to be larger in the impoundment than in the riverine habitats of the Kurram. However, it is unlikely that a commercial fishery could be established in the impoundment because of its small size.

Fish entrained into the intake of Powerhouse II will be subject to turbine-induced mortality. Most of the fish entrained will likely be small (less than 4 inches in length), and experience 5 percent to 6 percent mortality. Larger fish (8 inches or longer) passing the turbines are likely to experience 10 percent to 30 percent mortality. The likelihood of entrainment will depend on the distribution and movements of the species in the reservoir. Fish not in the vicinity of the hydropower intakes will not be entrained. Thus, the potential impact of fish entrainment will be of minor significance for most species in the Kurram. However, it can be expected to be significant for the Golden Mahseer (*Tor putitora*) because of its migratory habits. Golden Mahseer can be expected to attempt to migrate downstream if water temperatures in the impoundment become lower than the zone of thermal preference for this species.

The flows in the Kurram River downstream of the Weir II will be reduced during filling the impoundment and altered by the operation of Powerhouse II. During impoundment filling, it is assumed that only the flow required for downstream irrigation demands will be released from the weir. Such flows may periodically be less than needed to maintain the aquatic ecosystem in the reach of river between Weir II and the confluence of the Kurram with the Kaitu River. When Powerhouse II is in operation, it is assumed that no flow would be released from the weir because there is no irrigation use between the weir and the confluence of the Kurram and Kaitu rivers. The resulting degradation in aquatic habitat will result in the fauna in the reach below Weir II moving into the Weir III impoundment or into the Kaitu River. Some of the fauna will be lost. The loss of habitat will be significant for the Species of Concern because they are considered Endangered at the international level on the basis of habitat loss.

Sub-Component 3) Weir III, its impoundment and Powerhouse III. Weir III will further fragment the aquatic ecosystem of the Kurram River. It will isolate the portion of the river above the weir from the 5-mile reach that extends downstream to the Kurram Garhi Headworks. Weir III will prohibit the downstream fauna from moving not only into the Kurram above the weir, but also the Kaitu River. The extent of aquatic habitat between Weir III and Weir II totals 22 river miles, including the 4.5 miles between the weirs plus 17.5 miles of the Kaitu River from the confluence with the Kurram to the Kaitu Weir. The potential impact of this lack of access by downstream fauna to these reaches will be significant. *Tor putitora* is assumed to presently migrate upstream from the reach below Weir III to the upper reaches of the Kurram (as well as the Kaitu River) for spawning. The additional loss of habitat can be expected to substantially reduce the population of this species in the reach of river between Weir III and the Kurram Garhi Headworks.

Weir III will form a reservoir that extends 3.5 miles upstream to the confluence of the Kurram and Kaitu rivers. The impoundment will change the aquatic habitat from riverine to lacustrine, resulting in a change in water quality characteristics and aquatic fauna. The changes in water quality will be similar to those in the Kurram Tangi Reservoir, but will be greatest near the 75-ft high dam. Water temperatures in the impoundment will be warmer than the ambient temperatures of the river

coming into the impoundment; levels of dissolved oxygen (DO) will be lower in the deeper parts of the reservoir. During the summer months, the reservoir will become weakly stratified. The aquatic fauna will change from predominantly riverine species to those that can adapt to a lacustrine environment.

The aquatic fauna most likely to be adversely impacted by the formation of the impoundment will be species presently inhabiting riffle areas inundated by the impoundment. Most of these species, especially some rheophilic species of benthic macroinvertebrates and *Glyptothorax kashmirensis*is, will likely leave the impounded reach for suitable habitats upstream, now restricted by the other sub-components of Component 11 and by Component 1. Golden Mahseer will lose spawning habitat as a result of the formation of the impoundment. This species may spend part of its lifecycle in the reservoir, but will leave it to migrate upstream to spawn. Without any barriers, upstream migrations of over 40 river miles could be expected for this species. *Salmophasia punjabensis*, *Barilius pakistanicus*, *Garra gotyla*, *Racoma labiata*, *Schizothorax plagiostomus*, *Schistura curtistigma*, *Glyptothorax naziri* and *Mastacembelus armatus* will likely adapt to the impoundment.

Because the biological productivity of the impoundment will be somewhat higher than that of the river, the populations of many species that adapt to the impoundment will likely to be larger in the impoundment than in the riverine habitats of the Kurram. Additionally, it is possible that a commercial fishery could be established in the impoundment.

Fish entrained into the intake of Powerhouse III will be subject to turbine-induced mortality. Most of the fish entrained will likely be small (less than 4 inches in length), and experience 5 percent to 6 percent mortality. Larger fish (8 inches or longer) passing the turbine are likely to experience 10 percent to 30 percent mortality. The likelihood of entrainment will depend on the distribution and movements of the species in the reservoir. Fish not in the vicinity of the hydropower intakes will not be entrained. Thus, the potential impact of fish entrainment will be of minor significance for most species in the Kurram. However, it can be expected to be significant for the Golden Mahseer (*Tor putitora*) because of its migratory habits. Golden Mahseer can be expected to attempt to migrate downstream if water temperatures in the reservoir become lower than the zone of thermal preference for this species.

The flows (when released) in the Kurram River downstream of the Weir III will be reduced during filling the impoundment and the operation of Powerhouse III. During impoundment filling, it is assumed that only the flow required for downstream irrigation demands will be released from the weir. These flows are likely to be sufficient to maintain the aquatic ecosystem in the reach of river between Weir III and the Kurram Garhi Headworks because of the irrigation demand at the Headworks. When Powerhouse III becomes operational, the 6,560-ft long reach of the river bypassed by the penstock will be dewatered (assuming there is no human use of flows in the bypass reach). The resulting aquatic habitat loss in the bypass reach will result in the bypass reach fauna moving downstream of Powerhouse III. Some of the fauna will be lost. The loss of bypass habitat will be of moderate significance for most species. However, the potential cumulative adverse impact that results from this loss for the Species of Concern will be significant.

Mitigation: The mitigation issues for Component 2 are the same as for Component 1. Ecological Flows need to be released at the Kurram Tangi Dam, Weir II and Weir III; and the blockage of upstream migrations by fish (especially Golden Mahseer, *Tor putitora*) downstream of these structures, and fish entrainment into the powerhouses need to be addressed.

The Ecological Flows for Component 2 are, as for Component 1, estimated using the Tennant Method (Tennant 1976), which utilizes a percentage of the annual mean flow on a seasonal basis. During low flow months, 20 percent of the annual mean flow is considered "Good." During high flow months, 40 percent of the annual mean flow is needed to maintain "Good" conditions; 30 percent of the annual mean flow is considered only "Fair." Based on the period of record from 1971-2011, the

annual mean flow of the Kurram River at the Thal Gage was 878 cfs (Sections 4.6.1.2 and 4.7.3.2). An Ecological Flow for the Kurram downstream of the Kurram Tangi Dam would then be about 176 cfs during the low flow months (September to June, on average), and at least 263 cfs during July and August. These flows would be needed during reservoir filling. When Powerhouse I is operational, the discharge from the three turbine units (each having a design discharge of about 449 cfs) will more than meet the Ecological Flow requirement.

There are no gauges at the sites of Weir II and Weir III. Thus, the hydrological characteristics at these sites were estimated using the proportion of the drainage area at these sites in comparison to that at the Kurram Garhi Headworks. Based on these proportions and the flows at the Headworks gauge for the period of record of 1971 - 2012, the annual mean flow at Weir II was 1,060 cfs and that at Weir III, 1,332 cfs. The Ecological Flows at Weir II would then be 212 cfs during the low flow months (September to June, on average), and at least 318 cfs during July and August. The Ecological Flows at Weir III would be about 266 cfs during the low flow months (September to June, on average), and at least 400 cfs during July and August.

The above Ecological Flows based on the Tennant Method are to be considered initial estimates. The method is not biologically based and will need to be adjusted based on additional studies that should begin with a year-long comprehensive survey of the fisheries resources in the reach of the Kurram River below the Dam. As for Component 1, when the biological uses of the reach from the Dam to the Kurram Garhi Headworks are known, the final Ecological Flows should be determined using a habitat modeling method, such as PHABSIM (Bovee, 1982). That study should be conducted by an experienced team of fisheries biologists, hydrologists and hydraulic engineers (see Dyson 2008), and focus on the fish species in the Kurram, including the Species of Concern, the Golden Mahseer and *Glyptothorax kashmirensis*.

As with Component 1, true water/wastewater requirements in Component 2 likely are negligible due to the lack of piped water supply and wastewater discharge systems. We have applied the same assumptions used in Component 1 to develop estimates in order to assess the relative impacts of human activity on surface water flows. These assumptions result in a consumptive water use of about 0.7 cfs and a non-consumptive wastewater use of about 6 cfs for Component 2, significantly less than the Ecological Flows of 176 cfs to 263 cfs at the Kurram Tangi Dam, and the Weir II and Weir III Ecological Flows of 212 cfs to 400 cfs estimated above. These Ecological Flow discharges are expected to be more than sufficient to meet water/wastewater Environmental Flow requirements as well. However, the irrigation demand component of the Environmental Flow requirements remains to be addressed.

The irrigation flows required for the Marwat and Civil Canals vary from 312 cfs to 1410 cfs, depending on the month. Because these flows are diverted from the Kurram River, they are a consumptive use and the total minimum releases need to accommodate them as well. Although these flows are diverted at the Kurram Garhi Headworks, it is assumed they would be met by releases at the Kurram Tangi Dam, and at Weirs II and III. As such, the flows released to meet irrigation demands at the Headworks will meet the Ecological Flow and Environmental Flow and Environmental Flow requirements between the Kurram Tangi Dam and the Headworks. The total minimum flow release requirements are, thus, the monthly irrigation flows, as shown in Table 5-13. The lowest total minimum release flows occur in December (313 cfs at Kurram Tangi Dam, Weir II and Weir III), while the highest releases occur in September (1,411 cfs at Kurram Tangi Dam, Weir II and Weir III).

The flows and the schedule of their release shown in Table 5-13 need to be included as part of the dam/reservoir operating procedures for the Kurram Tangi Dam, and Weirs II and III, and coordinated with the irrigation demand operations of Component 2.

Table 5-13: Minimum Ecological and Environmental Release Flows (cfs) for Component 2

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Kurram Tangi Dam												
Water (consumptive)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Wastewater (non-consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Ecological (non-consumptive)	176	176	176	176	176	176	263	263	176	176	176	176
Irrigation - Marwat & Civil Canals (consumptive)	726	921	1013	1140	1066	753	982	845	1410	1373	1264	312
Total Min Release (1)	727	922	1014	1141	1067	754	983	846	1411	1374	1265	313
Weir II												
Water (consumptive)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Wastewater (non-consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Ecological (non-consumptive)	212	212	212	212	212	212	318	318	212	212	212	212
Irrigation - Marwat & Civil Canals (consumptive)	726	921	1013	1140	1066	753	982	845	1410	1373	1264	312
Total Min Release (1)	727	922	1014	1141	1067	754	983	846	1411	1374	1265	313
Weir III												
Water (consumptive)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Wastewater (non-consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Ecological (non-consumptive)	266	266	266	266	266	266	400	400	266	266	266	266
Irrigation - Marwat & Civil Canals (consumptive)	726	921	1013	1140	1066	753	982	845	1410	1373	1264	312
Total Min Release (1)	727	922	1014	1141	1067	754	983	846	1411	1374	1265	313
Kurram Ghari Headworks												
Water (consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Wastewater (non-consumptive)	45	45	45	45	45	45	45	45	45	45	45	45
Ecological (non-consumptive)	269	269	269	269	269	269	403	403	269	269	269	269
Total Min Release (2)	275	275	275	275	275	275	409	409	275	275	275	275

(1) Irrigation withdrawals occur between Weir III and Kurram Garhi Headworks, so are non-consumptive in this reach. Therefore, Irrigation releases cover both Wastewater and Ecological requirements, and Total Minimum Release = Water + Irrigation.
2) Irrigation water for Marwat & Civil Canals diverted upstream of Kurram Garhi Headworks. Wastewater requirements are non-consumptive so are met by Ecological flows. Therefore, Minimum Release = Water + Ecological.

The total minimum flow releases will need to be revised when the Ecological Flow Requirements are finalized. This revision must be based on the PHABSIM study that as described in the Fisheries` Management Plan uses RHABSIM.

Mitigating the upstream blockage by the Dam and weirs will likely require "out-of-kind" mitigation. A conventional fish ladder could be expected to pass migratory species, including the Golden Mahseer, upstream at Weir II. However, the Kurram Tangi Dam is too high to utilize a fish ladder, and the height of Weir III is problematic for such a structure. A fish elevator would pass all species of fish at these sites, but is not economically justified based on the number of fish that are likely to attempt to pass upstream. Further, upstream migrants downstream of Weir III would have to pass three fishways to reach the Kurram River above the Dam. It is doubtful that many would do so. Alternatively, stocking the Weir III reservoir and the Kurram Tangi Dam Reservoir is likely to have more success in maintaining fish populations in the reaches of the Kurram River above the Kurram Garhi Headworks. Consequently, a stocking program for Golden Mahseer (and, perhaps, other migratory species) is recommended as the mitigation strategy for Component 2. The stocking program is described in more detail in the Fisheries Management Plan (Annex IV of the EMMP). Such a program is still dependent on Ecological Flows and a fishway at the Kaitu Weir for upstream migrants in the Weir III reservoir to access the upper reaches of the Kaitu River. Additionally, a year-long comprehensive fisheries and water quality study will be needed to determine the likelihood of the success of such a program.

Mitigating the loss of fish as a result of turbine-induced mortality at the powerhouses can be achieved by maintaining a low approach velocity to the intakes, and by designing the clear spacing of the trashracks to allow only small fish to pass through. As recommended for Component 1, an approach velocity to the trashrack of 0.5 fps, and a trashrack clear spacing of 2 inches is recommended as appropriate mitigation measures to reduce fish entrainment at each of the Component 2 powerhouses.

5.3.3.7 Socio-Economic Environment

Potential Impacts: During operation the main potential impacts are associated with the resettlement sites and the livelihood restoration. There are some examples in Pakistan where the resettlement and livelihood restoration did not deliver the expected results and resulted in grievances, protests, court cases and civil unrest. The potential impacts are significant.

Downstream populations will experience changes in water availability and flow levels in the Kurram. The proposed Environmental Flow Releases (Section 5.3.3.6) have been determined to meet the needs of these populations. However little information is available on the irrigation withdrawals in the downstream riparian areas and the current estimates for flow requirements may be too low. Given the above uncertainty a level of significance has not been assigned to this impact.

Populations in the footprint of Component 2 will realize that the Kurram Dam through Powerhouse I, II and III generates electricity, none of which is available to the local people. In particular those people that will continue to live around the reservoir and the powerhouses and along the transmission lines have presently no access to the grid and therefore might be quite unhappy about the limited sharing of project benefits. This potential impact is assessed as having a high significance.

The establishment of a water bodies in a dry arid area may facilitate vector-borne diseases such as malaria, leishmaniasis, Japanese encephalitis, dengue and dracunculiasis (Dracunculiasis or guinea-worm disease is caused by water fleas and was endemic in Pakistan but was eradicated in 1993. Nevertheless, chances for occurrence still exist, so this disease should be considered as a possible future threat). This change to the environment could increase health related issues.

At the intake point of the channel supplying water to turbines, there is normally an accumulation of all types of trash, both biodegradable and non-biodegradable. Commonly, this is removed and spread

in the vicinity of the dam/weir to decompose. This is a source of air pollution and could also affect the population located near to the project site. The polluted air could be deleterious effects to human health by triggering or causing asthma, chronic obstructive pulmonary disease, and other non-infectious respiratory ailments.

Potential health impacts are assessed as significant.

Mitigation: The RAP for Component 2 will need to contain contingencies to provide funding for monitoring, corrective actions and ongoing livelihood support for the resettled populations in order to assure their continuing support for the project. This is especially important because the involvement of many people in North Waziristan in the wars in Afghanistan have exposed them to skills and techniques that could result in a scenario where they threaten to destroy the dam if their requests are not met. Such threats must be taken seriously even at the preconstruction stage, as the tribal people constantly indicated that they would use regional guerilla warfare (suicide bombers) to assure that their demands are met.
As discussed in Section 5.3.3.1 further studies of the downstream riparian areas irrigation water requirements are needed. Results should be integrated into the reives flow releases discussed in Section 5.3.3.6. River flows and the availability of downstream water need to be monitored closely and additional mitigation measures (minimum flow rates, feeder canals etc.) might need to be established if the flow releases do not meet downstream needs In the lower riparian areas of the Kurram River.
It is highly recommended and best practice to establish a rural electrification project in the footprint of Component 2 to share benefits with those in the vicinity of the reservoir, power generation and exportation.

Proper prophylactic arrangements shall be offered to the local communities:

- Health education for making them aware of the impending threats and prophylactic techniques for avoiding these vectors such as mosquitoes, and snails etc., such as bed-netting, weekly chloroquin, repellent creams, removal of small impoundments in the dwelling places.
- Offering free vaccinations to the population for vaccine-preventable diseases.

5.3.3.8 Roads, Bridges and Traffic

Potential road and traffic impacts and their mitigation for Component 2 will be the same as for Component 1.

5.3.4 Decommissioning

5.3.4.1 Operational Life of the Kurram Tangi Dam, Weir II and Weir III

It is expected that the design and construction of the various major civil works facilities will have an economic life of 100 years. The live storage of the Kurram Tangi dam would slightly decrease over time, depending on the actual rate of erosion in the watershed area and sediment trapping in the reservoir. It is anticipated however that live storage would remain important at the end of the 100-year life.

5.3.4.2 Operational Life of the Powerhouses

Civil works associated with powerhouses have generally an economic life of 50 years. The electro-mechanical equipment typically has an economic life of 25 to 30 years. Both civil works and equipment can however be easily rehabilitated and upgraded so that power plants have indefinite life.

5.3.4.3 Closure/Decommissioning Plan

Large dams and reservoirs usually remain in operation. In addition to the regular annual maintenance activities, major rehabilitation or upgrades would occur at different time intervals to maintain the integrity and stability of civil works structures and efficiency of equipment.

In the unlikely case that it is decided that the dam or weir should be removed, a detailed decommissioning plan would need to be prepared as this would include the disposal of sediment deposit upstream of the dam or weirs. Decommissioning a project of this magnitude would require as much planning as the construction of the project in the first place, and major consultation with all affected stakeholders. At a minimum the plan would cover the fields described in Section 5.2.4.3 above.

Potential impacts: The potential impacts of closure and decommissioning would include severe economic consequences due to the loss of power generation and irrigation benefits. It would be very difficult for the population involved with the irrigated land to maintain a livelihood.

Removal of the dam or weirs would also be the source of potential negative impacts on water quality and the river ecology during the demolition period. A detailed investigation of the sediment deposits would be required to assess potential contamination and future use of the sediments.

In addition there would be potential adverse impacts related to disposal of demolition and other waste materials.

Mitigation: The potential impacts of decommissioning could be avoided by maintenance and upgrade of Component 2 infrastructure and electromechanical equipment to ensure perennity of irrigation water supply and power generation.

However, if the decision is made to decommission, alternative livelihood strategies would have to be developed as part of a decommissioning and closure plan to mitigate potential socio-economic impacts.

While the mitigation measures for potential impacts to water quality and the river ecology, and related to waste management proposed for the construction phase could be implemented, the actual measures would have to be developed in a decommissioning and closure plan. Since this would only be developed approximately 100 years after commissioning, it is considered likely that a new suite of potential mitigation measures would be available.

5.4 Potential Impacts Related to Component 3

As described in Section 3.1 and 3.4, Component 3 is comprised of the Kurram Garhi Headworks, the new Thal Canal and its command area, and the existing Marwat and Kachkot Canals, which are to be upgraded. A new head regulator will be installed at the Kurram Garhi Headworks to service the new Thal Canal. That canal will carry 350 cfs of water for an irrigated command area of 69,000 acres. The Project will also upgrade about 200 miles of old canals built by landowners, with a command area of approximately 107,000 acres, and the command area of the Marwat Canal, with a command area of 170,000 acres. The existing Kurram Garhi Headworks fragments the Kurram River, separating the lower Kurram River and its fauna from the mid and upper reaches of the river. As such, upstream movements by the fish fauna in the reach of the Kurram below the Headworks are presently blocked by that structure.

The only road works that may take place as part of Component 3 are the upgrading of the existing road from Bannu to Kurram Garhi Headworks (Road K).

5.4.1 Pre-Construction Phase

5.4.1.1 Land Resources

Geology, Geotechnical Issues and Seismicity

The potential geotechnical impacts for Component 3 are shown in Table 5-14 below. Overall these potential impacts are assessed as significant.

Table 5-14: Potential Geotechnical Impacts of Component 3 during Design Phase

Description	Magnitude	Extent	Duration	Probability of Likelihood
Non-availability of geotechnical investigation and laboratory testing information	High/major	Regional	Long-Term	Highly probable
Establishment of geotechnical design parameters	Moderate	Site Specific	Long-Term	Probable
Stability and seepage analysis	Moderate	Site Specific	Long-Term	Probable

Mitigation: No geological site investigations were carried out for this scheme. Based on experience in this area, the overall scheme is reasonable and the conceptual layouts and designs are appropriate; however feasibility level designs and more accurate cost estimates must be verified by a field investigation program that includes drilling, geological mapping and a construction materials assessment.

Agriculture and Irrigation

Potential Impact: Planning and coordination deficit: The planning and design of the construction of the main structures (remodeling the Kurram Garhi Headworks, Thal main canal network) and the tertiary distribution networks are not coordinated. This could lead to a long time lag between the construction of the main structure and the actual; use of the system for irrigated production. The magnitude of this potential impact is high, the extent is regional and the duration could be long. Therefore, this is assessed as a significant potential impact.

Mitigation: There must be strong coordination between WAPDA and the Agriculture and Irrigation Department of KP concerning the planning and design of the entire systems, particularly of the water courses and on-farm irrigation development as well as the surface drainage network.

Waste Management

Potential Impacts: The potential impacts identified for Component 3 are similar to those for Components 1 and 2.

Mitigation: Component 3 mitigation measures are the same as those for Components 1 and 2.

5.4.1.2 Water Resources

5.4.1.3 Biological Resources

Aquatic Resources

No potential impacts on the aquatic resources of the Project area of influence are anticipated in the pre-construction phase. However, the aquatic resource baseline conditions in this area are presently inadequate to evaluate potential impacts on the fishery resource and determine appropriate mitigation actions. The recommended mitigation action is to conduct the Fish and Water Quality Survey described in the Fisheries Management Plan (Annex IV of the EMMP).

5.4.1.4 Socio-Economic Environment

Potential Impacts: The most significant potential impact during the pre-construction phase is the acquisition of land with a total surface area of more than 145,000 acres. While the need to potentially physically relocate up to an estimated 50,000 people in the footprint of Component 3 might be significantly reduced through the alignment of primary, secondary and tertiary canals, the

challenge would be to restore and enhance the livelihoods of up to 500,000 people that presently use the area earmarked for the CCAs and main canals. While these people are expected to benefit in the long run from the enhancement of irrigation on 140,000 acres, it needs to be mentioned that the period between land take and allocation of irrigated land is expected to take 2-3 years at least and could be longer. The potential impact is of high significance.

Mitigation: Mitigating actions for potential impacts associated to land acquisition in Component 3 are covered in detail in RPF. As is the case for Components 1and 2 they will include payment of compensation and allowances, replacement of land/resettlement of PAPs, livelihood restoration and monitoring and evaluation. The main task here is to establish a RAP for Component 3 and assure that the people presently using the land have priority access to the land allocation process in the upgraded and new CCAs.

5.4.1.5 Roads, Bridges and Traffic

5.4.2 Construction Phase

5.4.2.1 Land Resources

Topography and Drainage

Potential Impacts: During construction there will be changes to the visual resources typical of construction activity. This potential visual impact is also short-term, of low magnitude and local and will cease at the end of construction. The potential impact is therefore assessed to be of low significance and does not require mitigation.

Geology, Geotechnical issues and Seismicity

Potential Impacts: The potential geotechnical impacts for Component 3 during operations are shown in Table 5-15below. The overall potential impact is assessed as a significant.

Table 5-15: Potential Geotechnical Impacts of Component 3 during Operation Phase

Description	Magnitude	Extent	Duration	Probability of Likelihood
Loss of water due to seepage and its effect on surrounding areas	High/major	Regional	Long-Term	Highly probable

Seepage can contribute to waterlogging, the mitigation of which is discussed in Agriculture and Irrigation below.

Soils

Potential Impacts: Soil Pollution: The construction of the proposed Thal canal network (main, distributaries and minors), remodeling of the Kurram Garhi head works, the rehabilitation and lining of canals in the Civil Canals and Marwat Command areas and the associated temporary structures (contractor camps etc.) may lead to temporary soil degradation as a result of improper disposal of construction materials as well as soil pollution by leaks of combustibles and lubricants, disposal of wastewater etc. The magnitude of this potential impact is assigned a low value. The extent of this potential impact will be local and the duration will be short as it will last only during the construction activities. Therefore, this potential impact has been ranked as having a low significance.

Erosion risks: The clearance of trees and vegetation, the excavation and collection of borrow material exposed to water and/or wind, the incorrect cutting of slopes of borrow pits and fill storage depots, heavy equipment moving and construction operations (blasting, cutting, filling, compacting etc.) may lead to soil erosion and landslides particularly in bad weather conditions. This will be a temporary, probable potential impact. This potential impact will be of low magnitude with a local extent as this will be restricted to the surroundings of the created or remodeled infrastructures.

The duration of this potential impact on the soil will only be for the stretch of the construction phase. Therefore, this is a low significance potential impact.

Soil Compaction: The construction of Thal canal networks, rural roads and the improvement of Civil and Marwat canals will require the use of heavy earth moving equipment. This equipment will need access routes (for instance to borrow pits etc.) which are not limited to the canal width but will affect also neighboring areas, including cultivated land. This can lead to soil compaction which will affect soil suitability for agricultural production. The magnitude of this potential impact is foreseen to be low; the extent is local and duration short term as it will only last for the construction stage. Thus the potential impact is assessed to be of low significance.

Mitigation: Soil Pollution: proper disposal and storage of materials and chemicals (in impervious lined pits), correct handling of chemicals and construction materials, checking for leaks and spill of oil and chemical products, proper waste management, proper training of workers for storage and handling of materials on construction sites and contractor camps.

Erosion risks: Good engineering practices such as keeping the project traffic away from sensitive slopes, keeping the spoil/ borrow materials covered, provided proper slopes for cutting activities, appropriate siting of borrow pits and fill storage depots, construction of protection structures (gabions, rip raps), proper cutting of slopes, plantation of trees and shrubs and drainage management should be implemented. Further measures for mitigation of potential spoil-related impacts are described in the waste management sections below.

Soil Compaction:

- Restriction of machinery and vehicles to designated areas
- Monetary compensation of affected households for foregone production during the construction phase.
- Restoration of the original soil structure of the cultivated land which could involve ripping and deep plowing.

Land Use

Potential Impacts: Land Acquisition: Land will be needed for the construction of the proposed Thal canal network (about 1,960 acre for main canal, distributaries and minors) and principal drains (about 1,100 acre), remodeling of the Kurram Garhi head works, the rehabilitation and lining of canals in the Civil Canals and Marwat Command areas, associated structures and borrow pits for aggregate. Later, land will also be required for tertiary canals, water courses, drains, feeder roads and on-farm development, principally in the Thal plain. The development of the Thal irrigation system may also cause land fragmentation of local farms. This may lead to the need for new farm buildings and houses. This is an irreversible, significant potential impact.

Land will be required for temporary structures such as contractor camps, bypasses of roads in construction, alternative routes and paths etc. This could affect private land. The magnitude of this potential impact is low; the extent is local and duration is short term as it will only last for construction stage. While the temporary acquisition is considered to be of low significance, the overall potential impact of all land acquisition remains significant.

Obstruction of nullahs and other waterways: The Thal canal and distributaries cross many nullahs. The construction of these crossings could cause inundation of cultivated land. This potential impact is of a temporary nature as it will only be for the construction stage. The potential impact is of low significance.

Mitigation: Land Acquisition:

- Resettlement and relocation of affected households shall be carried out as per the RAP and RPF documents. Measures will include prompt and full compensation in the form of alternative irrigated land or payment for affected private property land before or during construction phase and/or provision of support services including timely supply of agricultural inputs and of soft loans to the farmers must also be implemented.
- Land acquisition and construction activities will be scheduled in such a way as to have a minimum effect on the standing crops. Where permitted by the construction schedule, farmers will be allowed to harvest crops. Where this is not possible, cash compensation will be paid. Cash compensation will also be paid for loss of fruit and other trees based on market value and could also include establishment of small fruit nurseries by local farmers with expert advice from the Provincial Agriculture Department.
- Restriction of machinery and vehicles to designated area
- Temporary structures should be located on barren land.
- Leasing of affected private lands in exchange for financial payments.
- Restoration of affected private lands to their original condition or to the satisfaction of the land owner.

Obstruction of nullahs and other waterways: Provision of temporary culverts and drains to evacuate excess water.

Agriculture and Irrigation

Potential Impacts: Hindering of agricultural activities: The construction of the regulator at Kurram Garhi Head works, the Thal canal and the remodeling of Civil and Marwat canals may hinder access to fields and markets, disturb agricultural activities and affect cropping in the vicinity of the construction sites. Although very intensive agriculture is not currently practiced in the Thal and Marwat command areas, in the Rabi season part of the wheat crop, the major crop of both command areas, may be affected by construction activities. Even though this will be temporary, damage to crops will be major in the Civil Canals command area, where agriculture is more intensive. Therefore, the magnitude of this potential impact is foreseen to be high in the Civil Canals command area, medium in Marwat and low in the Thal plain; the extent is local and duration short term as it will only last for the construction stage. Overall the potential impact is assessed to be of low significance.

Shifting of labor from agriculture to construction: During Irrigation system development and the construction of the new regulation structures at Kurram Garhi Headworks a labor force (about 200 for all Component 3 construction activities) will be required. This will provide employment opportunities for local residents. There could be a potential negative impact on agriculture in the form shifting of local labor from agriculture to construction. Routine agricultural routine activities may be affected. This potential impact is of small magnitude as it will cause some foregone production. The extent will be local and the duration will only be for the construction stage. The potential impact is of low significance.

Interruption of irrigation water supply: While the remodeling of the existing irrigation systems, Marwat and Civil Canals is taking place, the irrigation supply may suffer resulting in water shortage to crops. This potential impact is expected to be of small magnitude as it will cause some foregone production. The extent will be local and the duration will only be for the construction stage. The potential impact is of low significance.

Gender issues: Women play an important role as labor in the agriculture sector. They help to plant, harvest and process crops, care for poultry and livestock, and help to renovate their homes at least once a year in addition to traditionally assigned domestic roles. Most of the tribes of Khyber Pakhtunkhwa are very traditional and conservative. The women may be reticent to carry out their

agricultural activities when laborers and project staff are in the vicinity. In addition contact (whether intentional or accidental) between women and project personnel could create social tension if they are perceived to infringe local social mores. Hence the women should be provided special consideration to avoid occurrence of any conflicts between the locals and the workforce. The magnitude of this potential impact is assessed to be moderate, with a moderate probability and short term duration. Therefore, the potential impact can be categorized as medium significant.

Mitigation: Hindering of agricultural activities:

- Restriction of machinery and vehicles to designated areas
- Building of alternative routes and footbridges for access to cultivated lands
- Monetary compensation of affected households for foregone and/or lost production during the construction phase.

Shifting of labor from agriculture to construction: The extent of foregone production is not known. However, given the very low use of labor other than family labor as an input into agriculture it is likely to be very low. In addition earnings from construction activity will compensate for the foregone production. Therefore mitigation is not required.

Interruption of irrigation water supply:

- Proper planning of construction activities, coordination with the WUAs (either existing or that need to be created) and communication to the affected farmers.
- Monetary compensation of affected households for foregone production.

Gender Issues: Contractors need to ensure that labor is restricted to their work areas and construction camp and/or residential colony. The Contractor should also ensure that all personnel are aware that infringement of these requirements will result in disciplinary action.

Waste Management
It is anticipated that construction of Component 3 will require 200 workers. Estimated waste generation rates of domestic solid waste and wastewater based on the assumptions discussed in Section 5.2.3.1 are 80 kg/day and 6,400 gpd respectively.

Total excavation for Component 3 will amount to 125 million ft^3, less than the 160 million ft^3 of fill required. However, it is not currently known whether the excavated material will be suitable for fill or not. As a result quantities of spoil requiring permanent storage have not been estimated.

Estimates for concrete and steel reinforcement waste generation during construction based on generation rates of one to nine percent by weight are 1,900 – 17,000 t and 160 – 1,500T respectively.

Potential Impacts: The potential impacts identified for the construction stage of Component 3 are similar to those identified for Components 1 and 2. The main receiving water body receiving the potential impacts will be the Kurram River. Thus water users in downstream settlements (e.g. Bannu, Ghoriwala, Sada Khel, Naurang Sarai, Lakki Marwat, Wandha Khajjar, etc.) and aquatic life could be impacted.

Mitigation: The mitigation measures for Component 3 construction potential impacts are identical to those for Components 1 and 2.

5.4.2.2 Climate and Climate Change

Construction of Component 1 is not expected to bring changes to the local or regional climate.

5.4.2.3 Air Quality

Potential Impacts: Potential impacts during the construction of Component 3 are described in the following sections.

Vehicular and Fugitive Dust Emissions: Since the machinery used in Component 3 will either be the same or less than that required in Component 1 and 2, at the most the estimated vehicular emissions will also be the same (see Section 5.2.2.3). However, the Component 3 area is densely populated and includes a tightly knit road network. Main roads include Mir Ali-Spinwam road, Bannu-Thal road, Bannu-Kohat road and Mir Ali-Bannu road, which will be used frequently.

Emissions will affect about 50 major settlements between the Tochi River and the Kurram River, namely: Sorang, Mianjikhel, Kotbarra, Fatimakhel, Sherahmadkilli, Abezai, Sherkhan, Nawalkhan, Kilris, Jumakhan, Bannu, Hinjalnurbaz, Badarkilli, Akbaralikhan, Bhittanikili, Bahadurkalle, Sarugkili, Berikhel, Mazarshah, Shahjahanshah, Mirabbaskhan, Nurar, Ismailkhel, Marmandimultan, Muhammadkhan, Ghoriwala,Kandarwala, Michankhel,Zamankhan, Mamakhel, Gandikhankhel, Arazshahqulikhan, Zarif, Saraigambila, Kotkamahmud, Paharkhel, Kotkashmir, Multani, Simankhan, Sikandarkhan, Hassankhan, Sagai, Gidari, Sarainaurang, Sikandarkhan, Foujdar, Kotkatias, Aribabad, Shermuhammadkilli and Saudullah. Domail, Alamsher, Sadakhel and Omarzai are major settlements in the Thal Plains, through which the Bannu-Kohat road will pass. The magnitude of the potential impact is assessed to be moderate and the duration to be temporary (that is, until the remodeling of Civil and Marwat canals and construction of the new Thal Canal is complete in less than 5 years). Another cause of fugitive dust emissions will be the excavations done over the Kurram Garhi Headworks for borrowing material, for constructing the Thal Canal and for remodeling more than 200 miles of the Marwat and Civil canals. As described above, about 50 major settlements will be affected between the Tochi River and the Kurram River. Overall the potential impact is of medium significance.

Particulate Matter Emissions from Concrete Batching: Since the type and maximum number of concrete batch plants in Component 3 will probably the same as in Component 1 and 2, at most the estimated levels of emissions will be the same. The magnitude of the potential impact is assessed is to be moderate while the duration is temporary. Since the area is densely populated with 50 major settlements between the Tochi and Kurram River, 23 major settlements between the Right Bank Canal and the AOI boundary, and 4 major settlements in the Thal Plains, the overall potential impact is of medium significance.

Mitigation: The mitigation measures adopted for Component 3 will be the same as for Component 1 and 2.

5.4.2.4 Noise

Potential Impacts: Component 3 mainly involves excavation for the construction of the Thal Canal and remodeling activities for the Civil and Marwat canals. No tunnel blasting will take place as part of Component 3. Since the type and maximum quantities of heavy machinery used in Component 3 will be the same as in Components 1 and, noise pollution from heavy machinery in Component 3 will be similar to that described for Components 1 and 2 (see Section 5.4.1.2). However, as described below, the areas affected will be different.

Unlike the Component 1 and 2 areas, the Component 3 area is densely populated, with 50 major settlements existing between the Tochi and Kurram rivers (the core concentration of canal remodeling activities lies between these two rivers). These settlements include: Sorang, Mianjikhel, Kotbarra, Fatimakhel, Sherahmadkilli, Abezai, Sherkhan, Nawalkhan, Kilris, Jumakhan, Bannu, Hinjalnurbaz, Badarkilli, Akbaralikhan, Bhittanikili, Bahadurkalle, Sarugkili, Berikhel, Mazarshah, Shahjahanshah, Mirabbaskhan, Nurar, Ismailkhel, Marmandimultan, Muhammadkhan, Ghoriwala, Kandarwala, Michankhel,Zamankhan, Mamakhel, Gandikhankhel, Arazshahqulikhan, Zarif, Saraigambila, Kotkamahmud, Paharkhel, Kotkashmir, Multani, Simankhan, Sikandarkhan, Hassankhan,

Sagai, Gidari, Sarainaurang, Sikandarkhan, Foujdar, Kotkatias, Aribabad, Shermuhammadkilli and Saudullah. Domail, Alamsher, Sadakhel and Omarzai are major settlements in the proposed Thal Plains, through which the Bannu-Kohat road will pass. There is a large and dense road network in the Component 3 area. Persistent noise will be generated by these roads, including the Mir Ali – Spinwam road, the Bannu-Thal road, the Bannu-Kohat road and the Mir Ali-Bannu road. The magnitude of the potential impact will be moderate and the duration temporary (less than 5 years). The overall potential impact can be regarded as being of medium significance.

Mitigation: With the exception of standard operating procedures for blasting, which are not needed for Component 3 construction, mitigation measures will be similar to those for Component 1 and 2 construction.

5.4.2.5 Water Resources

Hydrology

Potential Impacts: Modification of the Kurram Garhi Headworks and construction of the Thal canal head regulator will have some unavoidable potential impact to the morphology of the river in the immediate vicinity of the Kurram Garhi Headworks. Amount of river flow further downstream of the Kurram Garhi Headworks will not change during the construction phase. However, excavation of river banks for the construction of the Thal canal head regulator may have minor potential impact on the downstream river water quality, in the form of increased sedimentation resulting from construction activities.

Mitigation: Mitigation of increased turbidity due to of excavation of the river banks are discussed under water quality.

Water Quality

Potential Impacts of Thal Canal: During the construction of the proposed Thal Canal, water quality will deteriorate due to excavation and construction activities. The recipients of the generated wastes will be about eight streams that flow into the Kurram River near Mamakhel.

The duration of the potential impact is short, but its magnitude is high. Excavation and construction activities for the Thal Main Canal, which is about 53 km in length, will produce large amounts of construction debris and spoil that could deteriorate the water quality. On the left bank of an affected stream there are eight minor settlements, while there are three minor settlements on its right bank. Similarly, there are six minor and one major settlement (Omarzai) on the left bank of another affected stream and six minor settlements on its right bank. Another minor stream provides water to the major settlement at Domail. Potential impacts to water quality in a fourth stream will affect seven minor settlements and one major settlement (Sadakhel) on its left bank and three minor settlements on the right. A fifth stream has four minor settlements on its right bank and four on its left bank. Seven minor settlements will be affected by water quality deterioration of three more streams in the area. Therefore based on these factors and the number of recipients the potential impact is categorized as significant.

Potential Impacts of the Remodeling of the Civil and Marwat Canals: Remodeling of more than 200 miles of the Civil and Marwat canals will include increasing the bed grade and lining the canals. Remodeling the Marwat canal will mainly affect the Tochi River. Civil Canal remodeling activities will mainly affect the Kurram River. The magnitude of the potential impact is assessed to be moderate, because only remodeling of the canals will take place. However, since the Tochi River, Kurram River and the intricate web of canals spread over a large area, the potential impact will be regional in extent.

There are about 50 major settlements and numerous minor settlements between the Tochi and Kurram rivers, all of which will be affected by the water quality deterioration caused by remodeling of the Civil and Marwat canals. These settlements include Sorang, Mianjikhel, Kotbarra, Fatimakhel, Sherahmadkilli, Abezai, Sherkhan, Nawalkhan, Kilris, Jumakhan, Bannu, Hinjalnurbaz, Badarkilli,

Akbaralikhan, Bhittanikili, Bahadurkalle, Sarugkili, Berikhel, Mazarshah, Shahjahanshah, Mirabbaskhan, Nurar, Ismailkhel, Marmandimultan, Muhammadkhan, Ghoriwala, Kandarwala, Michankhel, Zamankhan, Mamakhel, Gandikhankhel, Arazshahqulikhan, Zarif, Saraigambila, Kotkamahmud, Paharkhel, Kotkashmir, Multani, Simankhan, Sikandarkhan, Hassankhan, Sagai, Gidari, Sarainaurang, Sikandarkhan, Foujdar, Kotkatias, Aribabad, Shermuhammadkilli and Saudullah. The area is densely cultivated and includes manyroads. Main roads include the Mir Ali – Spinwam road, the Bannu – Thal road, and the Mir Ali – Bannu road, all of which will be used frequently. Potential water quality impacts are regarded as significant.

Mitigation of Potential Impacts
Mitigation measures will be similar to those described for the Sheratalla and Spaira Ragha canal systems.

5.4.2.6 Biological Resources

Terrestrial Ecology
Potential Impacts: Vegetation and Habitat Destruction: The deposition of tunnel spoil will obliterate the terrestrial vegetation in the area selected for the spoil, but the areas selected are expected to be barren land, which is in abundance near the tunnel portals. This is a highly probable and local potential impact. It will be permanent if spoil requires permanent storage. Currently the volumes of spoil that may require storage are unknown; therefore neither the magnitude nor the significance of the potential impact can be assessed.

As noted above in Section 3.4, some river training and diversion will be necessary for the construction of the head regulator of the canal. This part of the river contains a small brushy island, about three-eighths of an acre in area, separated from the bank by about 30 feet of mudflat, which is underwater at high flows. The portal of the first tunnel will be located in the region of the left abutment, possibly causing some disturbance of the whole area. The precise form of construction needed for installing the regulator is not described in the Feasibility Report, so the nature of intrusion into the ecosystem here cannot be specified. It is possible that this island and its connecting mudflats may serve as a staging area for the tunnel excavation, which will be only about 100 feet away. In this case, the mudflat could be filled in with tunnel spoil, to provide a stable work area. Given that little is known about the extent of intrusion by construction activities on this mudflat, it has not been possible to assess the significance of the potential impact.

Pests and scavengers: As is the case in the other components, the terrestrial habitat is highly degraded and there is little wildlife in the area. Poor management of kitchen waste at the construction camp could attract rats and other scavengers and possibly larger mammals. Many local people view any wildlife species as game, so they are liable to shoot any wild animal as fair game. The cooks at the camp may keep poultry, which will attract mongooses, cats, and foxes, placing these animals at risk of being shot. This is a local, short-term, probable potential impact of low magnitude. It is non-significant.

There are no threats likely to any endangered, rare and threatened species and no endemic species in the Component 1 area.

Mitigation: The measures identified for mitigation of similar construction related potential impacts in Component 1 will be implemented for Component 3. In addition, wherever possible spoil should be used in concrete for canals and for road fill. Spoil sites should be chosen in function of the land use, preferably on barren land.

Aquatic Resources

Potential Impacts: The potential impacts on the Kurram River aquatic resource caused by the construction of Component 3 will be minor. The Kurram Garhi Headworks are already in place and it is assumed that the only construction at the river will be the regulator gate to the new Thal Canal. The construction of the regulator gate may result in some temporary localized increase in turbidity in the river.

Mitigation: The increase in sediment load to the Kurram River can be reduced by the use of silt fencing.

5.4.2.7 Socio-Economic Environment

Potential Impacts: Again, land take exacerbates land pressures, and can increase local conflicts over natural resources. One of the key challenges is that replacement land will only be available after the end of construction, which is scheduled to take two to three years.

The establishment of the new command areas by the Department of Agriculture entails the risk that those affected by land acquisition and those living in the project area are not provided with new land and/or considered as priority beneficiaries in the land allocation process. There are numerous examples where local and/or regional elites and the military used the allocation of land to either establish large landholdings for themselves and/or to invite other populations for various reasons. The potential impact is significant.

A less significant potential impact is that some cultural heritage sites may be discovered during the construction. Construction activities may be slowed as rescue excavation assesses the importance of the late find(s).

There will be an influx of construction workers[45] and security personnel, who may carry certain diseases to which the local communities are not immune. In turn, the construction workers might not be immune to certain diseases that are endemic, such as polio (FATA is a hotspot for this disease), cutaneous leishmaniasis and diphtheria.

The construction contractor is responsibility for establishing a health unit to treat minor illnesses of the construction crew with an ambulance at standby to transport medical and surgical emergencies to the relevant health care facilities. The staff at the health unit is usually not adequately trained to tackle emergencies, especially the surgical emergencies, while it is a known that efficient and timely first aid reduces fatalities. So the potential impact might be that due to insufficient preparation, the number of fatalities and injuries is unreasonably high. In the absence of mitigation this is a significant potential impact.

Mitigation: The RAP provides comprehensive compensation and livelihood restoration measures to mitigate the impoverishment risks associated with the time between land take and provision of replacement land.

To assure the priority access of project affected people and other people from the project area to the land allocation in upgraded and new Command Areas, as early as possible a well-defined land allocation process need to be established in close consultation with all stakeholders to a level that it obtains the free, prior and informed broad community support of the people having or claiming ownership to the land in and around the Command Areas.

The CHPP outlines detailed late find procedures to assure that no valuable cultural heritage site is destroyed and all valuable sites surveyed through rescue or full blown excavations.

[45] About 200 workers will be required for Component 3 construction.

The construction crew shall be requested to present appropriate heath certificates before being allowed to enter the construction camp. Disease data shall be maintained centrally by the Contractor's Health, Safety and Environmental Department (as proposed in the EMMP) and should be monitored regularly in line with the Contractor's Site Specific Environmental Management Plan.

The construction workers including survey teams shall be offered the opportunity to be vaccinated against possible occurring diseases and offered free of charge other prophylactic measures to control transmission of vector-borne diseases such as malaria, dengue and cutaneous leishmaniasis. This may include bed-netting, monitoring for small impoundments in the construction worker's camps, spraying to destroy mosquitoes and other insects such as sand flies and other vectors.

Health and Safety training shall be mandatory during induction and once every four months to make the project personnel aware of the possible diseases and to educate them about the measures to control transmission of diseases such as polio, HIV/AIDS and other STDs.

5.4.2.8 Roads, Bridges and Traffic

Potential Impacts: Potential impacts for road construction and traffic will be the same as those identified for Component 1. The receiving body for water pollution from work on Road K is the Kaitu River.

Mitigation: As Road K passes through the suburbs of Bannu which is a densely populated area, extra care will be required to control the traffic in order to minimize accident risk. Therefore in addition to the measures preconized for Component 1, where ever possible construction traffic should be rerouted around settlements rather than passing through them. It may be possible to allow access through alternate routes along the existing canal roads provided it does not cause breaches to the canal. If it is not possible to reroute traffic then the road will need to be upgraded to provide defined pedestrian access that is not in conflict with vehicles.

5.4.3 Operational Phase

5.4.3.1 Land Resources

Topography and Drainage

Potential Impacts: Once completed, the Thal canal system will add 73 miles to the drainage network. Remodeling of the Civil Canals and Marwat Canal will also add to the drainage network. These are permanent but local changes of moderate magnitude and are considered to be of moderate significance. The potential impact is positive in that it will increase the availability of water for agricultural activities, and as such does not require mitigation.

Geology, Geotechnical Issues and Seismicity
No potential impacts have been identified for the Operation Phase of Component 3.

Soils
Potential Impacts: Waterlogging and salinization may occur. These potential impacts and their mitigation are discussed in more detail under Agriculture and Irrigation below.

Land Use
Potential Impacts: Increasing difficulties of gravity irrigation in riparian areas downstream of the Kurram Garhi Headworks: The diversion of required irrigation flows for the Thal, Civil Canals and Marwat command areas (Totaling about 846,000 acre-feet/year, varying from about 370 cfs. in mid-December to about 1,900 cfs in early November) and the reduced flow of the Kaitu River (due to irrigation diversion to Component 1 command areas) will considerably reduce river flows and water levels downstream of the Kurram Garhi Headworks, particularly in periods of low river flow (Rabi season). This potential impact will be felt mostly in the lower riparian areas which not are part of the Civil Canals and Marwat command areas. Currently little is known about the irrigated riparian areas, but in all likelihood, irrigation of these riparian areas is by flood water or by river water that is lifted

and diverted by temporary stone weirs across the river bed. If water flow in the river is less and consequently water levels are lower it will be more difficult to lift and divert the water using temporary, heavily leaking structures and to irrigate by gravity. The magnitude of this potential impact will be high, the extent is regional and its duration is permanent. Therefore this will be a significant potential impact.

Loss of grazing lands and blocked access: Animal husbandry is a very important activity of the local people. The magnitude of this potential impact will be high, particularly in the new Thal command area, the extent is regional and its duration is permanent. Therefore this will be a significant potential impact.

Mitigation: Increasing difficulties of gravity irrigation in riparian areas downstream of the Kurram Garhi Headworks:

- The replacement of the temporary stone weirs by low permanent weirs.
- If this is not possible conversion to pump irrigation will be necessary but this will make irrigation much more expensive and compensation to the affected households or farmer communities will be needed.

Loss of grazing lands and blocked access:

- Provide alternative routes to reach grazing lands with all needed facilities such as canal, nullah and road crossings, drinking pools supplied by canal water, fences etc.
- Promote the cultivation of fodder crops (alfalfa, berseem) to compensate for the loss of grazing lands. At the same time, fodder crops are very suitable in a sound crop rotation system and for improving the soil structure and fertility (N-fixation).

Agriculture and Irrigation

Potential Impacts: Waterlogging and Salinization risks: The risk of waterlogging and secondary salinization in the Thal, Civil Canals and Marwat command areas will increase with time. Currently the nullahs crossing the command areas form the natural drainage channels which mainly get rid of excess precipitation. With the project interventions, new canal irrigation systems will be constructed or extended to meet the irrigation requirements of these command areas. The proposed irrigation systems have been designed with an overall irrigation efficiency of about 60 percent. That means that 40 percent of the irrigation supply will be lost, mainly by infiltration losses due to surface irrigation application and earth canal/watercourse infiltration. Due to these large infiltration losses the recharge rate of the groundwater will be high and it is likely that groundwater levels will rise if there is insufficient natural groundwater drainage to the nullahs.

Therefore, it can be expected that eventually a greater area may be threatened by water logging and subsequently secondary salinization. Salinization has already occurred in the Marwat and particularly the Civil Canals command areas near Sarai Gambila, Lakki Marwat, Sarai Naurang and Ghoriwala where soils are classified as moderately to strongly saline. Waterlogging and salinization are very important negative impacts of irrigation development in semi-arid Pakistan. The magnitude of this potential impact is rated high, the extent will be local, the duration is long-term and the likelihood is high. Hence this is a significant potential impact.

Agricultural development: In Component 3, a command area of about 68,000 acres of the Thal plain which are currently mainly rainfed, will be brought under canal irrigation, water supply will increase to Marwat (command area: 170,000 acres) and irrigation efficiency will increase in the Civil Canals command area thru canal lining (command area: 107,000 acres). Cropping intensity will increase up to 130 percent in the Civil Canals and 80 percent in the Thal and Marwat command areas from the current cropping intensity of 112 percent in the Civil Canals, 43 percent in the Thal and 17 percent in the Marwat command areas. Cropping patterns will change. Farmers will have the opportunity to

grow new crops and/or more cash crops and increase their earnings considerably. All these factors could potentially have a tremendous positive impact on farm production and farmers' earnings. There are also considerable positive spin-off effects on a regional scale. These spin-off effects could include the expansion and creation of agro-processing industries, and development of commercial networks, banking, schools and health posts. All this development creates opportunities for employment, trade and technological development. The magnitude of this potential impact is rated high, the extent will be regional, the duration is long-term and the likelihood is high. Hence this is a significant potential positive impact.

This potential impact could be further enhanced if water allocation (water rights) promotes a fair water distribution between the head and tail ends of the systems. However in many irrigation systems unequal distribution is a persistent problem. In some traditional law systems in Pakistan and PK/ North Waziristan it is even defined that the users at the head end have the right to take the water when they want and as much as they want. The Irrigation Department has a very important role to play in ensuring rational water management and a fair water distribution.

Pollution of water by excessive use of fertilizers and pesticides: The current use of pesticides and fertilizers in the Thal command area is practically zero. With the project interventions the use of pesticides and fertilizers may increase. However, hazardous effects are not expected as the anticipated cropping intensity is only 80 percent in the calendar year. Pesticide and fertilizer use in the Marwat and Civil Canals command area is not known but is expected to be higher than in the Thal command area, particularly in the Civil Canals area. Irrigation could be accompanied by excessive use of fertilizers and/or pesticides by farmers. This would result in pollution of groundwater and surface water as a result of leaching of nutrients and pesticide residues, particularly where marginal suitable agricultural land is irrigated. This concerns about 9,350 acre of sandy texture or 11 percent (Land capability class IV-s3) in Thal CCA and an estimated 3 percent of sandy texture (Land capability class IV-s3) in the Bannu Scarp area (taken as a proxy for the soil types in the Civil Canals and Marwat Command areas).

Pollution could also lead to illness due to exposure to high levels of nitrates and pesticide residues in the groundwater and surface water.

The magnitude of this potential impact is rated high, the extent will be local and the likelihood is medium. Hence this is a significant potential impact.

Lack of capital: With the conversion from rainfed to irrigated agriculture, implying a more intensive agriculture, demand for agricultural inputs will rise, particularly in the Thal Command area. Currently most farmers are small land owners with few resources, particularly in the Thal plain. Under such circumstances, the local farmers may lack the capital to buy these inputs and agricultural production will be suboptimal. The magnitude of this probable potential impact is rated moderate, the extent will be local and the duration is medium-term. Hence this is a less significant potential impact.

Creation of conditions for improved water management in the Civil Canals command area: The irrigation problems of the Civil Canals Command area are a special case and have their origin in the complex history of the development of the Civil Canals Command Area. It is thought that sometime in the first half of the 20th century, local farmers and landowners gradually excavated a network of canals linked to the Kurram River. These canals are inundation canals, locally called vials. During the flood season these canals draw their supply of irrigation water directly from the Kurram River, a clear case of spate irrigation. These vials serve still an area of about 56,650 acres. Naturally, landowners and farmers who started and extended the excavation of canals from the Kurram River to the Bannu flood plain are at the head end of the system. Since these pioneers built and invested in

these canals, their heirs and descendants put a claim on the water[46]. Under this claim, they use the water first, and any excess is for others who came later (i.e. after the construction of the Kurram Garhi Head works) and probably did not contribute to the construction of the system. This explains, at least partly, the actual water allocation system, and in particular the origin and the intensity of the head-tail end problems in the Civil Canals command area.

Meanwhile, the construction of the Kurram Garhi Head works in 1962 and the construction of new canals with State support allowed a gradual extension of the Civil Canals command area to about 107,520 acres. At the same time the Irrigation Department of the Pakistani State became active in the management of the system. At a later stage the water supply was complemented with tubewells, particularly at the tail end of the command area.

The history of the Civil Canals Command area is still much reflected in the actual state of the canal network and water allocation. The existing Civil Canals have neither proper alignments nor bed grades. The canals generally follow the course of depressions and nullahs. Present cross sections of the canals cannot cope with the discharges being conveyed and as such, overflow of these inundation canals is common as there are no freeboards. This leads to water wastages and also breaches which may lead to canal breakage and inundation and devastation of standing crops. In the Civil Canals command area there are no regulators on any distributaries or minors. Withdrawals are un-proportional withdrawal resulting into inequitable distribution. Excessive withdrawal in the upper reaches of the canals results in colossal waste of irrigation water which gives rise to water-logging and increased salinity conditions. It also results in acute shortage of water in the lower reaches, thus reducing the cropping intensity and crop yields. The excessive application of water in the upstream areas is estimated to waste about 160,000 acre feet annually. This situation has given rise to salinity in about 8 percent area of the CCA (KTDC, 2004).

Moreover, the current Civil Canals system is unlined and leaks all along the channels, which drastically affects irrigation efficiency. Proposed project interventions include lining and remodeling of the Civil Canals and minors, which would greatly reduce conveyance losses and increase irrigation efficiency up to about 60 percent, leading to an improved and permanent water supply. This should enable a more equitable and optimal water distribution throughout the command area, thus minimizing the salinity and water logging threats. Soils of the command areas have a large production potential and the agro climatic conditions are also favorable (KTDC, 2004). Moreover, farmers are provided with Government facilities such as agriculture extension, research and fruit nurseries.

The critical limiting factor is the distribution of irrigation water. With the remodeling of the canal system, the agricultural productivity of the area can much improve but it needs to be combined with improved water management (particularly the water allocation between head and tail ends). A more equitable water distribution will lead to higher cropping intensities in the tail ends and less problems of water logging and salinity in the head ends.The magnitude of this potential impact is rated high, the extent will be regional, the duration is long-term and the likelihood is high. Hence this is a significant potential positive impact. This potential impact could be further enhanced if changes in the actual water allocation (water rights) promote a fair water distribution between head and tail ends of the systems. However, the actual distribution of water rights is deeply ingrained in the collective conscience Changing this mind set will require a lot of effort, but project interventions could be a catalyst. The Irrigation Department has a very important role to play in ensuring rational water management and a fair water distribution

[4646] The creation of water rights is empirically and theoretically underpinned by the common property resource school of Elinor Ostrom in many publications (for instance: E.Ostrom, 1990, Governing the commons; The evolution of institutions for collective action) and the hydraulic property theorem of E. Coward (E. Coward (1985), State and Locality in Asian Irrigation development: the Property factor).

Mitigation: Waterlogging and Salinization risks: Mitigation in the Civil Canals and Marwat Canal command areas will involve implementation of the same measures as those identified for the Sheratalla and Spaira Ragha command areas in Component 1

Agricultural development: Formation of WUAs in the command areas to encourage the farmers in equitable water use for irrigation. Water rights must be clearly defined and agreed upon by both upstream and downstream farmers

Pollution of water by excessive use of fertilizers and pesticides:

- Crop rotation (hindering pest proliferation), mechanical weed destruction (instead of herbicide applications), green manuring (leguminoses) and addition of farmyard manure to improve the soil structure , light (small water applications) but frequent irrigation and split doses of fertilizer application.
- Training of farmers in safe use of pesticides/ fertilizers.
- Adoption of an effective IPM Module is recommendable. IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment as discussed under Component 1 above. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. Pesticides used shall comply with Pakistan legal requirements and USAID 22CFR 216.3 and the PERSUAP and 2013 PPERSUAP.

Lack of capital: Farmers should be provided financial assistance through credit facilities and input subsidies.

Creation of conditions for an improved water management in the Civil Canals command area: Form WUAs in the command area to encourage the farmers in equitable water use for irrigation. Water rights must be clearly defined and agreed upon by both upstream and downstream farmers.

Waste Management
Estimates of waste generation during operations have not been broken down by component as only a global estimate of the project operations staff has been made. The generation rates for solid waste and wastewater are 160 kg/day and 12,800 gpd respectively (Section 5.2.3.1).

Potential Impacts: The potential impacts identified for operation stage of Component 3 would be similar to Component 1 and 2. The main receiving water bodies are the Kurram River, Thal canal, right bank canal and Kachkot Canal. Thus water users in downstream settlements (e.g. Bannu, Ghoriwala, Sada Khel, Naurang Sarai, Lakki Marwat, Wandha Khajjar, etc.) and aquatic life in these water bodies could be impacted.

Mitigation: Component 3 operations mitigation measures are the same as those proposed for Components 2 and 1.

5.4.3.2 Climate and Climate Change

Operation of Component 3 is not expected to bring changes to local or regional climate or induce microclimatic changes. However, as for Components 1 and 2 the potential impacts of climate change are considered to be a more critical concern. These are discussed under Component 2 in Section 5.2.3.2 above.

5.4.3.3 Air Quality

The potential impacts during the operation stage of Component 3 are described below.

Potential Impacts: Vehicular Emissions: As noted in previously, the Component 3 area is densely populated, with 50 major settlements found between the Tochi and the Kurram River, 23 major settlements between the Right Bank Canal and the AOI boundary and 4 major settlements in the Thal Plains. Moreover, the Component 3 area has a highly developed and heavily used road network, including Mir Ali-Spinwam road, Bannu-Thal road, Bannu – Kohat road and Mir Ali-Bannu road. The magnitude of potential air quality impacts from vehicular emissions will be moderate and the affects long term. Since the area will grow further to accommodate a larger population, the overall significance will be medium.

Mitigation: The mitigation measures adopted for Component 3 will be the same as those for Component 1 and 2.

5.4.3.4 Noise

Potential Impacts: Increase in Vehicular Traffic**:** There is a dense road network in the Component 3 area. Main roads include Mir Ali – Spinwam road, Bannu – Thal road, Bannu – Kohat road and Mir Ali – Bannu road, which will continue to be used frequently. Since the Component 3 area is already densely populated with about 50 major settlements as described in Section 5.4.3.2 above, the potential impact is assessed to have a high magnitude and a long duration. Based on these factors and a growing population, the potential impact is evaluated to have a medium significance.

Establishment of New Industries/ Settlements: Improvement of the existing road network, establishment of the new Thal Canal and increased availability of water downstream of the Kurram Garhi Headworks could potentially encourage establishment of industries. These industries could possibly cause noise pollution and disturb those living nearby. The magnitude of the potential impact will depend on the number of industries, which in turn will not only be conditioned by potential agricultural intensification, but other factors such as the security situation, labor availability, skills and education of available labor and access to markets amongst others. While the magnitude of this potential impact would be high and the duration long term if many industries developed, it is currently considered to have a low likelihood of occurring on a large scale. The potential impact is considered non-significant.

Mitigation: Mitigation measures for Component 3 operation will be similar to those described for Component 1 and 2 operations.

5.4.3.5 Water Resources

Hydrology

No potential impacts on hydrology are envisaged as it is considered likely that the Ecological and Environmental Flow requirements would be met under normal operating conditions at the Kurram Garhi Headworks

Remodeling of the Marwat and Civil Canals will result in the decrease of the unintended water losses from the canals.

Water Quality

Potential Impacts of the Thal Canal: Irrigated agriculture using tubewells is practiced in some parts of the area of proposed Thal Canal, however, the command area and cropping intensity is very low. Wheat and gram are the major crops which are currently cultivated in the area. The yield of wheat and gram is 227 and 114 Kg/ acre, respectively.

With the operation of Thal Canal, the command area will increase. The use of fertilizers and pesticides will increase with time to boost agricultural production. This will deteriorate the surface

and ground water quality of the area as a result of agricultural runoff and percolation, respectively. It is anticipated that wheat, maize, sorghum, gram, rice, sugarcane, vegetables and orchards will be cultivated after construction of the Thal Canal. Nitrogen and phosphorous fertilizers, along with pesticides, will be used to increase crop yields. Additionally, potassium will be used to increase the yield of rice, maize, sugarcane, vegetables and orchards. The use of fertilizers and pesticides will deteriorate the water quality more pronouncedly during the low flow season. Stagnation of water during low flows will result in eutrophication due to the presence of phosphorous and nitrogen. The recipients of pesticide and fertilizer induced water pollution will be three major settlements (Alamsher, Domail and Omarzai) and numerous minor settlements in the Thal Canal Command Area. As polluted water would not be suitable for irrigation purposes farm production would potentially be impacted. In addition, waterlogging can lead to concentration of salts and potentially result in arsenic contamination off shallow groundwater as has been the case in Sindh (Baig, 2011). Water quality deterioration is regarded as a significant potential impact.

Potential Impacts of Remodeling of Civil and Marwat Canals: Fertilizers and pesticides are used both in the Civil and Marwat Canal command areas. Fertilizers are used more frequently in the command area of the Civil Canal than the Marwat Canal. The major crops cultivated in the Civil Canal Command Area include wheat, maize, Kharif and Rabi fodder, vegetables, sugarcane, rice and orchards. The major crops cultivated in Marwat Canal Command Area are wheat, Kharif fodder, maize and pulses. A few orchards are also cultivated in the Marwat Canal Command Area. After the remodeling of these canals, cropping intensity will increase and cropping patterns will change, with an increase in fertilizers and pesticides used per unit area.

Increased use of fertilizers and pesticides would result in deterioration of water quality; therefore, the potential impact is assessed as being of high magnitude, with definite probability of occurrence and long term. Moreover, waterlogging can lead to concentration of salts and potentially result in arsenic contamination off shallow groundwater as has been the case in Sindh (Baig, 2011). Since the area is highly populated, with about 50 major settlements between the Tochi and the Kurram Rivers and about 23 major settlements between the AOI demarcation line and the Tochi River, and numerous minor settlements, the potential impact is assessed as significant.

Potential Impacts on Low Riparian Areas: Though the dam would be constructed in Component 2, it could potentially have a direct impact on the low riparian areas in the Component 3 area as soon as it is operational. These areas will be negatively affected by the reduced assimilative capacity of the Kurram River. This will, in turn, reduce the DO and increase the BOD in the Kurram River, affecting cultivation in areas such as Lakki Marwat, Michankheltal, Ziaratmianumar, Dabak Mandra khel, Jabar khel and Armatewala. The magnitude of potential impact is assessed to be high and the duration long term. As many residents in the area are solely dependent on agriculture for household income, the potential impact is deemed significant.

Mitigation: The following mitigation measures are proposed:

- Farmers will be properly trained in the use of fertilizers and pesticides. This training will be carried out by the Agricultural Department of Bannu, KPK who should recommend the dose, type, amount and economic feasibility of different fertilizers. They should also recommend fertilizers and pesticides that are environmentally friendly and have minimal residual effect.
- Organic fertilizers will be promoted. It is strongly recommended that a Pest Management Plan be prepared and implemented.
- Bi-annual monitoring of water quality will be carried out. The locations where water quality samples are to be taken in the operational stage have been marked on Map 4-33. The parameters that shall be analyzed are listed in Chapter 8 of the EMMP and include arsenic.

- Reduction in the assimilative capacity of the Kurram River and its effect on low riparian areas will be mitigated by releasing a downstream minimum flow. Sections 5.7.3.2 and 5.7.3.3 discuss ecological flow requirements in detail. It is currently anticipated that the low riparian area requirements will be maintained during operations. However, as discussed in these sections further studies are needed to make a biologically based determination of flow requirements. . The mitigation measures described above will result in an overall potential impact of medium significance.

5.4.3.6 Biological Resources

Terrestrial Ecosystems

Extension of habitat: To the extent that cropland provides habitat for resident and migratory wildlife, the introduction of irrigation to 68,000 acres of the Thal Plain represents a major habitat change. A whole suite of ecological changes may be expected as cropping patterns change and more surface water becomes available, producing semiaquatic ecosystems where the ecosystems had been seasonal. This may be expected to provide a base for herons and other predators of amphibians and insects, as well as the small fish that move into the canals. Migratory cranes and waterfowl may be expected to visit the irrigated areas, seeking prey in the canal and drainage systems and food in the fields. The expansion of habitat can be further enhanced by planting of trees along canal banks, as these will provide nesting and roosting sites to birds, and may also serve as food sources.

While the potential expansion of bird habitat and feeding grounds is positive, the application of pesticides to their crops by farmers could result in occasional secondary poisoning of wildlife. This potential negative impact is local, potentially long term and of low magnitude. It is assessed as non-significant and does not require mitigation.

Increase in agricultural pests: Agricultural development in the Thal Command Area could result in an increase in agricultural pests as a result of the expansion of cultivation. This could in turn lead to increased use of pesticides as discussed in more detail in Section 5.4.3.1 above.

There are no threats likely to any endangered, rare and threatened species and no endemic species in the Component 1 area.

Mitigation: Increase in agricultural pests: Mitigation of increased pesticide use to control agricultural pests is described involves training of farmers, the preparation of a Pest Management Plan and implementation of IMP as discussed in detail in Section 5.2.3.1 and 5.4.3.1 above. Pesticides used shall comply with Pakistan legal requirements and USAID 22CFR 216.3 and the PERSUAP and 2013 PPERSUAP.

Aquatic Resources

Potential Impacts: The fragmentation of the Kurram River by the Kurram Garhi Headworks results in the isolation of the aquatic fauna upstream of the Headworks from the fauna downstream of the structure. Upstream movements by fish in the downstream reach of the river are presently blocked by the Headworks. However, the fish fauna below the Headworks is different from that above it. According to the Rapid Assessment Kurram Tangi Dam or REA (Design Consulting Engineers [Pvt.] Ltd. and Elan Partners [Pvt.] Ltd. 2012), the fish fauna in the reach of the river downstream of the Headworks is comprised mostly of warmwater species, whereas the fish fauna above the Headworks is primarily comprised of coolwater-coldwater species. Because of the colder water temperatures in much of the Kurram River above the Headworks, the warmwater species would not likely move (and remain) very far upstream above the Headworks even if the structure did not block that movement. Further, although there is likely some overlap in species composition in a limited portion of the river that includes the reach encompassing the Headworks, the populations of coolwater species in the reach downstream of the Headworks are likely much smaller than the populations of those same species above it (because of the warmer temperatures in the downstream reach), and coldwater species are either absent, or do not survive long if they are

transported below the Headworks by floods (Design Consulting Engineers [Pvt.] Ltd. and Elan Partners [Pvt.] Ltd. 2012). It is therefore likely that most of the fish downstream of the Headworks would not migrate to the upper portion of the river as part of their lifecycle. Therefore, the migration blockage by the Headworks is considered only a minor potential impact.

During the operation of Component III, up to 278 cfs water would be diverted from the Kurram River upstream of the Headworks into the new Thal Canal. This would be in addition to the 800 cfs presently diverted at the Headworks into the existing Marwat Canal and 600 cfs into the Civil Canal. The diversion into the new Thal Canal would reduce the downstream flow from the Headworks and would reduce the amount of aquatic habitat downstream of the Headworks correspondingly. There are a few riffle areas in the channels just downstream of the Headworks. However, the river in this reach appears to consist mostly of glides and pools. The riffle areas would be more adversely impacted by the potential flow reduction than would the glides and pool.

Of the Species of Concern and Representative Important Species found in the reach of the Kurram below the Headworks to Bannu, *Glyptothorax kashmirensis* would be most adversely impacted by the potential decline in riffle habitat. However, it may move into the glides in the reach if riffle habitat is unavailable. The Representative Important Species, *Salmophasia punjabensis*, *Cirrhinus mrigala*, *Puntius punjabensis*, *Sperata seenghala*, *Ompok bimaculatus*, *Wallago attu* and M*astacembelus armatus*, found in the this reach of the Kurram River are not anticipated to be adversely impacted by the loss of riffle habitat. These species are found in a variety of aquatic habitats and are not dependent on riffle areas.

Mitigation: An Ecological Flow will need to be maintained in the reach of the Kurram downstream of the Headworks. The Ecological Flows for Component III are, as for Components I and II, estimated using the Tennant Method (Tennant 1976). Based on the period of record from 1971-2012, the annual mean flow of the Kurram River at the Kurram Garhi Headworks was 1,342 cfs (Sections 4.6.1.2 and 4.7.3.3). An Ecological Flow for the Kurram downstream of the Headworks would then be about 269 cfs during the low flow months (September to June, on average), and at least 403 cfs during July and August. The 25 percentile, 50 percentile and 75 percentile flows were 1,653 cfs, 1,311 cfs and 969 cfs, respectively. The high flow period Ecological Flow (403 cfs) was exceeded at least 75 percent of the time. It is, therefore, likely that the Ecological Flow would be maintained under the Component III operating conditions. Nonetheless, the Ecological Flow determined by the Tennant Method will need to be confirmed, or revised, based on the use of a habitat modeling method, such as PHABSIM (Bovee, 1982).

Even though Component 3 includes significantly higher population centers than Components 1 or 2, groundwater still represents the principal source of water supply and no piped wastewater discharge systems are known. As a result, the true water/wastewater Environmental Flow requirements in Component 3 also likely are negligible. Applying the same assumptions used in Component 1 estimates were developed in order to assess the relative impacts of human activity on surface water flows. downstream of the Kurram Garhi Headworks. These assumptions result in a consumptive water use of about 6 cfs and a non-consumptive wastewater use of about 45 cfs, as the water/wastewater components of the Environmental Flow release requirements for Component 3. The water/wastewater components are significantly less than the Ecological Flows of 269 cfs to 403 cfs. The Ecological Flow releases are, thus, expected to be more than sufficient to meet water/wastewater Environmental Flow requirements. No irrigation demands downstream of the Headworks are addressed here. However, the irrigation demand of the new Thal Canal will change the irrigation demand releases from the Kurram Tangi Dam, and Weirs II and III in Component 2, and thus change the total release requirements from those structures. . .

Component 3 includes the new Thal Canal and the rehabilitated Marwat and Civil Canals. Water withdrawal requirements for the new Thal canal are estimated to vary from as low as 59 cfs in December to as high as 267 cfs in September. Since these flows are diverted from the Kurram River above the Headworks, the total flows released from the Dam, and Weirs II and III need to be

increased to include the additional Thal irrigation demands. The increased total minimum release flows from these structures with Component 3 in operation are shown in Table 5-16. These flows and the schedule of their release need to be included as part of the dam/reservoir operating procedures for the Kurram Tangi Dam, and Weirs II and III, and coordinated with the irrigation demand operations of Components 2 and 3.

The total minimum flow releases will need to be revised when the Ecological Flow Requirements are finalized. This revision must be based on the PHABSIM study that as described in the Fisheries` Management Plan uses RHABSIM.

5.4.3.7 Socio-Economic Environment

Potential Impacts: During operation the main potential impacts are changes in land use patterns. Presently most people in Component 3 have insufficient access to irrigation and/or are unfamiliar with the challenges of irrigated agriculture. In order to use the full potentials of the upgraded and new CCAs, the benefiting population will need to transform their production systems and land-use patterns. This transformation commonly results in situations where some local people become frustrated with the new challenges and lease it out to agro-industries and/or agriculturalists from other areas below market rates and gradually lose control over their lands. This potential impact is considered to be of high significance.

The establishment of a water bodies in a dry arid area may facilitate vector-borne diseases such as malaria, leishmaniasis, Japanese encephalitis, dengue and dracunculiasis (Dracunculiasis or guinea-worm disease is caused by water fleas and was endemic in Pakistan but was eradicated in 1993. Nevertheless, chances for occurrence still exist, so this disease should be considered as a possible future threat). This change to the environment could increase health related issues.

At the intake point of the channel supplying water to turbines, there is normally an accumulation of all types of trash, both biodegradable and non-biodegradable. Commonly, this is removed and spread in the vicinity of the dam/weir to decompose. This is a source of air pollution and could also affect the population located near to the project site. The polluted air could be deleterious effects to human health by triggering or causing asthma, chronic obstructive pulmonary disease, and other non-infectious respiratory ailments.

Potential health impacts are assessed as significant.

Mitigation: To utilize the potential of the CCA and to maximize the benefits of Component 3, the people in Component 3 will need to be provided with extensive training for capability enhancement and technical and financial support during the first five to six years so that they can transition to full-fledged irrigation agriculture. This needs to include the establishment of Water Users Associations and Agricultural Extension Services, as well as credit associations, input supply groups, value-added processing techniques, storage depots, and marketing facilities. While the RPF and the consecutive RAP provides guidance on such mitigating measures in the context of the livelihood restoration measures for the affected people, similar measures need to be established for the remaining populations in the footprint of Component 3.

Proper prophylactic arrangements shall be offered to the local communities:

- Health education for making them aware of the impending threats and prophylactic techniques for avoiding these vectors such as mosquitoes, and snails etc., such as bed-netting, weekly chloroquin, repellent creams, removal of small impoundments in the dwelling places.
- Offering free vaccinations to the population for vaccine-preventable diseases.

Table 5-16: Minimum Ecological and Environmental Release Flows (cfs) for Component 3

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Kurram Tangi Dam												
Water (consumptive)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Wastewater (non-consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Ecological (non-consumptive)	176	176	176	176	176	176	263	263	176	176	176	176
Irrigation - Marwat, Civil, & Thal Canals (consumptive)	864	1096	1205	1356	1268	896	1169	1005	1677	1633	1504	371
Total Min Release (1)	865	1097	1206	1357	1269	897	1170	1006	1678	1634	1505	372
Weir II												
Water (consumptive)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Wastewater (non-consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Ecological (non-consumptive)	212	212	212	212	212	212	318	318	212	212	212	212
Irrigation - Marwat, Civil, & Thal Canals (consumptive)	864	1096	1205	1356	1268	896	1169	1005	1677	1633	1504	371
Total Min Release (1)	865	1097	1206	1357	1269	897	1170	1006	1678	1634	1505	372
Weir III												
Water (consumptive)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Wastewater (non-consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Ecological (non-consumptive)	266	266	266	266	266	266	400	400	266	266	266	266
Irrigation - Marwat, Civil, & Thal Canals (consumptive)	864	1096	1205	1356	1268	896	1169	1005	1677	1633	1504	371
Total Min Release (1)	865	1097	1206	1357	1269	897	1170	1006	1678	1634	1505	372
Kurram Ghari Headworks												
Water (consumptive)	6	6	6	6	6	6	6	6	6	6	6	6
Wastewater (non-consumptive)	45	45	45	45	45	45	45	45	45	45	45	45
Ecological (non-consumptive)	269	269	269	269	269	269	403	403	269	269	269	269
Total Min Release (2)	275	275	275	275	275	275	409	409	275	275	275	275

(1) Irrigation withdrawals occur between Weir III and Kurram Garhi Headworks, so are non-consumptive in this reach. Therefore, Irrigation releases cover both Wastewater and Ecological requirements, and Total Minimum Release = Water + Irrigation.
(2) Irrigation water for Marwat, Civil, & Thal Canals diverted upstream of Kurram Garhi Headworks. Wastewater requirements are non-consumptive so are met by Ecological flows. Therefore, Minimum Release = Water + Ecological.

5.4.3.8 Roads, Bridges and Traffic

Potential road and traffic impacts and their mitigation for Component 3 will be the same as for Component 1.

5.4.4 Decommissioning

It is expected that the affected stakeholders will want to keep all the proposed irrigation facilities viable and not decommission them.

5.5 Potential Cumulative Impacts

5.5.1 Definition

Cumulative impacts are defined under the regulations implementing the US National Environmental Policy Act as:

- The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person… undertakes such other action (40 CFR ~ 1508.7).

The World Bank has defined cumulative effects as: "the combined effects of several projects or interventions within a project and these with development trends in a region or sector."

A helpful and expanded definition is provided by the California Environmental Quality Act:

- Cumulative impacts refer to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.
- The individual effects may be changes resulting from a single project or a number of separate projects.
- The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.

Cumulative effects analysis differs from the analysis of direct and indirect effects in two ways: (1) the focus should be on the sustainability of a particular resource, often called the Valued Ecosystem Component (VEC), and (2) there should be an expanded geographic and time frame of reference. The purpose of cumulative effects analysis is to determine if a particular project that might have individually limited impacts might contribute in the context of other actions to impacts that are cumulatively considerable and highly significant. For example, a few wells tapping an underground aquifer may have little effect, but hundreds or thousands of wells tapping the same aquifer may affect the sustainability of the water resource.

5.5.2 Strategic/Sector Environmental and Social Assessment of the Indus Basin

A Strategic/Sector Environmental and Social Assessment of the Indus Basin (SSESA) Strategic/Sector is currently being undertaken under World Bank funding through the Pakistan government managed Water Capacity Building Project, which is managed by the Project Management and Policy Implementation Unit, Ministry of Water and Power.

Netherlands funding to IUCN as part the National Impact Assessment Project, by SMEC International . This study affords an opportunity for sector-wide environmental and social considerations including cumulative impacts to determine investment priorities. The cumulative impact assessment is being conducted to estimate the potential cumulative of the hydropower options (individual projects or set of projects) on the environment, natural resource base and socio-economic conditions, taking into account the baseline situation, and multiple ongoing and planned water resources development and hydropower investments in the Indus River Basin.

Aspects of the study are planned to address: (i) environmentally and socially sustainable flows (minimum quantity of water to keep the river/stream alive) in different river stretches and the Indus Delta; and (2) climate change impacts. (See Government of Pakistan, Ministry of Water and Power, June 2013, Inception Report by SMEC International PTY Ltd., Australia.). At the time of producing this EA, the results of the SSEA or its Interim Report are not available, but should be consulted in the future to ascertain how the KTDP may engender or be affected by cumulative effects of other hydropower projects.

As part of the SSEA, the water demands of the Indus Basin were evaluated. Water availability in Pakistan is considered a critical issue, having fallen from 5,650 m^3 to 1,000 m^3 from 1951 to 2010. According to the SSEA Water Demands of Indus River Basin (June 2013, SMEC for the Government of Pakistan Ministry of Water and Power), Pakistan depends on its one river basin (the Indus), whose headwaters are located in different countries. Because of future water demand, irrigation use may need to decline with increased population (SSSEA, Water Demands of Indus Basin, pg. 11). The Basin is considered heavily reliant on the western Himalayan glaciers and rainfall, but with glacier depletion, dramatic decreases in river flow are predicted (30 to 40% in 100 years). Pakistan needs to double its water storage capacity by 2025 to compensate for sedimentation. Environmental flows are considered to need urgent implementation.

The combined mean annual flow of the Kurram and Kaitu Rivers is about 1.5% of that of the Indus. It is therefore likely that a reduction in flow by irrigation withdrawals in the Kurram and Kaitu Rivers will have minimal (likely not measurable) impact on the Indus River flows.

5.5.3 Potential Cumulative Impacts Related to the KTDP

Potential cumulative impacts on the KTDP are, in concept, related to (i) upstream withdrawals that could affect the functioning of the KTDP itself; (2) water withdrawals from the KTDP in conjunction with planned or proposed water withdrawals that could affect existing water withdrawals of downstream users; (3) major construction activities likely to occur in a similar time frame in the project areas, specifically in the North Waziristan, F.R. Bannu and Bannu District (the geographic areas most affected), including heavy use of roads that will transport equipment and materials to the KTDP; and (iv) overall potential cumulative impacts of the KTDP itself.

5.5.3.1 Upstream Water Withdrawals

Kaitu River Watershed

The Kaitu watershed covers a total area of about 1,946.6 square miles, out of which only about 30 percent lies in Pakistan while 70 percent is in Afghanistan. A 2009 report of the US Army Corps of Engineers describes the Shamal watershed (name in Afghanistan for the Kaitu River) as heavily irrigated with networks of irrigation diversions, canals and drains. They concluded that the watershed does **not** have high potential for irrigation storage dams nor for hydropower. Most of the watersheds contributing stream flow are in poor condition and any new dams would have to be designed and maintained to handle high sedimentation rates. The stream systems are unstable resulting in high sedimentation potential and flash flooding. A significant amount of recent deforestation has exacerbated the sediment problem. While, the possibility of large scale water withdrawals above the Kaitu weir cannot be dismissed entirely, this situation does not seem likely. However, it is likely that the cumulative effects of erosion that are likely to increase will cause sedimentation in the reservoir behind the Kaitu weir. See the Watershed Management Plan (EMMP Annex II) for more details on the severity of this issue and potential mitigative measures, such as dredging the sediment.

Kurram River Watershed

The Kurram River watershed upstream of the confluence with the Indus covers a total area of about 2,536 square miles out of which about 64% lies within Pakistan. About six miles upstream of the future reservoir of Component 2, the Pakistani part of the Kurram watershed lies almost entirely in Kurram Agency. There are no known major dam or irrigation developments planned or proposed in

Pakistan that would have cumulative effects on the KTDP. No information is available for the Afghan part of the watershed. Erosion and sedimentation, as a result of naturally occurring and anthropogenic causes, will contribute to sedimentation of the Kurram Tangi Reservoir, as described in the Watershed Management Plan (EMMP Annex II).

It has been reported in June 2013 (Express Tribune, June 4, 2013) that two dams completed in 2012, the Kot Ragha and Maidani dams, in Mali Khail, Upper Kurram and Enzari, Lower Kurram respectively, will allow 1,808 acres to be irrigated. According to the FATA Secretariat's irrigation department, the Kot Ragha Dam will irrigate 500 acres. The dam will also enable the extraction of 10 cusecs of water. The Maidani Dam, on the other hand, is the larger of the two in terms of rainwater collection. The Maidani Dam is 86 feet wide, has the capacity to store 2,975 hectares of water and will irrigate 1,308 acres of land. These dams are expected to boost agriculture and the fisheries business. These dams will mean less water availability downstream. However the planned withdrawals are low and are unlikely to affect the Kurram Tangi Dam

5.5.3.2 Relationship of KTDP to Downstream Water Uses

The level of detail currently available in the SSEA is not sufficient to allow a calculation of how much the flows of the KTDP represent of the total water demands for agriculture (shown as approximately 165 BCM in recent decades to irrigate 21.3 million to 22.75 million hectares) with approximately 130 BCM diverted to canals per annum in an average year.

Concerning the Kurram River, there will be increasing difficulties of gravity irrigation in riparian areas downstream of the Kurram Garhi Headworks. The diversion of required irrigation flows for the Thal, Civil Canals and Marwat command areas (about 846,000 acre-feet/year, varying from about 370 cfs in mid-December to about 1,900 cfs in early November) and the reduced flow of the Kaitu River (due to irrigation diversion to Component 1 command areas) will reduce river flows and water levels downstream of the Kurram Garhi Headworks, particularly in periods of low river flow (Rabi season). This potential impact will be felt mostly in the lower riparian areas which are not part of the Civil Canals and Marwat command areas.

The diversion of required irrigation flows for the Spaira Ragha & Sheratalla command areas (varying from 20cfs in December to 110 cfs in August and September) and flows to Powerhouse IV at the Kaitu weir will diminish by about 75 percent the downstream average yearly river flows (from 361,000 acre- feet to 88,000 acre-feet), daily river flows and water levels downstream of the Kaitu weir, especially in the periods of low river flow (Rabi season).

This EA recommends that additional research be conducted to determine the specific, cumulative effects of the impoundment and the water withdrawals on the downstream irrigation below the Kurram Garhi Headworks and in the Kaitu River.

5.5.3.3 Construction Projects Planned to Occur at the Same Time as the KTDP

No information about ongoing or planned major construction projects of the magnitude of KTDP in FATA, F.R. Bannu or Bannu District (the principal affected areas) has been located and we understand that within the part of the watershed that is within Pakistan, none are planned, based on information communicated to NESPAK by the Department of Forestry. The size and duration of the KTDP (see Chapter 3) are sufficiently major such that any road or social infrastructure projects will be dwarfed in comparison to KTDP. Thus, it is the effects of the KTDP itself that will dominate cumulative effects on most resources, i.e., valued ecosystem components. This means that the direct and indirect effects of KTDP as discussed in this EA already represent the bulk of any cumulative effects on natural and human resources.

A possible exception to this conclusion concerns the potential impact on highways/roads that will be transporting material and equipment to KTDP component sites. Insufficient information is available

to evaluate the extent of these cumulative effects. Nevertheless, the source of specific effects on highways and routes from major construction projects is likely to be largely the result of the KTDP.

5.5.3.4 Anticipated Cumulative Effects in the Project Area

The potential social cumulative effects of the KTDP are large and significant (see RPF for more detailed information on the basis of this information):

Table 5-17: Land Area and Population affected by the KTDP

Component	Land Area Affected (acres)	Physically and economically displaced population (households)
Component 1	24,000	Approximately 11,000
Component 2	14,000	Approximately 4,000
Component 3	145,000	Close to 55,600
Total	183,000	Close to 72,000, equivalent to about 684,000 persons

During the construction and operation of KTDP, the principal impacts are (i) the large-scale acquisition of land resulting in the physical and economic displacement of nearly 72,000 household; and (ii) the influx of security personnel and job seekers into semi-independent tribal lands. The physical and economic dislocation of the local population, in the context of significant in-migration of outsiders, exposes the tribal communities to modernization. The influx of construction activities portends the possibility of significant local inflation in the costs of commodities and services. The pressures will result in depletion of resources (as a result on the population associated with construction), unless strong mitigative measures are implemented to ensure reduced pressure on local resources.

The effects of this kind of land use change and the amount of displaced population that will need to be relocated and compensated is unprecedented in the region. Because the displaced population will largely remain in the region, these changes do not represent additional cumulative effects on natural resources. Nevertheless, KTMDP aims to transform pastoralism and rain-fed agriculture into irrigated farming, which entails significant potentials to enhance the living conditions and livelihoods of the local people. Thus, the cumulative effects of the project on the social and economic side are likely to be largely positive.

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6 ANALYSIS OF ALTERNATIVES

6.1 Analysis of Power and Irrigation Alternatives

There could be a number of alternatives to building the proposed project facilities, e.g., thermal, solar or wind power to generate electricity and ground water to irrigate. Additional power generation and irrigated land could also be developed in other regions of Pakistan, most likely at lower costs and potentially with less negative environmental and resettlement issues. It is understood that local alternatives were considered, but were ruled out as they would not meet the full extent of the proposed power generation and irrigated areas; the strategic location of the project, which is in an undeveloped area that has an urgent need for jobs, sustainable power generation and reliable agriculture makes it hard for smaller alternatives to meet all community needs. This study used the foundation from previous studies, and did not further evaluate alternative technologies and regional plans for energy and irrigation.

To provide a review of the previous studies, a number of additional "recommended options" are listed in this chapter under each component. The list is not exhaustive, as it was not part of the scope to enhance or optimize the project design. It is expected that a number of additional field, technical, environmental and resettlement investigations – and follow-up design studies – will be performed by WAPDA and others (Irrigation Department, FATA, etc.) to refine and optimize the proposed project features.

Although the project has a long history of development, having been conceived in 1955, planning of the present project began with the 1992 Pre-Feasibility Report (WAPDA, 1992). The 2004 Feasibility Report (KTDC, 2004) contains the major part of the present configuration of the project, but certain aspects, notably the height of the Main Dam have changed. The Detailed Engineering Design Report (PES et al, Vol. I Main Report 2011a), raised the dam height to 322 feet, with a corresponding increase in reservoir area and volumes. Small design changes were also made during the preparation of the Tender documents (PES, 2011b).

According to the 2004 Feasibility Study: "…the project continuously emphasized early identification of environmental and resettlement impacts. Environmental and resettlement considerations have been included in the process of selection of alternatives during the siting of structures, design of components and development of operational concepts. The impact of this approach is exemplified by the alignment selected for the new canals, particularly the Thal Canal that is by far the biggest in terms of length, discharge and CCA.".

"Another major planning activity has been early and frequent interactions with the local people. This has kept the planning team attuned to public concerns and desires, and facilitated the participation of the local population in the planning process. As a consequence of this approach, it has been possible to identify and avoid, or at least mitigate, the potentially serious social effects".

6.1.1 Alternatives for Power Supply in the Project Area

In WAPDA's planning to meet increasing demand, hydropower is increasingly favored because it is cleaner and lower in long-term cost than thermal power. But despite lower long-term costs, hydropower is not always suitable: for example, the 15,000 MW Skardu/Katzasah Hydroelectric Plant was rejected because it would have inundated two agriculturally productive valleys and required the resettlement of nearly 224,000 people.

Under the program WAPDA Vision-2025, WAPDA has completed five new hydropower projects, resulting in a total installed capacity of 31,057 MW. These dams vary in capacity from less than six to 3,478 MW (Tarbella). Another 25,000 MW of new projects is under studyand are being implemented, such as the 969MW Neelum Jhelum project.

6.1.2 Alternatives for Irrigation

The 2004 Pre-Feasibility Report listed a variety of alternatives to proposed irrigation project. These are summarized as follows:

- Adopt intensive (rather than extensive) irrigated cultivation.
- Use land in accordance with the potential of land: the water requirement of Class I and Class II lands must be fulfilled first, next comes the Class III land, whereas Class IV land should be allocated to tree plantation for forage and fuel wood.
- Supplement ground water in sweet ground water zones (flood plains) with the canal water irrigation.
- Initiate cultivation of salt tolerant crops in brackish groundwater zone (Piedmont Plains).
- Use sprinkler or drip irrigation as alternatives to surface irrigation on sandy soils to avoid wastage of precious water: this will also decrease the risk of water logging, salinization, erosion and inefficient water use.
- Establish a pilot project to experiment, confirm and demonstrate the merits of saline agriculture and drip/sprinkler irrigation.

Although the traditional surface irrigation was selected for the new commands due to the familiarity of the users, each new irrigation command is required to have a 20-acre demonstration plot to show the merits of sprinkler and drip irrigation methods. It is expected that water utilization and allocation will be further optimized during the upcoming detailed design studies for the tertiary canals and development of the command areas. For example, the use of sprinkler irrigation would require a reliable source of electric power, which is currently lacking in the project area but could become readily available through rural electrification from the proposed hydro-power plants.

6.2 Project Cost-Benefit Analysis

As there is no body of documentation that systematically and comprehensively addresses alternatives to the proposed project, a detailed cost-benefit analysis of the alternatives discussed in this chapter cannot be carried out. However, it is possible to present a simple analysis of comparison of the proposed project to the "no project option". This analysis assumes that under the no project option all future benefits related to project implementation are foregone and that no other development is implemented that could provide measurable economic benefits. Details on the project costs and benefits are presented in Volume II of the EA.

The results of the overall project indicate that the project is economically viable as its expected economic internal rate of return (EIRR) of 12.5 percent exceeds the 12 percent opportunity cost of capital presently being used by Planning and Development Division, Islamabad. The EIRRs for Component 1, Component 2 and Component 3 are calculated as 2.2 percent, 4.3 percent and 20.7 percent respectively, as shown in the tables below.

Table 6-1: Results of Overall Economic Analysis

Economic Indicator	5% Discount Rate	12% Discount Rate
Present Value of Benefits (PKR Million)	93,862	35,940
Present Value of Costs (PKR Million)	42,916	34,261
NPV (PKR Million)	50,945	1,680
BCR	2.19: 1	1.05: 1
EIRR	12.5%	

A sensitivity analysis examined the effects of decreased benefits or increased costs (or both); the three scenarios were:

(i) Decrease in Benefits by 10 percent;
(ii) Increase in costs by 10 percent;
(iii) Both (i) and (ii) occurring simultaneously.

The results of the sensitivity analysis are summarized below:

Table 6-2: Results of Sensitivity Analysis (Overall)

Assumption for Sensitivity Analysis	EIRR
10 percent decrease in benefits	11.4%
10 percent increase in costs	11.5%
Benefit reduction & cost over-run by 10 percent each(both occurring simultaneously)	10.4%

Component 1 comprises construction of Kaitu Weir and its affiliated canal structures to irrigate new areas in the Sheratalla and Spaira Ragha Plains, along with two hydropower stations (PH IV, PH V). The results of economic analysis are given below:

Table 6-3: Results of Economic Analysis Component 1

Economic Indicator	5% Discount Rate	12% Discount Rate
Present Value of Benefits (PKR Million)	6,725	2,712
Present Value of Costs (PKR Million)	9,503	7,843
NPV (PKR Million)	(-)2,778	(-)2,712
BCR	0.70 : 1	0.35 : 1
EIRR	2.2%	

Component 2 comprises construction of the main dam on the Kurram River in the North Waziristan Agency, just before it crosses the border between the North Waziristan Agency and Bannu. The results are given below:

Table 6-4: Results of Economic Analysis Component 2

Economic Indicator	5% Discount Rate	12% Discount Rate
Present Value of Benefits (PKR Million)	22,462	9101
Present Value of Costs (PKR Million)	24,228	19390
NPV (PKR Million)	(-)1,766	(-)10289
BCR	0.93 : 1	0.47 : 1
EIRR	4.3%	

Component 3 comprises the remodeling of the existing Kurram Garhi Headworks, the construction of the new Thal Canal and its command area, and the rehabilitation and upgrade of the existing Marwat and Civil canals and Command areas. The results are given below:

Table 6-5: Results of Economic Analysis Component 3

Economic Indicator	5% Discount Rate	12% Discount Rate
Present Value of Benefits (PKR Million)	63,652	23,397
Present Value of Costs (PKR Million)	14,078	11,266
NPV (PKR Million)	49,574	12,131
BCR	4.52 : 1	2.08: 1
EIRR	20.7%	

6.3 Component 1 Alternatives

6.3.1 No Action/Without Project Scenario

If Component 1 is not implemented, potential adverse impacts would not occur, however, the agricultural production in the region will continue to suffer water shortages.

- On the Spaira Ragha and Sheratalla Plains, rain-fed agriculture will continue to be practiced. As the populations of Bobali and Datta Khel increase, increased pressures will fall on the areas of irrigated agriculture. FATA may install additional dug wells, but the amount of available groundwater water is limited.
- The economic benefits offered by project employment would not occur. Potentially this could have a major impact on the possibility of reducing critical unemployment and poverty.
- Other benefits associated with the construction of the project such as training of skilled and unskilled local personnel and other social activities would most likely not happen.

6.3.2 Alternatives from Previous Studies

6.3.2.1 Kaitu Weir

Alternatives Considered: In the 1992 Pre-Feasibility Report (ACE *et* al., 1992), the designated site for the weir was specified as 50 feet upstream of the Spinwam Bridge; however, the feasibility study concluded that the origianal siting represented a risk to the bridge and the site was moved 350 feet upstream.

Potential Impacts of Alternatives: If the weir had been placed as close to the bridge as originally planned, it is likely that a new bridge for the Mir Ali-Thal Road would have been necessary and the bridge would have to be removed prior to construction, even if a new road would pass across the weir. In that event, the existing ford, 270 feet downstream of the bridge, could have been strengthened by the addition of a fording slab to protect the bridge from heavy vehicles.

6.3.2.2 Spaira Ragha Canal Routing

Alternatives Considered: The initial layout for the Spaira Ragha Main Canal included a tunnel through the hill on the southeast side of the Mir Ali-Thal road. During the feasibility study (KTDC, 2004) it was decided to eliminate the tunnel and route the canal around the west end of the hill.

Potential Impacts of Alternatives: If the tunnel route alternative had been selected, the project cost would have increased, and the residents would have potentially been affected by the necessary blasting during construction. By locating the canal on the contour, the project cost decreases, and the problems associated with tunnel construction (blasting, spoil disposal) are avoided.

6.3.2.3 Power Source for the Spaira Ragha Pumps

Alternatives Considered: In the Prefeasibility Report, the plan for the Spaira Ragha CCA was to have a pump station lifting the entire capacity of the Spaira Ragha Canal to the upper edge of the plain and letting it flow downward to irrigate. In the Feasibility Report, to avoid the higher cost of the larger pump station, with greater O&M costs, it was recommended to use four smaller pumps, irrigating only the upper third of the CCA, the remaining 2,720 acres being watered from the Main Canal.

The present design of the project stipulates a powerhouse (V) in the Sheratalla Canal, having an installed capacity of 400 kilowatts of electricity. It would supply power to the pumps on the Spaira Ragha Canal.

6.3.2.4 Contractor's Work Area

Alternatives Considered: Project documents indicate several locations for work camps. These camps were developed under the assumption that all three project components would be developed at the same time. The main ones are located on an access road between the KT dam and the Kaitu

weir. With the postponement of the start of construction of components 2 and 3 and in view of the very difficult security conditions, the construction contractor will have to re-define the best sites for work areas.

6.3.3 Recommended Options for Component 1

Geology and Geotechnical Aspects: Sufficient geological investigations were carried out for the Component 1 feature to establish overall project feasibility and enable preliminary cost estimates; however there is insufficient data and analysis for a final construction design effort. Additional drilling as specified in the previously planned investigation boreholes at the location of the Kaitu Weir should be performed and the results should be incorporated into the final design of the subject structure. It is noted that the previous three boreholes were drilled at the original alignment, some 200 ft to 300 ft downstream from the present one. Geological conditions have been inferred from this original location. New drilling is needed at the actual site of the weir.

Additional investigation boreholes should be drilled along the Kaitu Feeder Tunnel alignment prior to the construction phase. Core logging should include engineering geology descriptions and the estimation of rock mechanics indices such as RMR and Q in order to study the tunnel excavation and support parameters.

Due to the late designs of the two additional powerhouses (Powerhouses IV and V) no investigation boreholes have been drilled yet. A detailed geotechnical investigation program should be developed for these two powerhouses to assess the foundation conditions and other parameters needed for final design. Further details are provided in the Supplemental Report on Geotechnical Aspects.

The current review has not identified any fatal flaws and the level of geological detail supports the current project layouts and structure designs. Project planning may proceed on the basis of existing information; however further field investigations, including additional geological mapping and boreholes are needed to enable detailed design to be completed. Project designs are reasonable and appropriate for this level of study; however, as noted in the preceding chapters, design reviews, additional analyses and detailing work are still needed. Additional items of work to be completed to finalize the construction design and drawings include the following:

- Carry out additional field investigations as noted in the Supplemental Reports on Geology and Geotechnical Aspects.
- Perform seismic stability analyses using the new ground motion parameter.
- Carry out additional design work as recommended.
- Review the foundation designs of structures which are founded on overburden material. These should be revised and rock foundations should be used wherever possible. In general, it is expected that all major weirs and other water retaining structures can be placed on bedrock foundations. If still foundations are placed on overburden, liquefaction potential of foundation strata should be assessed and the design should be revised accordingly.

Seismic: See recommendations under Component 2

Electrical and Mechanical Systems: Based on the review of the available documents, the following issues are noted. The tender documents and relevant drawings should be updated to rectify these issues.

- Several International Electrotechnical Commission (IEC) Standards referred to in the tender documents are outdated with respect to the latest version and current numbering;
- Certain interfacing requirements are not clearly and explicitly defined in tender documents;
- Certain equipment and system types specified in the tender documents are not commensurate with their intended application/function and their commercial availability may not be guaranteed;

- Certain equipment ratings are not commensurate with actual system requirements i.e. in some areas, the equipment is grossly over-rated/over-sized. There will thus be cost repercussions; and
- There are several missing components/equipment and functional / technical specifications without which complete functionality of powerhouse (s) cannot be achieved.

Construction and Housing Camp: In August, 2013, WAPDA announced that they had received an offer from the Pakistan Army for the use of their cantonment in Spinwam. The cantonment is located on the main street of Spinwam, slightly less than a mile from the market center. In addition, two sites appear to be available for the construction camp:

- About 10 acres of land on the right bank of the Kaitu River, north of the Mir Ali-Thal Road.
- About 15 acres of open cultivated land on the left bank of the river immediately behind the irrigated fields that will be inundated by the weir pool. Since these fields will be acquired for the project, it may be possible to use that area to build a construction camp, prior to weir closure.

A detailed investigation of these sites will need to be performed to assess their availability and adequacy to meet the space requirements for the main construction and housing camp to be used for Component 1. Whichever site is selected, proper land acquisition procedures will need to be followed and a plan prepared to develop the site, including environmental mitigation and monitoring as well as health and safety aspects. Potential negative impacts to be investigated include the proximity of the market district, the mosque, commercial buildings, and local traffic.

Alternatives on the right bank of the river will produce noise that may be offensive to workers in the compounds to the west. Noise, odors of asphalt, concrete dust, and diesel fumes will mostly be carried by prevailing winds to the southeast, where the nearest residential compounds are about 1.5 miles away.

Road Relocation: As a measure to mitigate the construction of the tunnel entrance on the traffic of the Mir Ali-Thal Road, the relocation of a portion of the road is recommended. If this is not done, careful traffic management will be required.

Powerhouse at the Toe of Kaitu Weir: The feasibility of installing a small powerhouse at the toe of Kaitu Weir to use the minimum flow releases should be investigated. The power generated at the Kaitu Weir site could also drive the pumps on the Spaira Ragha Plain. This would offer the benefit of a shorter transmission line from Powerhouse V. The output of Powerhouse V could easily be used in the new surrounding villages associated with the Sheratalla Canal.

Minimum Flows: Additional investigations should be performed to assess and determine the appropriate minimum flows, downstream of the Kaitu Weir.

Enhancements for Downstream Users: A number of existing irrigated areas and settlements were observed downstream of the proposed Kaitu Weir, from satellite images. An inventory of all the existing right- and left-bank irrigation and rain-fed agricultural lands should be performed. As proposed for the Civil Canals in Component 3, a plan to rehabilitate and expand these irrigation systems should be developed and implemented, along with mitigation of its potential environmental and resettlement impacts.

6.4 Component 2 Alternatives

6.4.1 No Action/Without Project Scenario

Failure to implement Component 2 would result in a continuation of irrigation water deficits in the Marwat Command Area and no resolution of the head-tail end distribution problem in the Civil Command Areas. Cultivation on the 68,000 acres of the proposed Thal command would continue to be spotty, with some farmers drawing from wells in the nullahs.

One alternative considered in planning the project, but rejected as unnecessary with the storage reservoir, was the raising of the Kurram Garhi Headworks and Baran Dam located in Component 3. These actions would have compensated for the loss of the dam/reservoir system, but would not have provided enough storage to allow implementation of the Thal CCA.

Without the Kurram Tangi Reservoir, farmers and herders in that area would continue to live as they are now. However, due to continued overgrazing of the rangeland, livestock herds might become smaller or in poorer condition. It is also possible that FATA might implement additional programs that might reduce the impacts of not implementing Component 2.

The potential impacts foreseen on the aquatic ecosystem would not occur, either during construction or operation. Thus, no blockage of fish migrations would occur but no reservoir fishery would be developed. The siltation of the river reaches downstream of the Main Dam and the two weirs would not occur.

Although the proposed KT reservoir has the potential negative impact to physically displace about 15,000 local residents, the economic benefits offered by potential project employment would not occur. This would negatively impact reduction of critical unemployment and poverty in Component 2 area. Other benefits associated with the construction of the project such as training of skilled and unskilled local personnel and other social activities may most likely not happen.

6.4.2 Alternatives from Previous Studies

6.4.2.1 Main Dam

Alternative Dam Sites: The site of the Kurram Tangi Dam was dictated by topography and geological conditions. A second site was considered, immediately downstream of the confluence of the Kaitu and Kurram Rivers. The center line of this alternative dam would have passed directly through the village of Zarwam. To obtain the desired storage at this site, a dam about 450 feet high, with a crest length of 12,000 feet would have been required. It was abandoned, however, as it was estimated that the site foundations would not support a dam of more than 160 feet in height

Alternatives Considered for Type of Dam: Five types of dams were considered, but one, an arch dam, was quickly rejected as being technically unsuitable for the site. The other four consisted of (i) a concrete gravity dam (CGD), (ii) a roller compacted concrete dam (RCCD), (iii) a concrete faced rockfill dam (CFRD), and (iv) an earth core rockfill dam (ECRD). Initial consideration of the foundation rock resulted in the conclusion that either a CGD or a RCCD could be supported by the site rock. The CFRD was however selected because of the ready availability of sound rock from the tunnels and because it was estimated that it would cost approximately 20 percent less than a CGD or RCCD. As stated in the 2004 Feasibility Study, besides the technical advantages and lower cost of a CFRD at the proposed site, environmental considerations also favored this selection, as stated in the previous studies. The excavated material from the powerhouse tunnel would be used in the construction of the dam structure. This would obviate the need for disposal of large quantities of excavated material and avoid the environmental and ecological problems arising from this disposal.

There is a little difference in environmental effects of the various dam types, since all would involve tunneling for river diversion, spoiling of rock, concrete hatching, and other activities. All would require the same type and size of contractor's camp and housing areas.

Alternatives Considered for Height of the Dam: In the Prefeasibility Report (ACE et al., 1992), the ability of the project to meet irrigation demand at the Kurram Garhi Headworks over the 23 years of flow records was determined for various reservoir capacities. It was concluded that a dam height of 340 feet would meet irrigation demand in 19 out of the 23 years of flow records. In the Feasibility Report (KTDC, 2004), the dam height was initially lowered to 297 feet, based on additional hydrological data. During the Detailed Engineering Design Report (KTDC, Vol. I Main

Report 2011), further analysis of the hydrological data resulted in raising the dam height to 322 feet, with a reservoir elevation at 2,127 feet msl.

Potential Impacts of Alternatives: The additional elevation of the reservoir surface, from a dam height of 297 feet to 322 feet, resulted in more villages being flooded at the upper end of the reservoir, as most of the villages at the downstream end are below elevation 2067 feet. The effect of a 30-foot higher dam, with water elevation at 2097 feet, will increase the reservoir area by about 2,000 acre.

6.4.2.2 Tunnel Excavation

Alternatives Considered: In the 1992 Prefeasibility Report (ACE et al, 1992), it was recommended that the tunnels be excavated by a tunnel boring machine (TBM), as the Mangla Dam tunnels were during the 1960s. Blasting was specifically not recommended due to the likelihood of it causing fractures in the rock. In the Feasibility Report (KTDC, 2004), the recommended use of a TBM was reversed and "conventional drill-blast method" was recommended.

Potential Impacts of Alternatives: While most of the spoil generated during excavation will be used for the construction of the KT dam, the remaining spoil material will need to be placed in specific spoil disposal areas. The location of these disposal areas will be determined once it is known how much spoil will be produced. Final sites for disposal will require proper environmental studies and local consultation.

6.4.2.3 Powerhouses

Alternatives Considered: The weir for Powerhouse III was re-designed into a dam 75-foot high dam to increase water storage and the installed capacity of Powerhouse III. The corresponding increase in the size of the weir pool (called Zarwam Reservoir in the Feasibility Report) will result in the loss of 15 acres of irrigated land in Zarwam.

Powerhouse I at the toe of the Kurram Tangi dam has been planned for base load energy production, but consideration was given to operating it as a peaking station. For this operating mode, the station would produce 100 MW of power for four hours a day during eight months of the year when flow is sufficient and 83.5 MW the rest of the year. The extra water passing the turbines would be stored in Baran Reservoir for subsequent release to the Marwat Canal.

This alternative was not retained as it carried the following disadvantages:

- There would be additional cost in generators for Powerhouse I, since a higher installed generating capacity would be required.
- The downstream powerhouses, sized for 2,000 cfs would not be able to operate at the 5,000 cfs expected for peaking at Powerhouse 1, which would result in a loss of total annual generation.

Potential Impacts of Alternatives: In addition to the loss of irrigated agricultural land at Zarwam, the higher dam would increase the cost of installing a fish passage facility at the weir, in the event that one is determined to be feasible and desirable.

6.4.3 Recommended Options for Component 2

Geology and Geotechnical Aspects: As for Component 1, geological investigations were carried out for Component 2 to establish overall project feasibility and enable preliminary cost estimates; however there is insufficient data and analysis for a final construction design effort. Project planning may proceed on the basis of existing information; however further field investigations, including additional geological mapping and boreholes are needed to enable detailed design to be completed. It is noted that further work is needed to evaluate the Kurram Tangi reservoir area although current assessments of the satellite imagery and regional geology maps indicate that there are no significant unfavorable issues except the addition of a saddle dam. Project designs are reasonable and

appropriate for this level of study; however, design reviews, additional analyses and detailing work are still needed. Additional items of work to be completed to finalize the construction design and drawings include the following:

- Carry out additional field investigations as noted in the Supplemental Reports on Geology and Geotechnical Aspects.
- Carry out additional design work as recommended.
- Perform seismic stability analyses using the new ground motion parameter i.e. 0.8g.
- Review the foundation designs of structures which are founded on overburden material. These should be revised and rock foundations should be used wherever possible. In general, it is expected that all major weirs and other water retaining structures can be placed on bedrock foundations. If still foundations are placed on overburden, liquefaction potential of foundation strata should be assessed and the design should be revised accordingly.
- Assess the reservoir geology using published geological maps, topographic plans and satellite imagery. This task will establish the principal geology units and define major structure in the area to be flooded. Reservoir assessments will include the classification of lands to be flooded, landslide hazard assessment and confirmation that the reservoir will be acceptably watertight.
- Assemble and assess the various missing data items that are noted in the Supplemental Report on Geotechnical Aspects. This includes feasibility study borehole logs and laboratory testing data and all other geotechnical information. This information should be incorporated into the existing database and assessed in light of the current geotechnical designs. Design revisions should be made if warranted by the new information.
- The saddle dam, cofferdams and diversion system needs to be planned and designed.
- For the diversion and power tunnel, RMR values from exposed rock outcrop should be assessed to determine the rock condition and tunnel support requirements during tunnel excavation.
- Additional field work is needed to perform geological mapping in the reservoir area to confirm that there are no significant unfavorable issues as defined by current assessments of the satellite images and regional geology maps.
- For the tunnel of Powerhouse II, additional drilling of the remaining two investigation boreholes should be done. A RMR assessment of the exposed rock outcrops should be done before the tunnel excavation starts in order to evaluate the unforeseen geological conditions and select appropriate rock support.
- The three proposed exploratory boreholes which were planned during the feasibility stage for the tunnel of Powerhouse III should be drilled. The RMR assessment should also been done from the exposed rock outcrop.

Seismic Considerations: During the feasibility study a Design Basis Earthquake (equivalent to Maximum Credible Earthquake or MCE) with a PGA of 0.20g was recommended for the design of the Kurram Tangi Dam. Based on MWH's analysis presented in the Supplemental Report on Seismic Hazard (MWH, 2013c), the previously recommended seismic design value is too low. Because the dam is a high hazard structure, with large potential consequences in terms of life and property should it fail catastrophically, it is recommended that the Safety Evaluation Earthquake (SEE) be defined as the 10,000 year return period event. Consequently, a PGA of 0.80g is recommended for design of the main dam and all other components necessary for maintaining dam safety.

It is recommended that the design basis for appurtenant structures, excluding those that are critical for dam safety, be the 475 year return period event. It is further recommended that the local seismic building code be followed if it is greater than the 475 year event, as presented in this report.

The KTDP will have a shallow and small reservoir, which puts the likelihood of reservoir triggered seismicity of occurring as very low. Available geologic data and geological studies carried out on satellite imagery suggest that there is no likelihood of rock slides around the dam and on the reservoir rims. Therefore, the hazard of rockslides during a strong earthquake is insignificant.

Electrical Equipment: Based on the available/referenced documents for electrical systems, the following issues are noted. The tender documents and relevant drawings should be updated to rectify these issues:

- Several IEC Standards referred to in the tender documents are outdated with respect to the latest version and current numbering;
- Certain interfacing requirements are not clearly and explicitly defined in the tender documents;
- Certain equipment and system types specified in the tender documents are not commensurate with their intended application/function and their commercial availability may not be guaranteed;
- A number of ambiguities and discrepancies have been noticed in the tender documents;
- Certain equipment ratings are not commensurate with actual system requirements i.e. in some areas the equipment is grossly over-rated/over-sized. There will thus be cost repercussions;
- There are several missing components/equipment and functional/technical specifications without which complete functionality of powerhouse (s) cannot be achieved.; and
- Some error/discrepancies have also been noticed in the tender drawings.

Mechanical Equipment: Based on the available/referenced documents for electrical systems, the following issues are noted. The tender documents and relevant drawings should be updated to rectify these issues:

- The installed capacities of the proposed powerhouses and pump stations are contingent on the hydrological data; hence changes in observed recent hydrological data may result in changes to powerhouse and pump station parameters.
- The project documents do not provide a complete description of the gate equipment. The draft tube gates are not specified for the powerhouses in any of the submitted project documents except tailrace levels in the feasibility report. Complete details of the gate equipment/stoplogs for the draft tubes of the powerhouses are needed as well as support of design parameters.

The project documents shall be updated to include complete project requirements and missing data shall be provided.

Construction Material: Various sources of construction materials have been identified and some testing has been carried out. In general, there are sufficient natural aggregates and other construction materials available in the project area to meet construction requirements. Further testing work will be needed however and additional sources of construction material should be investigated in detail, in accordance with the site specific conditions.

The proposed plan to excavate the 24 test pits to determine the depth, extent and estimate the quantity of fine and course aggregate material for filters and concrete aggregate should be executed before the construction phase is started. The test pit locations should be marked on the map after ground verification of the availability of the stated material.

The available laboratory test results for rock fill material, fine and coarse aggregate and cement are incomplete. These have been sufficient to identify general availability of various construction materials but further work is needed. The following testing of rock fill, fine and coarse aggregate for filters and concrete aggregate, and cement are recommended to finalize construction materials assessments.

- Identification of potential rock quarries nearest to the project area.
- Sampling and testing of host rock of identified rock quarries.
- Determination of the suitability of riverbed deposits and crushed rock obtained from required excavations as a source of concrete aggregates, asphalt and filter materials.

- Identification, investigation and testing of the river/ terrace deposits for coarse and fine aggregates.
- Identification, sampling and testing of natural sand deposits/ manufacturing sand.
- Potential of ASR study in the sources of construction materials.
- Availability of cement and pozzolan materials.
- Suitability of the river water for the production and curing of concrete.
- Petrographic studies to delineate reactive materials in the aggregates and Mortar bar tests (ASTM C1260) on the aggregates.

Resettlement Sites: It was proposed that the population displaced by the reservoir inundation area be resettled on a new 500-acre land provided in the Spaira Ragha Command Area. This original approach was intended to avoid resettling displaced people in host communities with may have led to difficulties. This single plan was however not approved by the tribal leaders. Additional resettlement options will need to be developed and could include resettlement sites around the proposed Kurram Tangi reservoir, into various Bannu settlements and the new Thal Command Area, or outside the project area.

Access Roads and Bridges: The construction of access roads and bridges is proposed to be completed prior to and during mobilization for main dam construction. New access roads and upgraded roads will be provided to allow for heavy vehicles and heavy traffic during construction.

Construction Camps: Two colonies with residential and office accommodation have been proposed; one site in the Spaira Ragha Plain with reasonable amenities and the other at Bannu with all amenities available in the city The colony proposed at Spaira Ragha Plain is at a convenient distance of eight Kilometers from dam site. Approximately 10 acres of land will be needed to establish construction camps. Since Component 2 will be built at a later date alternative construction camp sites closer to the Kurram Tangi Dam should also be investigated to avoid potential impacts on the Spaira Ragha irrigated area.

6.5 Component 3 Alternatives

6.5.1 No Action/Without Project Scenario

If no action is taken to improve the water supply for the Civil and Marwat CCAs, the supply will continue to dwindle, as the Baran Reservoir and the Headworks pool accumulate sediments.

Without the Thal Canal, farmers on the Thal Plain will continue rain-fed agriculture. In the event that Component 2 was constructed without the proposed Thal irrigation systems, more water would be available in the Marwat and Civil Canal systems.

As for the other two Components, the economic benefits offered by potential project employment would not occur. This would have a major negative impact on reduction of critical unemployment and poverty. Other benefits associated with the construction of the project such as training of skilled and unskilled local personnel, health facilities and other social activities may most likely not happen.

6.5.2 Alternatives from Previous Studies

6.5.2.1 Kurram Garhi Headworks

Alternatives Considered: In 1985, a link between the Tochi and Baran Rivers was proposed in order to augment the amount of water available in the Baran Reservoir. This alternative was later eliminated by the alternative of raising Baran Dam.

In the Prefeasibility Report (ACE et al., 1992), a regulator was proposed for a new feeder canal on the right bank upstream of the existing head regulator of the Upper Main Canal. Subsequently, the Kurram Garhi Headworks would have been raised by 6.5 feet, with higher gates for the new feeder canal and river training works. A third stage of this work would have been raised Baran Dam by 8

feet, in order to increase the live storage capacity as most of the storage has been lost through siltation. This scheme would have also resulted in the construction of a channel storage reservoir with a 226-foot high dam on the Tangi Algad (nullah) near Gumatti. Although raising Baran Dam would have facilitated irrigation in the Marwat Command Area, this alternative was rendered unnecessary by the proposed construction of the Kurram Tangi Dam.

Potential Impacts of Alternatives: There were potential impacts associated with the proposed Gumatti reservoir as the land is vegetated and used for grazing by the people of Gumatti. The Bannu-Thal Road passes close to the proposed dam site, so the construction of new access roads would have been limited but construction traffic would have created major inconvenience on regular traffic on this main road. It is also expected that the construction of a feeder canal from the reservoir would have had some negative impacts on the affected agricultural lands. As for the current scheme, the presence of a construction crew would have brought employment and commerce to Gumatti.

6.5.2.2 Alignment of the Thal Main Canal

Alternatives Considered: The initial alignment of the Thal Main Canal traversed several settled areas for which resettlement of families would have been required. During the pre-feasibility stage, the initial alignment considered for the project was the least cost option that achieved a balance between cut and fill resulting in minimal spoil. Though this option offered an economic advantage, the resulting alignment would have passed through some villages. This was considered unacceptable from resettlement considerations. Subsequently, it was determined that the proposed canal could not be laid out to follow the contour of the terrain after leaving the Kurram Garhi Headworks and a tunnel was proposed passing through the hills. It is noteworthy that this alignment option that was eventually selected directly addresses major resettlement concerns in two ways. Minimal resettlement will take place because the adopted alignment avoids all villages by shifting the Thal canal to higher ground. This option may increase the requirement for excavation but decreases not only its potential negative social and environmental impacts but also adds to the irrigated areas.

Potential Impacts of Alternatives: The principal potential impact of the two tunnels on the Thal canal will be the production of rock spoil. If this cannot be used in the canal embankments, it can be stored near its sources.

6.5.3 Recommended Options

Geology and Geotechnical Aspects: No geological site investigations were carried out for Component 3. The overall scheme seems reasonable and the conceptual layouts and designs are appropriate based on experience of this area. More detailed designs and accurate cost estimates must be verified by a field investigation program that will include geological mapping and assessment of construction material. An additional geotechnical investigation plan should include drilling of boreholes at the proposed locations of main structure and excavation of test pits at suitable intervals along the canal routes. A comprehensive laboratory testing should also be done on the samples collected from the boreholes and test pits in order to determine the design parameters.

Seismic: See recommendations under Component 2.

Electrical and Mechanical Systems: Specific details and technical specifications of mechanical and electrical equipment and systems will need some updating once final design is completed.

Miscellaneous: Topographic survey of the whole area needs re-confirmation. Longitudinal profiles of channels need refinement according to precise ground profile after precise topographic survey of the Right of Ways. Detailed maps for channel outlets should be prepared. Detailed investigations of the tertiary canals and development of command area capacity should be prepared.

7 STAKEHOLDER CONSULTATIONS AND INFORMATION DISCLOSURE

As in every Environmental Assessment study, consultations with stakeholders remained an integral part of the Environmental Assessment of the Kurram Tangi Dam Construction. However, due to the security issues in the project area some unconventional means and strategies for public consultations and disclosure had to be employed.

A series of consultations with stakeholders at various levels was held in the course of the Environmental Assessment. These included assorted group as well as individual sessions with direct stakeholders and experts. These sessions were held in Bannu, Peshawar, Islamabad and Lahore.

The goal of the consultation process is to understand the interests and points of view from public, non-government organizations, sector experts, and government agencies in the EA process.

As envisioned in the Stakeholder Consultation Plan, submitted to USAID in July 2013, consultation activities were to be carried out in 4 phases with various groups of stakeholders including those on the Policy Level (Donor), on the Project Level (WAPDA, FATA Secretariat, State Officials) and on the Community Level (PAPs and tribal representatives). The 4 phases involved in the consultation process were at the Inception Phase, Consultations Prior to Field Surveys, Consultations while finalizing EA and RAP recommendations, and finally in the end to present the EA and RAP recommendations.

A series of consultations were held at the policy and project levels during the first 2 phases of the EA and RAP process. USAID, WAPDA, FATA Officials and stakeholders from various line agencies and state departments were taken into confidence and the whole process discussed with them. Similarly prior to launching of field work recommendations and suggestions from these officials were taken into consideration.

However, problems arose in arranging meetings with tribal representatives and PAPs, mainly due to security concerns, government clearances, and inaccessability of the actual project area to MWH and its sub-contractors. Working in the FATA on a project of this scale, put up unique challenges and unanticipated hindrances. Delays in granting of NOC and the volatile security situation in North Waziristan prevented MWH and its sub-contractors from visiting the project areas first hand and discussing things at the village level, as is customary in such projects.

Due to these constraints, tribal representatives were called to Bannu City at the sub-contractor office from the project areas where aspects of the EA and RAP were discussed.. A schedule for such meetings was prepared and shared with the donor but the changing security situation, unannounced curfews, militant activities and military response as well as religious festivals led to delays.

Appendix 9.4 provides a list of meetings held, the main participants and a summary of the main concerns raised and/or feedback.

7.1 Scoping

Pursuant to a Request for Proposal for an EA of the KTDP in August 2012 and a contract between USAID and MWH signed in November 2012, MWH and its sub-consultants, NESPAK and ACE, undertook a scoping process in accord with 22 CFR 216.3(a)(4). The principal aim of the scoping exercise was to identify the concerns and issues that needed to be considered in the EA, including direct, indirect, cumulative and induced effects of the project on the environment and socio-economic attributes.

In general, scoping identifies a number of issues, but only those most pertinent to the project in question are retained for further consideration in an EA. The process identifies and lists a large number of issues first and then analysis is followed which sorts out and eliminates the cases given below:

- Issues that are duplicated.
- Issues that are significant versus not significant per CFR 216.3 (a) (4) (1) (a) and (b).
- Issues not relevant to the particular project.

Scoping seeks to identify the most significant issues to be assessed. During scoping it was important to avoid focusing on insignificant or even non-existent issues. If this happens, the value of the EA will be reduced.

Owing to security considerations, the participative aspects of scoping could not be conducted to the extent desired.

The Scoping exercise started out in December 2012, when the project was launched and sub-contractors, ACE and NESPAK, brought on board. A long series of consultations took place between MWH, USAID, ACE and NESPAK to finalize the scope of work and the process involved in the process of developing the EA and Resettlement Reports. Regular interactions were held on a group as well as individual level between MWH, ACE, NESPAK and WAPDA and its consultants Mott McDonald Pakistan (MMP). These meetings were basically for basic confidence building and data gathering.

A series of meetings was later held with officials of other stakeholder agencies and government departments such as provincial Irrigation Department, Highways Department, Environment protection Agency, SUPARCO and many others. These served to provide knowledge of the present best practices and existing studies, as well as share experience from similar projects carried out in the past.

The EA team produced technical papers with discussions on the characteristics and issues related to relevant resources and the potential impacts of the project. A matrix analysis was conducted for the purpose of identifying potential project-resource interactions and deciding which potential impacts were likely to be significant.

To support the development and use of the scoping matrix, a series of annexes was developed focusing on different aspects of the project. The annexes were assembled by groups of specialists of the physical, biological, socioeconomic and cultural environments. The annexes aimed to:

- Review the information in the available reports.
- Evaluate the quality and accuracy of the data.
- Identify any information gaps and scoping issues.
- Develop plans to gather additional information.
- Describe proposed analyses.
- Identify any fatal flaws.

The scoping matrix was developed as a tool to assist with the initial screening and assessment of environmental parameters against each of the project sub-components. The preliminary Scoping Matrix with 2,300 interactive cells was project specific, site specific, and culturally specific. The matrix used was a standard "Leopold Matrix" developed by the USGS as a tool for environmental impact assessment Leopold *et al*, 1971).

It was used to identify interactions between project components and environmental components, thereby eliminating from consideration those environment/project interactions that were considered not to be relevant to the overall project.

As part of the scoping process, the technical papers and matrix analysis were discussed at a consultation workshop held on March 11, 2013 in Lahore attended by representatives of MWH,

NESPAK, ACE, USAID, WAPDA, MMP, Diamer Basha Consultants (DBC) and by individual resource specialists from Pakistani agencies.

Following presentations of the methodology and design of the Scoping Exercise and the resultant EA and RAP reports, the attendees were divided into 3 groups to discuss and come up with issues and recommendations pertaining to

- Socio-economics and resettlement.
- The physical environment and engineering.
- The biological environment.

The main purpose of this activity was to rank issues related to achieving the project's desired results. Social issues, gender, culture, legal, data gathering and analysis, trans-border issues, security, construction timelines, wildlife and forest parameters, and many other such subjects dominated the workshop proceedings and recommendations.

Issues were grouped into an impact matrix, together with a preliminary evaluation of their significance. The workshop was the final technical step of scoping. Its function for the EA and associated reports was also to integrate the technical experts as an interdisciplinary team rather than a multidisciplinary group, and to establish interdisciplinary links and identify synergies between the team members.

In addition, the criteria adopted by MWH to determine the significance of environmental and social impacts resulting from development of the KTDP were developed during the scoping exercise. They were used to rank the issues during the subgroups discussion at the scoping workshop. Further details of impact significance rating are presented in Section 5.1.2.

During scoping, the project Area of Influence (AOI) was discussed. The AOI covers almost the whole watershed area of Kurram Tangi Dam that includes the Kaitu Weir catchment (Kaitu River), the Kurram River catchment, the Dam Axis plus downstream riparian area. Towards the north and west, it extends into Afghanistan bounded by the Koh-e-Sufaid water divide between Pakistan and Afghanistan. It is bounded on the east by Khyber Agency, Kohat District and Isa Khel, and on the south by D.I. Khan District and South Waziristan. On the south-east, the limits of the AOI extend up to confluence of Kurram River with the Indus River.

During scoping each project component was reviewed under a series of environments. As is typically the case for water resource development projects similar to KTDP, three major environments 1) physical, 2) biological, and 3) socio-economic and cultural were analyzed.

In WAPDA's planning, the three components are sequenced. Component 1 could begin almost immediately and is, in terms of engineering, independent of Components 2 and 3. From initial observations, it seemed likely that Component 1 (as defined by WAPDA, i.e. not including development of the irrigation areas) would have less of an impact in regards to environmental and socio-economic disturbance than the other two components. It was determined that subsequent development of the Spaira Ragha and Sheratalla Canals and irrigation areas would potentially bring enormous economic benefits to existing agricultural land that currently depends on barani (rain-fed) crops. Impacts of land take would be offset by the payment of adequate compensation accompanied by livelihood restoration packages issues as well as the benefit of remaining farm land being continuously irrigated.

A priori, Component 2 which will be undertaken in the medium term, was likely to present the greatest environmental impacts, as well as serious social impacts. There are the obvious structural risks associated with construction, as well as high negative possibilities of socio-economic and cultural impacts. Seismic related issues were recognized as being a potential concern.

Although Component 3 is a major irrigation project, it would likely have fewer impacts compared to Component 2. The principal issue identified was human resettlement.

Scoping dealt with resettlement in detail looking at the need to determine following: number of project affected people, number of directly affected people, number of indirectly affected people, number of the beneficiaries, inventories of villages, households, houses and other built-up structures, investigation of the tribal system, strengths in resolving conflicts and disputes, and identification of inter and intra-tribal rivalries.

In addition to determining the issues that required assessment, scoping outputs included the methodology for data collection, with the recognition of the role that GIS and satellite imagery would play given the constraints on data collection on the ground, proposed formats for the EA, EMMP and RAP as well as an outline of the approach to public consultation.

The final scoping document (dated April 22, 2013) identified key significant issues for each project component and discussed approaches to conducting field work for each issue, within the context of security situation in the project area, particularly Component 1 and Component 2. USAID approved the scoping document on May 10, 2013.

7.2 Consultations with WAPDA and Other Direct Stakeholders

Among the direct stakeholders, MWH discussed all aspects of the EAKTDC Project with line agencies including WAPDA, USAID, Agency Political Administration, FATA Secretariat departments, WAPDA's design consultants MMP and the proposed construction contractor Frontier Works Organization (FWO), as well as the KP EPA.

These meetings were held at Lahore, Islamabad, Peshawar and Bannu over the period of the project, when MWH and its sub-contractors met and discussed issues with officials at all levels, from Chairmen to the ground staff. A large amount of data was received during these sessions, which proved vital in the final report compilation. These sessions also gave an opportunity to these agencies to voice their individual concerns about the KTDP and their views on various Components and process involved in the final construction of the KTDP.

7.3 Consultations with Various State Officials

On the next level, MWH and its sub-contractors had sessions with sector experts and secondary stakeholders including university professors, officials from provincial government departments such as Irrigation, Communications and Works, Fisheries, Forest, Wildlife, Archeology and others. These sessions helped greatly in uncovering lesser known aspects of the potential impacts of the project on local environment and heritage. Held over a period of several months during the course of the project, such meetings and consultation sessions were held in Lahore, Islamabad, Peshawar and Bannu.

7.4 Consultations with Local Communities on EA

At the grass root level, a series of public consultation sessions were held with representatives of the project affected population having residences, landholding or other stakes in the geographical perimeter of all three Components of the KTDP. They were organized in Bannu, Karak, and Lakki Marwat under the banner of sub-contractor, ACE. These meetings were attended by tribal leaders and elders, local Maliks and representatives of landowners. While such consultations are traditionally held at the village level and provide a forum for all individuals, including project affected persons, from the community to attend, the security situation did not allow on-site public events. As the best possible alternative, the political administration from North Waziristan, civil administration from Bannu Division and WAPDA were actively involved in the process and tribal representatives were invited to Bannu City for group meetings.

These sessions serve as a platform to discuss potential environmental impacts of the KTDP and encourage an open dialogue on individual and tribal concerns. In view of the large geographic area covered by the project components and keeping in view constraints of off-site meetings and tribal sensitivities, representatives are broken up into groups as per the recommendations from the office of the concerned Assistant Political Agent. However, it is ensured that all tribal representatives are accommodated for consultations in the various sessions.

During these sessions it is interesting to note that besides the inevitable tribal land disputes in a few selected cases, almost all public representatives were well aware of the potential benefits of the project. There was an evident level of awareness about the socio-economic and environmental implications of the KTDP. The local tribal population is in support of the project and offered a variety of suggestions and recommendations to promote the local interests in the project. Detailed reports on public consultation sessions on the RAP are also available for review in relevant annexures of the RAP report.

7.5 Final Consultation and Disclosure Session

In order to present the main findings and solicit comments and recommendations on the EA, EMMP, RAP, RPF, VTP, CHPP, Gender Plan and various supplemental reports from government and agency level stakeholders, a workshop was organized by MWH in Islamabad on November 26, 2013. The workshop was attended by representatives from USAID, WAPDA, FATA Secretariat, Provincial Government of Khyber Pakhtunkhwa, Mott McDonald Pakistan, ACE, NESPAK and MWH as well as and other consultants and participating agencies.

A total of 78 people participated in the discussions at the event. The event started off with presentations by MWH summarizing the findings of the reports. Following the presentations, the participants were divided into six thematic groups to discuss specific topics from the reports and come up with a set of recommendations, suggestions and comments, which they then presented for further discussion. The groups were Seismicity and Design, Hydrology and Sedimentation, Irrigation and Agriculture, Watershed Management, RAP and RPF, and Gender Aspects.

The findings of the EA, EMMP, RAP and RPF reports were accepted by the participants for the most part and some valuable comments and recommendations were also presented. An overall positive response was seen from all participants on the reports as well as the event. All stakeholders agreed to work together and contribute towards the early commencement of construction project of the KTDP.

While the findings of the MWH reports were accepted by WAPDA and other relevant agencies, there were concerns regarding the cost revisions which would have to be budgeted for in the light of a design review of the project. Concerns were expressed as to the cost of changing the specifications and designs of the main dam to account for the following: upward revision of the Maximum Probable Flood estimates; the recommended higher seismic ground motion parameter; and, the higher sediment yield.

Coordinated planning of development of the command areas of the new canals to ensure that the tertiary systems are developed concurrently with construction of the WAPDA project, i.e. the primary and secondary canals, was recommended. Capacity building of the farmers on modern irrigation techniques, water use and rights and grazing rotation methods were also recommended. It was agreed that the alignment of canals, roads and the transmission line should be enhanced to avoid structures where feasible.

7.6 Summary of Main Findings

In summary, while security constraints and the volatile situation in the project area hampered a more comprehensive series of consultations, a wide range of stakeholders was taken into confidence on the project and their views were incorporated into the compilation of this report.

By and large the individuals and groups consulted were in favor of the project and a minimum number of negative aspects were highlighted. Data gathering sessions with various departments showed that there is a severe lack of baseline data available from the Project AOI.

Security for all stakeholders remains a concern. It was further highlighted that involvement of local residents in the construction phase of the project and availability of employment for local residents in the project will be extremely helpful in mitigating the security challenges to be faced.

It can also be said that provision of direct short-term and long term benefits to the local residents and population of the project area is of vital importance. Not only is this expected by all stakeholders, it is also felt that this is the only way in which the successful completion of the project is envisioned.

WAPDA and other direct stakeholders remained optimistic and are eager to see the early commencement of the construction process. The top management of WAPDA is pushing hard for completion of pre-construction activities and studies and is willing to depute all its resources to these activities. While they have been made aware of the number of design revisions and additional studies required prior to awarding a contract, WAPDA is confident of covering all bases in time to start the project.

During consultations with various state officials, the processes required for the construction and post construction phase were clarified and the complex government machinery and distribution of responsibilities amongst various departments and officials were revealed. Concerns of security remained dominant in most sessions.

It was highly interesting to note that the PAPs from all 3 components of the project were found to possess sound knowledge of the KTDC project and its benefits. The sessions with the local representatives saw some highly relevant discussions on water rights, water logging and salinity issues, suggestions and recommendations on realignment of canals and mapping of the tertiary canals and water management.

During the construction phase the local population look forward to employment opportunities, as well as local contracts for material, logistics and manpower supply. Once the project is operational, rural electrification and irrigation of local lands need to be ensured.

The findings of the EA, EMMP, RAP and RPF reports were accepted by the government and agency level stakeholders.

8 ENVIRONMENTAL MITIGATION AND MONITORING

A stand-alone Environmental Management and Monitoring Plan (EMMP) has been developed for the KTDP. This EMMP identifies measures and procedures for mitigating significant potential adverse environmental and social impacts and enhancing beneficial effects of the Project identified in Chapter 5, throughout the life of the project. The EMMP also presents the monitoring and surveillance programs required to ensure sound environmental performance, legal and regulatory compliance (including compliance with donor and/or international financial institutions' standards) and detect changes or trends in the project's surroundings, either as a result of project activities or affecting them or that could render mitigation and enhancement measures ineffective. It is an early warning system that will allow the project proponent to adjust mitigation and enhancement programs, if required, to ensure the KTDP's environmental and social sustainability.

The document has two main parts, the Mitigation Plan and the Monitoring Plan. The former describes the institutions responsible for and their roles pertaining to environmental and social performance in all phases of the project. It particularly focuses on the mitigation actions to be carried out by the Construction Contractor and the Owner (WAPDA). It also identifies uncertainties in the current knowledge about the project and the risks that these may entail for environmental and social performance. The monitoring program describes the environmental receptors that should be monitored and by whom.

The EMMP describes mitigation and monitoring in the pre-construction, construction, operation and decommissioning phases for each Project component, in three sections, one for each Project component. Each section addresses mitigation prior to construction, during construction, during operation and during decommissioning.

The EMMP is a living document, and as such will require regular updating. Typical events that should trigger such updating include but are not limited to the following:

- Ongoing data collection improves knowledge about the current uncertainties allowing better definition of potential impacts and their associated mitigation measures.
- Evolution in the knowledge about the project's environmental and social surroundings during project implementation as a result of implementation of the monitoring program indicates the need for modification of existing and/or additional mitigation and enhancement measures.
- Delays in the start of project implementation are such that the baseline information in the EA requires updating to reflect actual conditions at the new time of project implementation, thereby triggering the need to update assessment of potential impacts, definition of mitigation measures and the EMMP.

The EMMP also provides and estimation of the costs of implementation of the plan as well as the means for

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9 APPENDICES

9.1 List of Preparers

1. Abdul Aleem Chaudhry, Terrestrial Biodiversity / Botanist / Wildlife Forestry Specialist, ACE. Ph.D (Wildlife Management). 45 years experience Environmental Studies, environmental assessment. Responsible for project study on Terrestrial Biodiversity / Botanist / Wildlife Forestry Specialist
2. Abdul Monaf, Hydraulics Specialist, NESPAK. B.Sc. 31 years' experience in Irrigation & Hydraulics. Main responsibilities include the review of the hydraulic parameters, its appurtenant structures and Assessment & Evaluation of the canals.
3. Anis Ahmad Chaudhry, Advisor Environment & Resettlement, ACE. M.Sc Soil Science. 45 years experience as Environment & Resettlement expert. Responsible for project's environment & resettlement plans.
4. Abdul Rehman, Senior Engineer (Environment), ACE. MS Environmental Engineering. 9 years Experience in planning designing and report writing for irrigation and Environmental projects. Responsible for assisting Safety & Health Specialist at the project.
5. Adriaan van den Dries, Irrigation Agronomist/Engineer to MWH. PhD. 35 years experience in rural, irrigation and water resources development. Responsible for coordination of the soil, land use, irrigation & agriculture sections of the EA report and quality.
6. Altaf Iqbal, Lead Social Specialist, ACE. MA(Economics), MBA Marketing & Finance, LLB. 30 years experience as Socio-Economic Expert, conducting community consultation session and training workshops. Responsible for socio-economic activities and field surveys of the project.
7. Aslam Chaudhry, Land Use Specialist, NESPAK. B.Sc. & M.Sc. 38 years' experience in Soil and landuse surveys, Air Photo Interpretation and Reclamation of saline-sodic soils. Main responsibilities include the review of baseline data, assessment and evaluation of the irrigable lands in the command areas, its mitigation measures and recommendations.
8. Atif Hassan, Community Outreach, ACE. Masters (Social work). 28 years experience in social work, as an individual consultant and principal sociologist. Responsible as counterpart of Resettlement Action Plan.
9. Bilal Ahmad Ghumman, GIS Coordinator & Document Control, MWH. MSc Applied GIS. 8 years experience in GIS. Responsible for project GIS related activities and to facilitate the interface between MWH, ACE and NESPAK.
10. Brandi Antal, MWH Dams and Hydropower Specialist. BS in Civil Engineering. 10 years of experience in heavy civil engineering and construction projects. Responsible for reviewing technical due diligence reports and drafting parts of the EA and EMMP reports.
11. Bruno Trouille, MWH Lead Technical and Economic Specialist. MS in Engineering and Industrial Relations. 35 years of experience in multi-purpose water resources, power and irrigation projects. Led all the technical due diligence, hydrology, climate change, and economic studies.
12. Bushra Waheed, Gender Specialist, ACE. M.Sc (Botany). 40 years experience in Gender studies, Environment & Resettlement, EIA of ground water. Responsible for project gender aspects.
13. Charlotte Bingham, Senior EA Advisor to MWH. MCP. 40 years experience in environmental assessment and involuntary resettlement. Responsible for coordination of EA document and quality.
14. Colin Boocock, Environmental Specialist for MWH. MSc. 30 years experience in environmental and geological evaluation and management. Assistance with writing of EA and EMMP reports.
15. Dina Hunt, Seismic Specialist, MWH. MSc. in Geotechnical Engineering. 9 years of experience as an engineering seismologist/geotechnical engineer. Responsible for the development of seismic design parameters for the dam, weirs and related appurtenances.
16. Dr. Naveed Aslam, Agriculture Specialist, NESPAK. B.Sc. & M.Sc. 16 years experience in Agriculture, Water Management (Drip/Sprinkler) and Resource Conservation. Main responsibilities include assessment of the potential impacts regarding irrigation and agriculture.
17. Gordon Appleby, Senior Resettlement Advisor to MWH. 40 years experience in involuntary resettlement, social impact assessment, and participation and community involvement. Responsible for coordination of social impact documents and plans, including the RPF, RAP

(Component 1), cultural heritage plan, vulnerable tribes plan, gender plan and social chapters of the EA document.

18. Hamid Ahmed Hassan, Assistant to Dy Chief of Party (Environement), MWH. MSc Civil Engineering. 4 years of Industrial Construction Experience. Responsible for Assisting Dy Chief of Party, editing and compiling of EA and EMMP reports.
19. Humaira Butt, Senior Gender Aspects, ACE. 20 years experience in gender studies. Responsible for project gender studies.
20. Imran-ul-Haq, Air/Noise Quality Expert, NESPAK. B.Sc. & M.Sc. 08 years' experience in Environment and Resettlement. Main responsibilities include the preparation of supplemental reports for air/noise and water.
21. International Development Consultants (IDC) as a Third Party Consultant and is responsible for the collection of baseline data for physical environment for three (03) Components covering the nine (09) aspects.
22. I.R. Mufti, Indigenous People Specialist, ACE. MA Social science. 45 years experience as social scientist, indigenous people expert & cultural heritage expert. Responsible for developing aspects and plans for indigenous People.
23. Irfan-ul-Haq, Quality Assurance Specialist, NESPAK. B.Sc. & M.Sc. 24 years' experience in Environmental Resettlement Studies, Health & Safety Audits. Main responsibilities include the Quality Assurance of the reports.
24. Jessica Menon, Gender Specialist to MWH. MPP. 10 years experience in social and gender assessment and analysis. Responsible for coordination of gender assessment inputs into ESIA, EMP, and RAP.
25. John W. Meldrim, Lead Fisheries Scientist, Consultant to MWH. Ph.D. 45 years of experience in environmental assessment of electric power and aquatic resource development projects. Responsible for Fisheries/Aquatic Ecology sections of the Project.
26. John Paul Velon, MWH Project Director, Vice President. BS Civil Engineering, MS Environmental Engineering. Over 25 years of experience in water resource projects. Role on project: overall project direction, senior management of the project and overall QA/QC
27. John Zhou, GIS Specialist, MWH, PhD in Environmental Engineering, 20 years in GIS & IT services. Responsible for project GIS data and analysis.
28. Kai Schmidt-Soltau, PhD. Manager Social Impacts and Resettlement. 20 years of experience in involuntary resettlement, social impact assessment, community development, vulnerable tribes issues and cultural heritage management. Responsible for producing the social impact documents and plans, including the Resettlement Policy Framework, Resettlement Action Plan for Component 1, Cultural Heritage Preservation Plan, Vulnerable Tribes Plan and social chapters of the EA document as well as for conducting all related field work.
29. Kamran Yousaf, Assistant Project Manager/ Water Quality Specialist, NESPAK. B.Sc. & M.Engg. 21 years' experience in Environment, Resettlement and Water & Sanitation sectors. Responsible for managing the inputs from various Technical as well as Environmental Experts and preparation of EA and EMMP.
30. Manoj Bhattarai, P.E., MWH Hydropower Specialist. MS in Civil Engineering. 10 years of experience in hydropower projects during ESIA, feasibility, design and construction phases. Provided technical inputs to the EA, EMMP and various supplemental reports.
31. Madiha Asif, GIS Specialist, ACE. M.Phil Remote Sensing & Geographic Information System.2 years experience GIS. Responsible for project GIS data.
32. Major (R) Mushtaq Ahmad Sahibzada, Security Officer / Office Manager, ACE. ……years experience in security and office management. Responsible for project site office management.
33. Malik Shahrukh Latif, Hydrology Specialist, NESPAK. B.Sc. 32 years' experience in Hydrological Studies. Main responsibilities include the Technical review of available hydrological data and identify the gaps and propose recommendations.
34. Mehar Ali Shah, Sedimentation Specialist, NESPAK. B.Sc. & M.Sc. 13 years' experience in Hydraulics/Hydrologic/Sedimentation Modelling. Responsible for review of sedimentation in Kurrum Tangi Dam and identify the gaps and propose measures.

35. Mohammad Amon Khan, Electrical Specialist, NESPAK. M.Sc. 28 years' experience in Hydro and Thermal Power Plants. Main responsibilities include the review of shortcomings, deficiencies, discrepancies and missing technical information based on the Technical review of Tender Documents and Drawings.
36. Muhammad Moeen, Geotech Specialist, NESPAK. B.Sc. & M.Sc. 8 years' experience in Dam Design. Main responsibilities include the review of available geotechnical data and design and assessment of findings and finally to document the evaluation of results.
37. Muhammad Hafeez Butt, Climate Change Specialist, ACE. M.Sc (Geophysics). 30 years experience in seismology, mineral development and ground water analysis. Responsible for project climate change report.
38. Muhammad Ilyas, Quality Assurance and Contractual Specialist, NESPAK. B.Sc. & M.Sc. 40 years' experience in Geotechnical and Rock Mechanics/Project Management. Main responsibilities include the Quality Assurance of the reports and handling Contractual matters.
39. Muhammad Irtaza Awan, Legal & Conflict Resolution Specialist, ACE. LLM. 15 years experience in preparation, review, persuasion and appeals against legal disputes. Responsible for project's Legal & Conflict Resolution part and for review of legal documents and developing legal aspects of the project.
40. Muhammad Javed, Seismic Specialist, NESPAK. B.Sc. & M.Sc. 30 years' experience in Geophysicist/seismologist. Main responsibilities include the interpretation of results and findings of Seismic Hazard Evaluation.
41. Muhammad Nasrullah Khan, Ornithologist & Health (HIV/AIDS) Specialist, ACE. Masters (Philosophy, Psychology), MBBS. 40 years experience in health function AC unit, District facilitator and medical officer. Responsible for Ornithology & Health (HIV/AIDS) activities of the project.
42. Muhammad Shariq Ahmed, Health/Safety Specialist, NESPAK. B.Sc. & M.Sc. 16 years' experience in Civil, Environment, Health and Safety Engineer, Resettlement Expert, Valuation Engineer. Main responsibilities include the preparation of Health and Safety Framework documents.
43. Dr. Muhammad Sikandar Hayat, Aquatic Biology / Fisheries Specialist, ACE. 25 years experience in Aquatic Biology / Fisheries. Responsible for Aquatic Biology / Fisheries of the project.
44. Muhammad Wasim Jalal, Data Management System, ACE. MS (Management Sciences) .2 years experience in office and data management. Responsible for project survey data management.
45. Naguib Sohail Kidwai, Construction Specialist, NESPAK. B.Sc. 32 years' experience in Construction Planning. Main responsibilities include the review of the construction plan and related cost given in the Tender Documents.
46. Nahyan Mirza, Communications and Media Management Specialist, MWH. BA (Honours). 15 years experience in media and communications. Responsible for project communications and related EA sections.
47. Nick Gregor, Seismological Consultant to MWH. Ph. D., Geophysics. 18 years experience as seismologist for ground motion and seismological studies for various engineering projects.
48. Omer Farooq, Roads Specialist, NESPAK. B.Sc. & M.Sc. 23 years' experience in Highways and Transportation. Main responsibilities include the detail review of existing road network, identification of the impacts and propose measures.
49. Peter L. Ames, Deputy Chief of Party, Environmental. 40 years of experience in evaluating the impacts of development structures. Responsible for the production of the KTDC Environmental Assessment and Environmental Mitigation and Monitoring Plan.
50. Qaiser Aslam Mughal, Senior Conflict Resolution / Legal Expert, ACE. Masters. 20 years experience in preparation of appeals and basic law review cases. Responsible for Conflict Resolution and developing legal aspects of the project.
51. Qayyem Awan, Economist, NESPAK. M.A. 28 years' experience in Irrigation, Dams, Barrages, Agriculture, Highways Environmental Impact Assessment (EIA) Studies. Main responsibility includes assessing the data and conducting the economic analysis of the project.
52. Ramla Siddiqui, Waste Clean-up Expert, NESPAK M.Sc. 06 years experience in Environmental Studies, EIA/IEE Report Preparations, EMMP Audits. Main responsibilities include the

identification and assessment of solid waste and wastewater generated during the construction and operation of the project.

53. Rana Nasir A. Khan, Watershed Management Specialist, NESPAK. B.Sc. & M.Phil. 35 years' experience in Irrigation/Drainage and Flood Management. Main responsibility is to analyze the erosion areas in the catchments of Kaitu and Kurrum Rivers and suggest a framework for watershed management.
54. Robyn McGuckin, Climate Change Adaptation for MWH. MS and BS in Biosystems Engineering. 17 years experience in climate change and international development. Responsible for the climate adaptation projections.
55. Saqib Rehman, Environment and Resettlement Analyst, NESPAK, MSC Environmental Sciences. 3 years of experience in Environmental & Resettlement studies of international funded projects. Responsible for Assisting Dy chief of party, editing & formatting of EMMP & Associated Plans.
56. Shahid Siddiq Goheer, Resettlement Specialist, ACE. M.Sc Statistics, MBA (Executive). 31 Years experience as social & resettlement expert. Responsible for project resettlement plan.
57. Shahzad Ahmad, Geology Specialist, NESPAK. B.Sc. & M.Sc. 23 years' experience in Geotechnical investigations, Dam site and Grouting. Main responsibilities include the Technical review of the available geological data, assessment and evaluation of the significant impacts and suggest mitigation measures and recommendations.
58. Sheikh Altaf Hussain, Hydroelectric Specialist, NESPAK. B.Sc. 36 years' experience in Hydropower plants. Main responsibilities include the identification of the shortcomings, deficiencies, discrepancies and missing technical information based on Technical review of Tender Documents and Drawings.
59. Stefan Gorzula, Chief of Party, MWH. PhD. 40 years experience in environment and natural resource management. Responsible for in-country management of the project.
60. Syed Tanveer Hassan, Junior Sociologist, ACE. 5 years experience in field surveys and sociology. Responsible for assisting social expert of the project.
61. Tahir ur Rehman, Structural Specialist, NESPAK. B.Sc. 30 years' experience in Hydraulic Structures and Bridges. Main responsibilities include the structural design review of civil works.
62. Tasneem Razi, Gender Aspects, ACE. M.A (Economics). 5 years experience in economic and financial analysis of dams and hydropower projects, and gender studies. Responsible for project gender data management and its evaluation.
63. Tauqeer Sadaqat, Mechanical Specialist, NESPAK. B.Sc. 31 years' experience in Gate Equipment and pumping plants/pipelines. Main responsibilities include the identification of the shortcomings, deficiencies, discrepancies and missing technical information based on Technical review of Tender Documents and Drawings.
64. Usman Ahmed, GIS Expert, NESPAK. B.Sc. & M.Sc. 07 years' experience in GIS / Remote Sensing. Main responsibilities include the preparation and development of various GIS maps and drawings.
65. Waheed-uz-Zaman Deputy Chief of Party –M.Phil. Water Resources Management- 25 years of experience, in charge of the social issues/resettlement aspects of the EA, responsible for coordinating and directing the work of the international and Pakistani technical experts.
66. Wayne Fix, Roading and Transport Specialist. NZCE (Civil). 28 years experience in the road and transport design and asset management. Responsible for providing technical advice on roads and bridges.
67. Zafar Iqbal Chaudhry, Safety & Health Specialist, ACE. M.E (water science & engineering). 46 years experience as Environment & Resettlement expert. Responsible for project Safety & Health activities.

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9.3 National Environmental Quality Standards

Appendix 9.3-1: Selected NEQS for Waste Effluents

Parameter	Unit	Standards (maximum allowable limit)
Temperature increase	°C	< 3
pH value (acidity/basicity)	pH	6-9
5-day biochemical oxygen demand (BOD) at 20 □C	mg/l	80
Chemical oxygen demand (COD)	mg/l	150
Total suspended solids	mg/l	200
Total dissolved solids	mg/l	3,500
Grease and oil	mg/l	10
Phenolic compounds (as phenol)	mg/l	0.1
Chloride (as Cl)	mg/l	1,000
Fluoride (as F)	mg/l	10
Sulfate (SO_4)	mg/l	600
Sulfide (S)	mg/l	1.0
Ammonia (NH_3)	mg/l	40
Cadmium	mg/l	0.1
Chromium (trivalent and hexavalent)	mg/l	1.0
Copper	mg/l	1.0
Lead	mg/l	0.5
Mercury	mg/l	0.01
Selenium	mg/l	0.5
Nickel	mg/l	1.0
Silver	mg/l	1.0
Total toxic metals	mg/l	2.0
Zinc	mg/l	5
Arsenic	mg/l	1.0
Barium	mg/l	1.5
Iron	mg/l	8.0
Manganese	mg/l	1.5
Boron	mg/l	6.0
Chlorine	mg/l	1.0

Source: Government of Pakistan (2000) (SRO 549 (I)/2000).

Notes:

- The standard assumes that dilution of 1:10 on discharge is available. That is, for each cubic meter of treated effluent, the recipient water body should have 10 m^3 of water for dilution of this effluent.
- Toxic metals include cadmium, chromium, copper, lead, mercury, selenium, nickel and silver. The effluent should meet the individual standards for these metals as well as the standard for total toxic metal concentration.

Appendix 9.3-2: NEQS for Industrial Gaseous Emissions

Parameter	Source of Emission	Maximum Allowable Limit
Smoke	Smoke opacity not to exceed	40% or 2 Ringlemann Scale or equivalent smoke number
Particulate matter[1]	(a) Boilers and furnaces:	
	i. Oil fired ii. Coal fired iii. Cement Kilns	300 500 300
	(b) Grinding, crushing, clinker coolers and related processes, metallurgical processes, converters, blast furnaces and cupolas	500
Hydrogen Chloride	Any	400
Chlorine	Any	150
Hydrogen fluoride	Any	150
Hydrogen sulfide	Any	10
Sulfur Oxides[2, 3]	Sulfuric acid/Sulfonic acid plants	5,000
	Other Plants except power Plants operating on oil and coal	1,700
Carbon Monoxide	Any	800
Lead	Any	50
Mercury	Any	10
Cadmium	Any	20
Arsenic	Any	20
Copper	Any	50
Antimony	Any	20
Zinc	Any	200
Oxides of Nitrogen[3]	Nitric acid manufacturing unit	3,000
	Other plants except power plants operating on oil or coal: i. Gas fired ii. Oil fired iii. Coal fired	 400 600 1,200

Source: Government of Pakistan (2000) (SRO 549 (I)/2000).

Explanations:

- Based on the assumption that the size of the particulate is 10 micron or more.
- Based on 1% sulfur content in fuel oil. Higher content of sulfur will cause standards to be pro-rated.
- In respect of emissions of sulfur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to NEQS specified above, comply with the standards provided separately.

Appendix 9.3-3: National Environmental Quality Standards for Ambient Air[47]

Pollutants	Time weighted Average	Concentration in Ambient Air		Method of Measurement
		Effective from 1st July 2010	Effective from 1st January 2013	
Sulfur Dioxide (SO_2)	Annual Average*	80 µg/m^3	80 µg/m^3	Ultraviolet Fluorescence
	24 hours**	120 µg/m^3	120 µg/m^3	
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	40 µg/m^3	40 µg/m^3	
Oxides of Nitrogen as (NO_2)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	80 µg/m^3	80 µg/m^3	
Ozone (O_3)	1 hour	180 µg/m^3	130 µg/m^3	Non dispersive UV absorption
Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m^3	360 µg/m^3	High Volume Sampling, (Average flow rate not less than1.1 m^3/minute).
	24 hours**	550 µg/m^3	500 µg/m^3	
Respirable Particulate Matter. PM_{10}	Annual Average*	200 µg/m^3	120 µg/m^3	Gamma Ray absorption
	24 hours**	250 µg/m^3	150 µg/m^3	
Respirable Particulate Matter. $PM_{2.5}$	Annual Average*	25 µg/m^3	15 µg/m^3	Gamma Ray absorption
	24 hours**	40 µg/m^3	35 µg/m^3	
	1 hour	25 µg/m^3	15 µg/m^3	
Lead (Pb)	Annual Average*	1.5 µg/m^3	1.0 µg/m^3	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2.0 µg/m^3	1.5 µg/m^3	
Carbon Monoxide (CO)	8 hours**	5 mg/m^3	5 mg/m^3	Non Dispersive Infra-Red (NDIR)
	1 hour	10 mg/m^3	10 mg/m^3	

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly /8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

Source: Government of Pakistan (2010) (SRO 1062 (I)/2010).

[47] Full text of the *Standards* is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm)

Appendix 9.3-4: NEQS for Motor Vehicles Exhaust and Noise

	Parameter	Standard (Maximum Permissible Limit)	Measuring Method	Applicability
1	Smoke	40% or 2 on the Ringlemann Scale during engine acceleration mode.	To be compared with Ringlemann Chart at a distance 6 or more.	Immediate effect
2	Carbon Monoxide	6%	Under idling conditions: Nondispersive infrared detection through gas analyzer.	
3	Noise	85 dB (A).	Sound meter at 7.5 meters from the source.	

Appendix 9.3-5: NEQS for Motor Vehicles Exhaust and Noise for New Diesel Vehicles, Passenger Cars and Light Commercial Vehicles (g/Km)

Type of Vehicle	Category/Class	Tiers	CO	HC+ NOx	PM	Measuring Method	Applicability
Passenger Cars	M 1: with reference mass (RW) up to 2500 kg. Cars with RW over 2500 kg to meet NI category standards.	Pak-II IDI	1.00	0.70	0.08	NEDC (ECE 15+ EUDCL)	All imported and local manufactured diesel vehicles with effect from 01-07-2012
		Pak-II DI	1.00	0.90	0.10		
Light Commercial Vehicles	NI-I (RW<1250 kg)	Pak-II IDI	1.00	0.70	0.08		
		Pak-II DI	1.00	0.90	0.10		
	NI-II (1250 kg< RW <1700 kg0	Pak-II IDI	1.25	1.00	0.12		
		Pak-II DI	1.25	1.30	0.14		
	NI-III (RW>1700 kg)	Pak-II IDI	1.50	1.20	0.17		
		Pak-II DI	1.50	1.60	0.20		
Parameter	*Standard (maximum permissible limit)*				*Measuring Method*		
Noise	85 dB (A)				Sound meter at 7.5 meters from the source.		

Appendix 9.3-6: NEQS for Motor Vehicles Exhaust and Noise for New Diesel Vehicles, Heavy Duty Diesel Engines and Large Goods Vehicles (g/Kwh)

Type of Vehicle	Category/ Class	Tiers	CO	HC	NOx	PM	Measuring Method	Applicability
Heavy Duty Diesel Engines	Trucks and Buses	Pak-II	4.0	1.1	7.0	0.15	ECE-R-49	All Imported and local manufactured diesel vehicles with the effect 1-7-2012
Large goods Vehicles	N2 (2000 and up	Pak-II	4.0	7.0	1.1	0.15	EDC	
Parameter	Standard (maximum permissible limit)					Measuring Method		
Noise	85 dB (A)					Sound meter at 7.5 meters from the source.		

Appendix 9.3-7: NEQS for Motor Vehicles Exhaust and Noise for New Petrol Vehicles (g/km)

Type of Vehicle	Category / Class	Tiers	CO	HC+ NOx	Measuring Method	Applicability
Passenger	M 1: With reference mass (RW) up to 2500 kg. Cars with RW over 2500 kg. to meet N1 category standards	Pak-II	2.20	0.50	NEDC (ECE 15 + EUDCL)	All imported and new models* locally manufactured petrol vehicles with effect from 1st July, 2009**
Light Commercial Vehicles	N1-I (RW<1250 kg)	Pak-II	2.20	0.50		
	N1-II (1250 kg>RW <1700 kg)	Pak-II	4.00	0.65		
	N1-III (RW>1700 kg)	Pak-II	5.00	0.80		
Motor Rickshaws & motor Cycles	2.4 strokes <150 cc	Pak-II	5.50	1.50	ECER 40	
	2.4 strokes>150 cc	Pak-II	5.50	1.30		
Parameters	Standard (maximum permissible limit)				Measuring Method	
Noise	85 dB (A)				Sound meter at 7.5 meters from the source	

Explanations for Table 2-4 to 2-7:
DI: Direct Injection
IDI: Indirect Injection
EUDCL: Extra Urban Driving Cycle
NEDC: New Urban Driving Cycle
M: Vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat
N: Motor vehicles with at least four wheels designed and constructed for the carriage of goods.
* New model means both model and engine type change
** The existing models of petrol driven vehicles locally manufactured will immediately switch ever to Pak-II emission standards but not later than 30th June, 2012

Source: Government of Pakistan (2009) (SRO 72 (KE)/2009).

Appendix 9.3-8: National Standards for Drinking Water Quality

Properties/Parameters	Standar Values for Pakistan
Bacterial	
All water intended for drinking (E. Coli or Thermo tolerant Coliform bacteria)	Must not be detectable in any 100 ml samples
Treated water entering the distribution system (E.	
Coli or thermo-tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml samples
Treated water in the distribution system (E. Coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml samples In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12- month period.
Physical	
Color	≤15 TCU
Taste	Non objectionable/Accept able
Odor	Non objectionable/Accept able
Turbidity	< 5 NTU
Total hardness as $CaCO_3$	< 500 mg/l
TDS	< 1000

pH	6.5 – 8.5
Chemical	
Essential Inorganic	**mg/Liter**
Aluminum (Al)	≤0.2
Antimony (Sb)	≤0.005 (P)
Arsenic (As)	≤ 0.05 (P)
Barium (Ba)	0.7
Boron (B)	0.3
Cadmium (Cd)	0.01
Chloride (Cl)	<250
Chromium (Cr)	≤0.05
Copper (Cu)	2
Toxic Inorganic	**mg/Liter**
Cyanide (CN)	≤0.05
Fluoride (F)*	≤1.5
Lead (Pb)	≤0.05
Manganese (Mn)	≤ 0.5
Mercury (Hg)	≤0.001
Nickel (Ni)	≤0.02
Nitrate (NO_3)*	≤50
Nitrite (NO_2)*	≤3 (P)
Selenium (Se)	0.01 (P)
Residual chlorine	0.2-0.5 at consumer end; 0.5-1.5 at source
Zinc (Zn)	5.0
Organic	
Pesticides mg/l	PSQCA No. 4639-2004, Page No. 4 Table No. 3 Serial No. 20- 58 may be consulted**
Phenolic compound (as phenols) mg/l	WHO standards: ≤ 0.002
Polynuclear Aromatic hydrocarbon (as PAH) g/L	WHO standards: ≤ 0.01v(by GC/MS method)
Properties/Parameters	Standard Values for Pakistan
Radioactive	
Alpha Emitters Bq/L or pCi	0.1
Beta Emitters	1

* indicates priority health related inorganic constituents which need regular monitoring.
** PSQCA: Pakistan Standards Quality Control Authority.

Source: Government of Pakistan (2010) (SRO 1063(I)/2010).

Appendix 9.3-9: National Environmental Quality Standards for Noise

Category of Area/Zone	Limit in dB(A) Leq*			
	Effective from 1st July 2010		Effective from 1st July 2012	
	Day time	Night time	Day time	Night time
Residential area	65	50	55	45
Commercial area	70	60	65	55
Industrial area	80	75	75	65
Silence zone	55	45	50	45

Notes:

- Day time hours: 6:00 a.m. to 10:00 p.m.
- Night time hours: 10:00 p.m. to 6:00 a.m.

- Silence zone: Zones that are declared as such by the competent authority. An area comprising not less than 100 m around the hospitals, educational institutions, and courts.
- Mixed categories of areas may be declared as one of the four above-listed categories by the competent authority.
- dB(A) Leq: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

Source: Government of Pakistan (2010) (SRO 1064(I)/2010).

9.4 Record of Interagency Forum and Consultation Meetings

Appendix 9.4-1: Consultations with WAPDA and other direct stakeholders

Date	Venue	Department/ Agency	Name of Participants and Designation	Main Concerns/ Feedback
Peshawar				
May 28, 2013	WAPDA House, Peshawar	Office of General Manager North, WAPDA, Peshawar	Mr. Rashid Bangash, General Manager North	• Resettlement sites, land pricing, land acquisition mechanism and negotiations with local leaders. • Training needs and capacity building requirements for WAPDA and allied staff for construction phase.
Islamabad				
September 6, 2013	WAPDA Rest House, Islamabad	WAPDA Rest House, Islamabad	Mr. Syed Raghib Abbas, Chairman WAPDA Mr. Rashid Bangash, General Manager, North	• Need to expedite studies and start actual construction • Close interaction between all stakeholders for resolution of issues in EA studies • Direct benefits to local population to help ensure cooperation and security
Lahore				
July 30, 2013	WAPDA House, Lahore	USAID, WAPDA, NESPAK, MWH, MMP	John Morgan, Director Program Office, USAID Syed Raghib Abbas, Chairman, WAPDA John Velon, Vice President MWH Others from all participating organizations	• Highlight findings of MWH technical review of project and way forward • Full cooperation and close interaction between WAPDA Officials and participating organizations • Disclosure and provision of all existing studies and reports by WAPDA and MMP
September 4, 2013	MMP Office, Lahore	WAPDA, MMP, NESPAK and others	Senior Officials from all stakeholders	• Need to finalize footprint of Component I • Discrepancies and shortfalls in project design • Need of accurate data for studies
September 11, 2013	NESPAK House, Lahore	USAID, MWH, NESPAK, WAPDA	Zahid Noor, project Consultant, USAID	• • Review of issues and design discrepancies in

			Bruno Trouille, Vice President, MWH Mr. Mohsin, Executive Engineer, KTDC Project, WAPDA Other officials from all organizations	the project • Discussions on WAPDA surveys of project area • Details of land acquisition • Sites for construction camps and distribution of total land to be acquired • Alignment of canals • Resolution of all issues and answers to queries from WAPDA and their consultants

Appendix 9.4-2: Consultations with various state officials

.

Date	Venue	Department/ Agency	Name of Participants and Designation	Main Concerns/ Feedback
F.R. Bannu				
August 29, 2013	Office of Assistant Political Agent, Bannu Cantt	Political Administration, Frontier Region Bannu	Mr. Ahsanullah Masood (Assistant Political Agent)	• Law and order situation in Frontier Region of Bannu is not good but can be resolved by developing consensus with tribal people. • Administration supports development in this region. This will bring prosperity in the area. • Jobs should be given to the local people. • Proper compensation must be made if any resettlement occurs.
District Bannu				
July 25, 2013	Office of Executive Engineer, C&W Department, Bannu.	Communication and Works Department, Bannu	Engr. Pir Muhammad (Executive Engineer)	• One crusher must be installed because at construction site huge reserves of sedimentary and metamorphic rocks are available. • For cement transportation use Shewa Tall road because construction site is 16 km away from Tall Parachinar.
July 25, 2013	Office of Executive Engineer (Public Health Engineering Department), Bannu	PHE Department, Bannu	Mr. Muhammad Ilyas (Assistant Engineer) Mr. Munawar Ahmad (Sub Divisional Officer)	• The catchment area extends to Afghanistan. Due to the bombing and drone attacks the water quality may have been effected .
July 25, 2013	Office of Executive Engr. Irrigation Department, Bannu	Irrigation Department, Bannu	Engr. Shah Muhammad Jalal (Superintending Engineer) Engr. Noor Kamal (Executive Engineer)	• WAPDA and consultants may keep close contact with Irrigation Department about iniation, execution and implementation of the project.

Date	Venue	Department/ Agency	Name of Participants and Designation	Main Concerns/ Feedback
July 26, 2013	Office of DFO, Divisional Wild Life Office, Bannu	Divisional Wild Life Office, Bannu	Mr. Khan Malook (Divisional Forest Officer)	• Local community should be involved in project implementation activities. • Proper arrangement of security is necessary.
July 29, 2013	Office of District Officer, On-farm Water Management Department, Bannu	On-Farm Water Management Department, Bannu	Mr. Azhar Ali Shah (Sub Engineer) Mr. Farmanullah (District Officer)	• In Domail about 500 tubewells and 500 to 600 pressure pumps need to be installed for irrigation and agriculture purposes. Due to KTDC, water table depth will rise. So this project is good for irrigation and agriculture.
July 31, 2013	Office of District Director, Agriculture Department, Bannu	Agriculture Department,Bannu	Mr. Zainullah Shah (District Director) Mr. KhudaYar (Subject Matter Specialist Agronomy) Mr. ZahoorIqbal (Manager Agriculture) Mr. Khalid (Field Assistant)	• Stake holder's coordination is necessary for successful completion of project.
August 05, 2013	Office of Member of the Provincial Assembly.	Local Representative of JaniKhel, Bannu	Mr. Malik Shah Muhammad Khan Wazir (Member of Provincial Assembly) Mr. Ikram Khan (Personnel Assistant to Commissioner)	• First right on KTDC project, regarding labour jobs during construction and operation stage, will be of North Waziristan people because KTD will construct on the river present in NW. • Proposed canals must be finalized after meeting with Maliks of that area. • Cooperate with the people during work to avoid any disturbance.
August 28, 2013	Office of Pakistan Bureau of Statistics, Bannu	Pakistan Bureau of Statistics, Bannu	Mr. Faridullah Khan (F/C. RO, Bannu)	• If local people are given jobs and resettlement funds, then no issue will arise. • People have concerns with their benefits, if they are given benefits, they will support the project.

Date	Venue	Department/ Agency	Name of Participants and Designation	Main Concerns/ Feedback
Lakki Marwat				
August 1, 2013	Office of Sub Engineer, C&W Department, Lakki Marwat	Communication and Works Department, Lakki Marwat	Mr. Hameedullah (Sub Engineer)	• Need to focus on volatile security situation in Project Area.
August 01, 2013	Office of Executive Engineer, Public Health Engineering Department, Lakki Marwat	Public Health Engineering Department, LakkiMarwat	Engr. Khan Muhammad (Executive Engineer) Mr. Alam Zeb (Sub Engineer).	• Drone attacks raise security issues. If army is involved then the project is possible.
August 02, 2013	Office of District Officer, Soil Conservation Department, Lakki Marwat	Soil Conservation Department, Lakki Marwat	Mr. Nazir Khan (District Officer, Soil Conservation)	• Terrorists are present. Kidnapping is their common task.
August 05, 2013	Office of District Director , Agriculture Department, Lakki Marwat	Agriculture Department, LakkiMarwat	Mr. Hussain Ahmad (District Director Agriculture Extension)	• Stakeholder's coordination is necessary for successful completion of project.
FATA Secretariat, Peshawar				
May 28, 2013	PC Hotel, Peshawar	Political Administration, FATA	My. Fayyaz Khan, Assistant Political Agent, MirAli	• Lack of formal revenue record and land ownership in region • Offering of social uplift schemes in project area will ensure cooperation of local population
May 29, 2013	FATA Secretariat, Peshawar	Office of Project Management Unit, FATA Secretariat	Mr. Roshan Mehsood, Director, PMU	• Capacity shortcomings of PMU to manage large development projects • Land transfer systems in project area
May 30, 2013	FATA Secretariat, Peshawar	Office of Irrigation Department, FATA Secretariat	Mr. Gultar Jan Mehsood, Director Irrigation	• Discussions on upgrade of canals in Component 3

Date	Venue	Department/ Agency	Name of Participants and Designation	Main Concerns/ Feedback
August 19, 2013	Office of P & D Department, Peshawar	Planning and Development Department (P &D), FATA Secretariat Peshawar	Mr. Junaid Khan (Chief Economist)	• The project must be prioritized. • All possible support and coordination must be provided by all the stakeholders for early initiation of the project
August 28, 2013	Admin Office, FATA Secretariat	Public Works Department (PWD), FATA Secretariat, Peshawar	Dr. Lal Zari (DP, PWD)	• During construction/ operation of the project, engage the local people, socially supporting staff, clerical staff and labor.
August 29, 2013	Admin Office, FATA Secretariat	Admin Office, FATA Secretariat	Mr. Kaffayt ullah	• Involve the local community, Maliks, Taliban, commanders, Mujahidin and Islamic fighters. • Involve the people during construction/operation of the project. • Engage the local people specially supporting staff and clerical staff.
August 29, 2013	Bureau of Statistics, FATA Secretariat	Bureau of Statistics, FATA Secretariat, Peshawar	Mr. Shah Hussain	• Involve the local community, Maliks, Taliban, commanders, Mujahidin and Islamic fighters. • Involve the people during construction/operation of the project. • Engage the local people specially supporting staff, clerical staff and labor.
August 30, 2013	Office of FATA Secretariat	Irrigation Department, FATA Secretariat	Mr. Awal Hussain (Deputy Director, Ground and Surface Water)	• Involve the local community, Maliks, Taliban, commanders, Mujahidin and Islamic fighters. • Involve the people during construction/operation of the project. • Engage the local people specially supporting staff, clerical staff and labor.
KPK Provincial Departments, Peshawar				

Date	Venue	Department/ Agency	Name of Participants and Designation	Main Concerns/ Feedback
April 17, 2013	Irrigation Department KP, Peshawar	Irrigation and Hydrology Department KP, Peshawar	Mr. Sheraz (Deputry Director, Design)	• Required Data is available at the department at a cost
April 17, 2013	Environment protection Agency, Peshawar	Office of Director General, EPA KP, Peshawar	Dr. M. Bashir Khan (Director General)	• Projects in FATA do not all in jurisdiction of EPA KP and FATA secretariat to be contact point for EA reports.
April 17, 2013	Highways Department, FATA	Highways Department FATA	Mr. Irshad (Head Draftsman)	• Discussed identification of bridges and access roads needing upgrade • All work requests for upgrades to be routed through WAPDA
Provincial Departments, Lahore				
April 3, 2013	SUPARCO Office, Lahore	Space Applications Division, SUPARCO	Dr. Arifa Lodhi (General Manager)	• No detailed studies conducted by SUPARCO in project area. • Frequency of baseline samples stressed
April 10, 2013	WAPDA Environment Cell, Lahore	Director Office, WEC, Lahore	Mr. Ishtiaq Ahmed Kaukab (Director) Mr. Rana Dastageer (Additional Deputy Director)	• Separate monitoring points should be considered for pre-construction, construction and operation and maintenance phases of the project • Need for detailed studies and samples stressed

Appendix 9.4-3: Consultations with Local Communities on EA

Date and Venue		Component	Prominent Participants	Discussion Points
October 29, 2013	Office of Chairman District Development Consultative Committee, Bannu	Component 3	35 community members and stakeholders including • Chairman, Kissan Board, Bannu Canal • Maliks and Tribal Leaders • Director Agriculture, Bannu • Executive Engineer, Marwat Canal and other public and private representative, agriculturists and water users from Marwat and Bannu Canals	Concerns raised by participants include • Waterlogging and salinity in the areas around Marwat Canal presently • Demand for waiver of Water Charges and Electricity Bills for the area • Demand for 1,400 cusecs of water for the area throughout the year • Demand for quick upgrade of Kachkot Canal • Demand for extension of Marwat Canal to area of Titter Khel to irrigate this arid region
October 30, 2013	District Council Hall, Lakki Marwat	Component 3	Around 50 community members and stake holders including tribal leaders and maliks, farmers associations, and representatives from the local agriculture and irrigation departments	• Lakki Marwat area offers good opportunities for avail benefits of the new canal systems due to its terrain • Demand for new farm to market roads
November 2, 2013	District Council Hall, Karak	Component 3	23 community members and stake holders including tribal leaders and maliks, farmers associations, and representatives from the local agriculture and irrigation departments	• Proposed change in canal alignments to reduce resettlement efforts and increased benefits
November 5, 2013	Bacha Khan Hall, Bannu	Component 3	Around 20 representatives from Tehsil Domail belonging to Wazir Tribe	• Demand for more benefits to Wazir Tribes as the KTD project is on Wazir's Tribal Land primarily. • Increased water share for Wazir Tribes
December 3, 2013	Bacha Khan Hall, Bannu	Component 2	Around 40 tribal representatives from tribes and sub-tribes from Component 2 areas of the project	• Demand for involving local tribes in project planning and execution • Concerns over relocation of shrine • Consensus achieved on project and full support solicited

Appendix 9.4-4: Stakeholder Disclosure and Consultation Workshop

Date and Venue		Prominent Participants	Discussion Points
November 26, 2013	Serena Hotel, Islamabad	• USAID • MWH • WAPDA • FATA Administration • ACE • NESPAK • Provincial Government Departments • MMP	• Presentations on EA, EMMP, RAP, RPF, VTP, CHPP, GP and others • Group discussions and recommendations on (i) Hydrology and Sedimentation (ii) Seismicity and Design (iii) RAP and RPF (iv) Gender Aspects (v) Irrigation and Agriculture (vi) Watershed Management • Concerns on cost increases in view of Hydrology, Sedimentation and Seismicity recommendations • Recommendations for simultaneous development of new Command Areas • Overall support to the recommendations and reports by MWH and its sub-consultants

9.5 Structural Design Criteria

Codes and Standards. The following Codes and Standards shall be used for Design and Material Specifications and Testing.

Sr. No.	Structural Design Criteria	
1	BCP (1986)	Building Code of Pakistan
2	WPCPHB (1967)	West Pakistan Code of Practice for Highway Bridges, 1967
3	AASHTO (1996)	Standard Specifications for Highway Bridges, 1996
4	ACI 318-02	Building Code Requirements for Reinforced Concrete
5	ACI 301-96	Specifications for Structural Concrete. American Concrete Institute.
6	ASTM -150	Specifications for Portland cement
7	ACI-350 R	Environmental Engineering Concrete Structures
8	ASTM -C33	Specifications for Concrete Aggregate
9	ASTM -A615	Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
10	UBC 1997	Uniform Building Code of USA

Loads. Structures have been designed to resist the following main loads and forces safely.

- Dead Load
- Live Load
- Impact
- Wind Load
- Longitudinal forces due to tractive/breaking effort of vehicles
- Earth Pressure
- Earthquake Forces

Dead Loads. Dead Loads have been computed from the unit weights of the materials as given

Live Loads. Either class AA or class A live load of WPCPHB 1967, whichever results in more severe efforts have been considered for design.

Impact. Impact on live loads is considered as specified in Section 2.9 for 'Truck Train Loading' and Section 4.4 for 'Military Loading' of WPCPHB-1967, as appropriate.

Wind Loads. Wind loads are computed according to UBC considering wind velocity of 160 km per hour.

Longitudinal Forces. Longitudinal forces due to tractive/braking is taken equal to 30 percent of the weight of the vehicle considering that only one lane is occupied for class 'A' Loading and 15 percent of weight of military vehicle for class 'AA' Loading as per Section 2.9 of WPCPHB-1967.

Earth Pressures. Lateral earth pressures due to backfill have been computed as per Section 2.16 of WPCPHB-1967.

9.6 List of Banned Pesticides in FATA/Khyber Pakhtunkhwa

Sr. No.	Name of Pesticide	Sr. No.	Name of Pesticide
1	Leptophos	25	Scharadan
2	BHC	26	Sulfotep
3	Endrin	27	Amitrole
4	DDT	28	Beta-HCH
5	Toxaphene	29	Carbon tetrachloride
6	Dinoseb	30	Lead arsenate
7	Captain	31	Lindane
8	Cyhexation	32	Mirex
9	Dieldrin	33	Strobone
10	Aldrin	34	TDF
11	Heptacholr	35	BHC
12	Daminozide	36	TEPP
13	Demon	37	Chlorophenols
14	Fenthion	38	Azinphos methyl
15	Nitrofen	39	Mevinphos
16	Dimefox	40	Binapacryl
17	Phorate	41	Bromophos
18	Endosulfan	42	Dimofox
19	Aramite	43	Chlorobenzilate
20	Chlordane	44	Copper arsenate hydroxide
21	Phenylthiol	45	Hexachlorobenzene
22	MCPP	46	Storbane
23	Calcium arsenate	47	Thallium sulphate
24	Disulfoton	48	Methamidophos

Source: Director Plant Protection, Agriculture Extension Department, Khyber Pakhtunkhwa, Peshawar (10.09.2013)

9.7 Fauna of the Project AOI

Appendix 9.7-1: Mammal species recorded from Kurram Tangi Multipurpose Dam Area

Sr. No.	Common Name	Zoological Name	Order	Status
1	Indian Gerbil Chooha (u)	Tatera indica	Rodentia	LC
2	Asiatic Jackal Geedar (u), Giddar	Canis aureus	Carnivora	LC
3	Indian Grey Mongoose Neola (u)	Herpestes edwardsii	Carnivora	LC
4	Small Asian Mongoose Neola (u)	Herpestes javanicus	Carnivora	LC
5	Jungle cat Jangli billi(u) , Pisshu (P)	Felis chaus	Carnivora	LC
6	Asiatic Steppe Wildcat Jangli billi(u) , Pisshu (P)	Felis sylvestris	Carnivora	LC
7	Common Red Fox Loomari (u)	Vulpes vulpes	Carnivora	LC
8	Wild Boar Jangli suar(u), Khinzeer	Sus scrofa	Artiodactyla	LC
9	Desert Hare	Lepus nigricollis	Lagomorpha	LC

Sr. No.	Common Name	Zoological Name	Order	Status
	Khargosh (u)			
10	Indian Crested Porcupine Seehar	Hystrix indica	Rodentia	LC
11	House Shrew Chuchunder (u)	Suncus murinus	Rodentia	LC
12	Soft-furred Rat	Millardia meltada	Rodentia	LC
13	House or Black Rat	Rattus rattus	Rodentia	LC
14	House Mouse	Mus musculus	Rodentia	LC
15	Northern Palm Squirrel Gulheri (u)	Funambulus pennantii	Insectivora	LC

Legend: LC = Least Concern, u: Urdu

Appendix 9.7-2: Bird species recorded by ACE from Kurram Tangi Multipurpose Dam Area

S.No.	English / Local name	Scientific name	Status	Occurrence
Order Podicepidiformes				
Family Podicipedidae				
1	Little Grebe Choti pundabi (u)	*Tachybaptus ruficollis*	Common	R
2	Black-necked Grebe Choti pundabi (u)	*Podiceps nigricollis*	Rare	WV
Order Pelecaniformes				
Family Phalacrocoracidae				
3	Little Cormorant Jal kawa (u)	*Phalacrocorax niger*	Common	R
Order Ciconiiformes				
Family Ardeidae				
4	Grey Heron Sain bagla, (u), Narri	*Ardea cinerea*	Scarce	WV
5	Purple Heron Laal sain bagla (u), Narri	*Ardea purpurea*	Rare	R
6	Indian Pond Heron Chhota Bagla (u)	*Ardeola grayii*	Common	R
7	Cattle Egret Bagla (u)	*Bubulcus ibis*	Common	R
8	Large Egret Bagla (u)	*Egretta alba*	Common	WV
9	Intermediate Egret Bagla (u)	*Egretta intermedia*	Common	R
10	Little Egret Bagla (u)	*Egretta garzetta*	Common	R
Order Anseriformes				
Family Anatidae				
11	Greylag Goose	*Anser anser*	Common	WV
12	Northern Pintail	*Anas acuta*	Common	WV
13	Northern Shoveler	*Anas clypeata*	Common	WV
14	Common Teal Chikoo battakh (u)	*Anas crecca*	Common	WV
15	Mallard	*Anas platyrhyncos*	Common	WV
16	Gadwall	*Anas strepra*	Common	WV
17	Common Pochard	*Aythya ferina*	Common	WV

S.No.	English / Local name	Scientific name	Status	Occurrence
18	Tufted duck	*Aythya fuligula*	Common	WV
19	Ferruginous duck	*Aythya nyroca*	Rare	WV
20	Shelduck	*Tadorna tadorna*	Rare	WV
Order Falconiformes				
Family Accipitridae				
21	Black-shouldered Kite Kohamar	*Elanus caeruleus*	Scarce	R
22	Common Kite Cheel (u)	*Milvus migrans*	Common	R
23	Egyptian Vulture	*Neophron percnopterus*	Common	R
24	Eurasian Griffon Vulture	Gyps fulvus	Common	R
25	Eurasian Sparrowhawk	Accipiter nisus	Common	R
26	Shikra	Accipiter badius	Common	R
27	Desert Buzzard	Buteo buteo	Common	R
28	Short-toed Snake-eagle	Circaetus gallicus	Common	R
29	Marsh Harrier Sufaid sira (u)	*Circus aeruginosus*	Common	WV
30	Hen Harrier Chhota baaz (u)	*Circus cyaneus*	Common	WV
Family Falconiformes				
31	Eurasian Kestrel	*Falco tinnunculus*	Common	WV
32	Laggar Falcon	*Falco jugger*	Scarce	WV
33	Saker Falcon	*Falco cherrug*	Scarce	WV
34	Peregrine Falcon	*Falco peregrinus*	Scarce	WV
Family Pandionidae				
35	Osprey Machli mar (u)	*Pandion haliaetus*	Rare	WV
Order Galliformes				
Family Phasianidae				
36	Black Francolin Kala teetar (u), Torr	*Francolinus francolinus*	Scarce	R
37	Grey Francolin Bhura teetar (u), Spin	*Francolinus pondicerianus*	Common	R
38	Chukar Partridge Chakor (U)	*Alectoris chukar*	Common	R
39	Seesee Partridge Seesee	*Ammoperdix grisseogularis*	Common	R
40	Common Quail	*Coturnix coturnix*	Common	M
Order Gruiformes				
Family Rallidae				
41	White-breasted Waterhen Sufaid seena jal murghi (u)	*Amaurornis phoenicurus*	Scarce	R
42	Common Moorhen Jal murghi (u)	*Gallinula chloropus*	Common	R
43	Purple Swamphen Neeli jal murghi (u)	*Porphyrio porphyrio*	Common	R
	Black Coot	*Fulica atra*	Common	WV
Family Gruidae				
44	Demoiselle Crane	*Anthropoides virgo*	Rare	Passage migrant
45	Common Crane	*Grus grus*	Rare	Passage migrant
Family Otidae				

S.No.	English / Local name	Scientific name	Status	Occurrence
46	Houbara Bustard	*Chlamydotis undulata*	Rare	Passage migrant
Order Charadriiformes				
Family Charadriidae				
47	Red-wattled Lapwing Surkh gosha tatri (u)	*Vanellus indicus*	Common	R
48	Little Ringed Plover Choti halkaydartatri (u)	*Charadrius dubius*	Scarce	WV
49	Kentish Plover	*Charadrius alexandrinus*	Scarce	WV
Order Scolopacidae				
Family Scolopacidae				
50	Common Sandpiper Karli chaha (u)	*Tringa hypoleucos*	Common	WV
51	Little Stint Chota punluva (u)	*Calidris minuta*	Common	WV
52	Common Snipe Raj chaha (u)	*Gallinago gallinago*	Scarce	WV
Family Recurvirostridae				
53	Black-winged Stilt Siah parpa bansa (u)	*Himantopus himantopus*	Common	R
Family Sternidae				
54	Indian River Tern	*Sterna aurantia*	Scarce	R
55	Caspian Tern	*Sterna caspia*	Common	R
Order Columbiformes				
Family Columbidae				
56	Blue Rock Pigeon Jangli kabutar (u)	*Columba livia*	Common	R
57	Collared Dove Halkaydar kabutar (u)	*Streptopelia decaocto*	Common	R
58	Red Collared-dove	*Streptopelia tranquebarica*	Common	R
59	Little Brown Dove Chhoti fakhta (u)	*Streptopelia senegalensis*	Common	R
Order Psittaciformes				
Family Psittacidae				
60	Rose-ringed Parakeet Gulabi kanthidar tota (u)	*Psittacula krameri*	Common	R
Order Cuculiformes				
Family Cuculidae				
61	Common Koel Koel(u)	*Eudynamys scolopacea*	Common	Summer breeding
62	Crow Pheasant or Greater Coucal Jangli Kukar (u)	*Centropus sinensis*	Common	R
Order Strigiformes				
Family Strigidae				
63	Spotted Owlet Dhabbaydar ullu (u)	*Athene brama*	Rare	R
64	Indian Scops-owl	*Otus bakkamoena*	Rare	R
65	Eurasian Eagle-owl	*Bubo bubo*	Common	R
Order Caprimulgiformes				
Family Caprimulgidae				
66	Eurasian Nightjar Chapako (u)	*Caprimulgus europaeus*	Rare	Occasional WV

S.No.	English / Local name	Scientific name	Status	Occurrence
Order Coraciiformes				
Family Alcedinidae				
67	Pied Kingfisher Sah mahi khor (u)	*Ceryle rudis*	Common	R
68	Common Kingfisher Machi Mar (u)	*Alcedo atthis*	Rare	R
69	White-throated Kingfisher Sufaid seena shah mahi khor (u)	*Halcyon smyrnensis*	Common	R
Family Meropidae				
70	Little Green Bee-eater Sabz Makhi khor(u)	*Merops orientalis*	Common	R
Family Coracidae				
71	Indian Roller Chahi (u), Neel Kantth(u)	*Coracias benghalensis*	Common	R
72	Kashmir Roller	*Coracias garrulus*	Common	R
Family Upupidae				
73	Common Hoopoe Hudhud (u)	*Upupa epops*	Rare	WV
Order Piciformes				
Family Capitonidae				
74	Coppersmith Barbet	*Megalaima haemacephala*	Common	R
Family Picidae				
75	Golden-backed Woodpecker Kath barrdhai (u)	*Dinopium benghalense*	Common	R
Order Passeriformes				
Family Alaudidae				
76	Crested Lark Chandola (u)	*Galerida cristata*	Common	R
77	Small Skylark	*Alauda gulgula*	Common	Summer breeding
Family Hirundinidae				
78	Plain Sand Martin Ababil (u)	*Riparia paludicola*	Common	WV
79	Barn or Common Swallow Ababil (u)	*Hirundo rustica*	Common	WV
Family Laniidae				
80	Isabelline or Pale Brown Shrike	*Lanius isabellinus*	Scarce	WV
81	Rufous-backed Shrike	*Lanius schach*		
82	Great Grey Shrike	*Lanius excubitor*	Common	Summer breeding
83	Bay-backed Shrike	*Lanius vittatus*	Scarce	Summer breeding
Family Dicruridae				
84	Black Drongo Siah kotwal kawa, Kaleech (u)	*Dicrurus macrocercus*	Common	R
Family Sturnidae				
85	Indian Myna Myna, Shark, Laalli (u)	*Acridotheres tristis*	Common	R
86	Bank Myna Jangli myna, Laalli (u)	*Acridotheres ginginianus*	Common	R
Family Muscicapidae				
87	Black Redstart	*Phoenicurus ochruros*	Rare	WV

S.No.	English / Local name	Scientific name	Status	Occurrence
88	Red-breasted Flycatcher	*Ficedula parva*	Rare	Double passage migrant
Family Corvidae				
89	House Crow Kawa (u)	*Corvus splendens*	Common	R
90	Rufous Treepie	*Dendrocitta vagabunda*	Scarce	R
Family Cisticolidae				
91	Yellow-bellied Prinia	*Prinia flaviventris*	Common	R
92	Rufous-vented Prinia	*Prinia burnesii*	Common	R
93	Plain Prinia	*Prinia inornata*	Common	R
94	Common Tailorbird Baya (u)	*Orthotomus sutorius*	Common	R
Family Pycnonotidae				
95	Himalayan Bulbul Sufaid rukhsar bulbul (u)	*Pycnonotus leucogenys*	Common	R
96	Red-vented Bulbul Bulbul (u)	*Pycnonotus cafer*	Scarce	R
Family Turtidae				
97	Pied Bush Chat	*Saxicola caprata*	Common	R
98	Isabelline Wheatear	*Oenanthe isabellina*	Common	WV
99	Indian Robin	*Saxicoloides fulicata*	Common	R
100	Blue Rock Thrush	*Monticola solitarius*	Scarce	Summer breeding
101	Hume's Wheatear	*Oenanthe alboniger*	Common	R
102	Indian Robin	*Saxicoloides fulicata*	Common	R
103	Pied Bush Chat	*Saxicola caprata*	Common	R
104	Stone Chat	*Saxicola torquata*	Common	Double passage migrant
Family Timaliidae				
105	Common Babbler Sohrr (u)	*Turdoides caudatus*	Common	R
106	Striated Babbler Dhadidhar Sohrr (u)	*Turdoides earlie*	Rare	R
107	Jungle Babbler Jangli Sohrr, Haro	*Turdoides striatus*	Common	R
Family Sylviidae				
108	Zitting Cisticola	*Cisticola juncidis*	Common	R
109	Streaked Wren-Warbler	*Prinia gracilis*	Common	R
110	Blyth's Reed Warbler	*Acrocephalus dumetorum*	Common	Passage migrant
111	Lesser Whitethroat	*Sylvia curruca*	Scarce	Summer breeding
112	Chiffchaff	*Phylloscopus collybita*	Common	WV
Family Motacillidae				
113	White Wagtail Sufaid Posi (u)	*Motacilla alba*	Common	WV
114	Yellow Wagtail Peeli Posi (u)	*Motacilla flava*	Common	PM
115	Tawny Pipit Piddi (u)	*Anthus campastris*	Common	WV
Family Nectarinidae				
116	Purple Sunbird	*Nectarinia asiatica*	Common	R

S.No.	English / Local name	Scientific name	Status	Occurrence
Family Passeridae				
117	House Sparrow Chirya, Goraya (u)	*Passer domesticus*	Common	R
118	Spanish Sparrow	*Passer hispaniolensis*	Scarce	Passage migrant
Family Paridae				
119	Great Tit	*Parus major*	Rare	WV
Family Oriolidae				
120	Eurasian Golden Oriole	*Oriolus oriolus*	Scarce	Passage migrant
Family Emberizidae				
121	Rock Bunting	*Emberiza cia*	Scarce	WV

Legend: R = Resident, WV = Winter visitor, PM = Passage Migrant, u: Local name in Urdu

Appendix 9.7-3: Amphibian and Reptile Species Recorded by ACE from the Kurram Tangi Multipurpose Dam

Project Influence Area

Sr. No.	Common Name	Zoological Name	Order	Status
Amphibians				
1	Common Toad Maidani ghauk (u)	Bufo stomaticus	Anura	Common
2	Skittering Frog Tapakta maindak (u)	Euphlyctis cyanophlyctis	Anura	Common
3	Bullfrog	Hoplobatrachus tigerinus	Anura	Common
Reptiles				
4	Indian Flap-shell Turtle Thaila, Kummi, kachoo	Lissemys punctata andersoni	Chelonia	Rare
5	Indian Garden Lizard Girgit (u)	Calotes versicolor	Squamata	Common
6	Agror Agama	Laudakia agrorensis	Squamata	Common
7	Siah Agama	Laudakia melanura	Squamata	Common
8	House Gecko Ghar chipkali (u)	Hemidactylus flaviviridis	Squamata	Common
9	Brook's House Gecko Dhabbe-dar chipkali (u)	Hemidactylus brookii	Squamata	Common
10	Common Leopard Gecko	Eublepharis macularius	Squamata	Common
11	Minor Snake-eyed Skink	Ablepharus grayanus	Squamata	Common
12	Common Indian Monitor Bengali Goh (u)	Varanus bengalensis	Squamata	Common
13	Common Sand Boa Sindhi do-muhi (u), Ba-moha	Eryx johnii	Ophidia	Rare
14	Pakistani Ribbon Snake	Psammophis leithii	Ophidia	Rare
15	Indian Rat Snake Dhaman	Ptyas mucosus	Ophidia	Rare
16	Central Asian Cobra Bhoora naag (u)	Naja oxiana	Ophidia	Rare
17	Saw-scaled Viper	Echinus carinatus		Rare

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