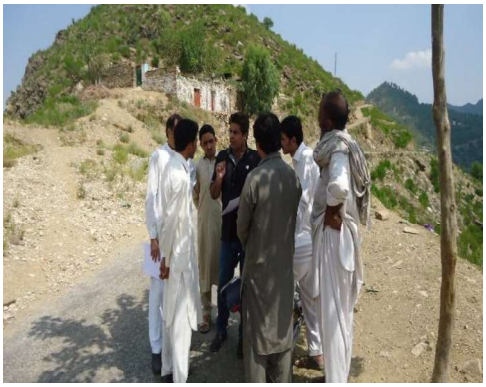
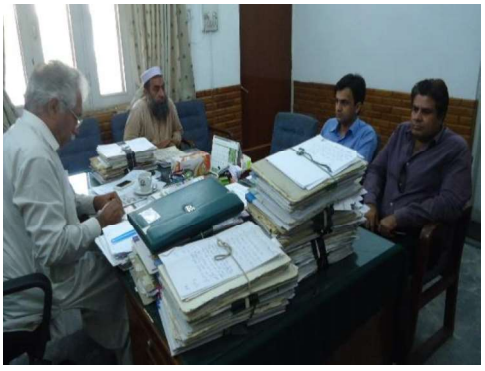
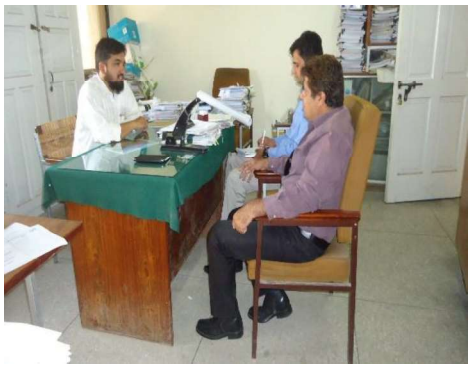
PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

# MOHMAND DAM HYDROPOWER PROJECT



# ENVIRONMENTAL IMPACT ASSESSMENT REPORT

## VOLUME 01 OF 02

## (MAIN REPORT)

## SEPTEMBER, 2017


| | | |
|---|---|---|
| SMEC | *SMEC International Pty Ltd.* | *(Australia)* |
| NIPPON KOEI | *Nippon Koei Co., Ltd.* | *(Japan)* |
| NESPAK | *National Engineering Services Pakistan (Pvt.) Limited.* | *(Pakistan)* |
| ACE | *Associated Consulting Engineers – ACE (Pvt) Ltd.* | *(Pakistan)* |
| EGC | *Engineering General Consultants EGC (Pvt) Ltd.* | *(Pakistan)* |
| BAK | *BAK Consulting Engineers* | *(Pakistan)* |

# EXECUTIVE SUMMARY

## INTRODUCTION

The idea of the proposed Mohmand Dam Project formally known as Munda Dam[1] dates back to 1963, when the Water and Power Development Authority (WAPDA) started some initial geological investigations at the dam site considering the future electricity demand of the country as well as the socio-economic development of the Swat River Basin. At that time, the idea of the construction of 210 meters high rockfill dam to generate 400 MW of electricity along with water storage for irrigation and flood protection was conceived. Later, Pre-Feasibility Study of the subject Project was carried out in 1992 by WAPDA. The Feasibility Study of the Project was carried out by JICA (Japan International Co-operation Agency) in 2000.

Considering the crisis of Power Sector in Pakistan since 2008 and after the historical flood of 2010 which further emphasized the need of Mohmand Dam Project. In order to overcome the current power crisis, to augment the irrigation demands of Lower Swat Canal (LSC) and Doaba Canals and to provide irrigation water to the new canal commands in the lower plans of Charsadda and to minimize the flood damages as experienced in the past the implementation of the Mohmand Dam is greatly felt. In this background, WAPDA entered into an agreement with a joint venture of consulting firms i.e. M/s SMEC International Pty Ltd., Australia, (Lead Firm) Nippon Koei Ltd. Japan, National Engineering Services Pakistan (NESPAK), Associated Consulting Engineers (Pvt.) Ltd., Lahore in association with Engineering General Consultants (EGC) (Pvt.) Ltd., Lahore and BAK called Mohmand Dam Consultants (MDC) for the Review of Feasibility Study, Preparation of Project Planning Report (PPR), Detailed Design and Tender documents of the Mohmand Dam Project. This EIA study was conducted as part of this contact agreement.

## APPLICABLE POLICES, LAWS AND GUIDELINES

Following are the applicable policies, laws, regulations and guidelines related to the proposed Project:

- National Policy Framework;
- National Conservation Strategy (NCS), 1992;
- National Environment Policy, 2005;
- National Forest Policy Pakistan, 2001;
- National Electricity Policy, 2005;
- Federal Government Institutions;
- Pakistan Environmental Protection Agency (Review of IEE/EIA) Regulations, 2000;
- Federal Environmental Protection Agency (PAK EPA);
- Provincial EPA's / EPA;
- Pakistan Environmental Impact Assessment (EIA) Approval Procedures;
- Guidelines for Environmental Assessment (EA);
- National Environmental Quality Standards (NEQS), 2000;
- National Standards for Drinking Water Quality (NSDWQ), 2008;
- Other Environment Related Statutes with Probable Application to Mohmand Dam Project
- Land Acquisition Act (LAA), 1894;
- Forest Act, 1927;
- Pakistan Penal Code, 1860;
- Explosives Act, 1884;

[1] *The previous name of "Mohmand Dam" was Munda Dam which was altered to "Mohmand Dam Hydropower Project" on the demand of Govt. of Khyber Pakhtunkhwa and elders of Mohmand Agency.*

- The Telegraphy Act, 1910;
- The West Pakistan Water and Power Act, 1958;
- Antiquities Act, 1975;
- Regulations 2010 Indus River System Authority (IRSA), Islamabad;
- Regulation of Mines, Oil Fields and Mineral Development Act, 1948
- The Canal and Drainage Act, 1873;
- Provincial Wildlife (Protection, Preservation, Conservation and Management) Acts, Ordinances and Rules (Act, 1972);
- Khyber Pakhtunkhwa Environmental Protection Act, 2014;
- Provincial Local Government Ordinances, 2001;
- Lower Riparian Water Rights;
- Labour and Health and Safety Legislation;
- Hazardous Substance Rules, 2003;
- Frontier Crimes Regulations, 1901;
- Khyber Pakhtunkhwa Wildlife and Biodiversity (Protection, Preservation, Conservation and Management) Act, 2015;
- Policies and Guidelines of International Financial Institutions;
- World Bank (WB) Operational Policies;
- Policies of International Conventions (International Protocols and Obligations);
- Bonn Convention-The Convention on Conservation of Migratory Species of Wild Animals, 1979;
- The Rio Declaration, 1992;
- Convention on Protection of World Cultural and Natural Heritage, Paris 1972; and
- Convention on International Trade of Endangered Species of Flora and Fauna (CITES)-1979.

**PROJECT DESCRIPTION**

The Mohmand Dam Hydropower Project is comprised of the following components:

- Main Dam Concrete Face Rockfill Dam (CFRD);
- Spillway;
- Intake Structures;
- Low Level Outlet (LLO) and Flushing Outlet Tunnels;
- Powerhouse;
- Switchyard and Transmission System;
- Left and Right Bank Irrigation Tunnels with Irrigation Facilities;
- Infrastructure; and
- Auxiliaries Components.

**Salient Features of Mohmand Dam Project**

| Sr. no. | DESCRIPTION | UNITS | QUANTITY |
|---|---|---|---|
| | **HYDROLOGY & RESERVOIR** | | |
| 1 | Catchment area | $km^2$ | 13,650 |
| 2 | Length of Reservoir | km | 56 |
| 3 | Reservoir Area | $km^2$ | 24 |
| 4 | Annual mean discharge | $m^3/sec$ | 233 |
| 5 | Annual mean sediment load | $Ton/km^2$ | 380 |
| 6 | Probable Maximum Flood (PMF) | $m^3/s$ | 27,427 |
| 7 | Surcharge Water Level | masl | 559.4 |
| 8 | Maximum Flood Water Level | masl | 562.85 |

| Sr. no. | DESCRIPTION | UNITS | QUANTITY |
|---|---|---|---|
| 9 | Full Supply Level (FSL) | masl | 555 |
| 10 | Minimum operation level (MOL) | masl | 510 |
| 11 | Gross storage volume | Million $m^3$ | 1,594 |
| 12 | Live storage volume | Million $m^3$ | 834 |
| **RIVER DIVERSION** | | | |
| 11 | Upstream Cofferdam | masl | 409 |
| 12 | Downstream Cofferdam | masl | 380 |
| 13 | Design Flood - 25 year return period | $m^3$/sec | 4,000 |
| 14 | Design Flood - 100 year return period | $m^3$/sec | 5,900 |
| 15 | Tunnels | No. | 2 |
| 16 | Diversion tunnel Diameter (each) | m | 15 |
| 17 | Diversion Tunnel-1 Inlet invert level | masl | 362 |
| 18 | Diversion Tunnel-2 Inlet invert level | masl | 374 |
| 19 | Diversion Tunnel-1 outlet invert level | masl | 360 |
| 20 | Diversion Tunnel-2 outlet invert level | masl | 360 |
| 21 | Diversion Tunnels Total Length | m | 3,317 |
| **DAM** | | | |
| 22 | Type | | CFRD |
| 23 | Dam height | M | 213 |
| 24 | Dam Crest level | Masl | 563 |
| 25 | Parapet Wall Top Level | Masl | 564.5 |
| 26 | River Bed level | Masl | 360 |
| 27 | Plinth base level/Foundation Level | Masl | 350 |
| 28 | Dam Crest length | M | 716.6 |
| 29 | Dam Crest width | M | 12 |
| 30 | Upstream Slope | | 1:1.4 |
| 31 | Downstream Slope | | 1:1.6 |
| **SPILLWAY** | | | |
| 32 | Type | | Gated |
| 33 | Gated Ogee Weir Crest El. | Masl | 539 |
| 34 | Gated Ogee Weir Width (waterway without piers) | M | 105 |
| 35 | Design inflow flood for spillway (PMF) | $m^3$/sec | 27,427 |
| 36 | Spillway gate | | Radial gate |
| 37 | Spillway gate width | M | 15 |
| 38 | Spillway gate height | M | 21 |
| 39 | No. of Gates | no. | 7 |
| 40 | Total Spillway Crest Length including piers | M | 136.8 |
| 41 | Energy dissipation Arrangement | | Double Stilling Basin Approach |
| **Powerhouse – Hydropower Generation Facilities** | | | |
| 42 | Installed capacity | MW | 800 |
| 43 | Mean Annual Energy | GWh | 2,862 |
| 44 | Maximum plant discharge | $m^3$/sec | 544 |
| 45 | Plant Factor | % | 40.84 |
| 46 | Tail water level at plant discharge | Masl | 369 |
| 47 | Maximum gross head at plant discharge | m | 186 |
| **Headrace Tunnel** | | | |
| 48 | Number | No. | 1 |
| 49 | Total Length | M | 722 |
| | -Concrete Lined | M | 402 |
| | -Steel Lined | M | *320* |

| Sr. no. | DESCRIPTION | UNITS | QUANTITY |
|---|---|---|---|
| 50 | Diameter | M | 13.2 |
| **Penstock/Reducer/Manifold** | | | |
| 51 | Total Length | M | 406 |
| 52 | Diameter | M | varies from 10m to 4.9m |
| **Powerhouse Building- (Surface Type)** | | | |
| 53 | Width | M | 55.3 |
| 54 | Length | M | 157.4 |
| **Turbine** | | | |
| 55 | Type - Vertical shaft Francis | MW | 204 |
| 56 | No. of Turbines | | 4 |
| 57 | Turbine speed | rpm | 200 |
| **LEFT BANK** | | | |
| 58 | Cultivable Command Area - CCA | Ha | 3,649 |
| 59 | Length of Canal | Km | 12.4 |
| 60 | Length of irrigation tunnel (D shape) | Km | 4.3 |
| 61 | Tunnel Diameter (Inner) | M | 2.5 |
| 62 | Maximum discharge | $m^3$/sec | 3.5 |
| **RIGHT BANK** | | | |
| 63 | Cultivable Command Area - CCA | Ha | 3,124 |
| 64 | Length of Canal | Km | 14.75 |
| 65 | Length of irrigation tunnel (D shape) | Km | 3 |
| 66 | Tunnel Diameter (Inner) | M | 2.5 |
| 67 | Maximum discharge | $m^3$/sec | 3.32 |
| | TOTAL - CCA | Ha | 6,772 |
| **PROJECT COST** | | | |
| 68 | Base Cost | US$ Million | 1,869 |
| 69 | Total Project Cost (Including price Escalation) | US$ Million | 2,783 |
| | **IERR** | | |
| 70 | With Emission Reduction Benefits | | 21.36% |
| 71 | Without Emission Reduction Benefits | | 20.00% |
| | **B/C Ratio** | | |
| 72 | With Emission Reduction Benefits | | 1.89 |
| 73 | Without Emission Reduction Benefits | | 1.74 |
| | **NPV** | | |
| 74 | With Emission Reduction Benefits | | 110,661.94 |
| 75 | Without Emission Reduction Benefits | | 92,185.48 |
| | **Construction Period** | | |
| 76 | Pre Construction Activities | | 8 months |
| 77 | Construction period | | 5 years 8 months |

**Analysis of Alternatives**

The various alternatives which have been considered during the conduct of the study are:

- No Project Option (NPO);
- Location Alternative; and
- Technological Alternatives.

The proposed Dam Project is a cost effective, sustainable and environmental friendly option. The no project option means that no storage reservoir will be built, command area will not have regulated supply of irrigation, no water supply to Peshawar, no flood protection and no generation of electricity to overcome the crises. In light of these facts, NPO is not acceptable for Pakistan.

The proposed study considered the following aspects to compare the technological alternatives for the proposed Dam:

- Dam Height;
- Dam Type Alternative (gravity, Rockfill, Concrete, etc.);
- Comparison of Open and Underground Powerhouse;
- Selection of Waterway Options;
- Options for Energy Dissipation;
- Re-Regulation Weir;
- Evaluation of Dam Safety for Overtopping;
- River Diversion Optimization Studies;
- Supply Alternatives; and
- Power Station Operation and Thermal Alternatives.

Technical comparison of various alternatives the proposed study concluded that CFRD type dam of 213 m height with an open powerhouse option has been considered for the proposed Mohmand Dam Project.

**DESCRIPTION OF EXISTING ENVIRONMENTS**

The purpose of the Baseline Study is to document the existing conditions of the parametrs likely to be affected in physical, ecological and socio-economic domains includign existing infrastructure such as roads, houses, shops, mosques, cultivated land, trees, jeepable tracks and the social conditions of the inhabitants.

Satellite Imagery, Topographical maps, GT sheets were also utilized for the collection of baseline data. For the collection of socioeconomic data, various proformas and questionnaires were developed. Scoping sessions were held with all the major Project stakeholders for disclosure of information and to clear queries and misconceptions regarding the proposed intervention. Government offices were also contacted and visited for the verification of baseline data collected during the field visit and to obtain published documents related to the Study Area. Similarly, Non-Governmental Organizations (NGOs) were contacted to review their programs/ developments Projects in the Study Area. In addition, efforts were made to collect information regarding the future development plans in the Study Area.

**Physical Environment**

The Mohmand Dam site is proposed in a mountainous area with rough and rugged topography. The bedrocks are fresh and is in intact condition is hard or moderately hard. The rock outcrop appears more or less weak on the surface and weathered along joints and faliatim planes. However, the weathering does not appear to be so deeply developed and becomes slight or virtually fresh at the depth of 5m from the ground surface, especially near the valley floor.

The valley is about 45m wide and rock is exposed on both flanks and slopes are generally stable at the dam axis. The dam will rest on Metadolorite/ Dolorite, Quarty Talcosic schist and chlorite mica schist on the left and right banks.

The Mohmand Dam Project Area is in the proximity of the collisional zone between the north moving Indian Plate and the Eurasian Plate which is over-riding the Indian plate. For the seismic hazard evaluation, a study of regional geological and tectonic information collected from the available literature and maps has been carried out by MDC. On the basis of this data, the critical seismotectonic features located within more than 200 km radius of the Project Area have been identified and seismic hazard evaluation has been conducted using probabilistic as well as

deterministic approach for selecting the seismic design parameter for the Project in accordance with the ICOLD guidelines (Bulletin 148, 2016).

Based on the study of seismotectonic setting of Mohmand Dam Hydropower Project and the results of seismic hazard evaluation are as follows:

- The Project Area is located in the northern part of the Peshawar Basin, close to the boundary between the Indian plate and Kohistan Island arc which is sandwiched between the Indian and Eurasian tectonic plates;
- As the Project Area is located within the collision zone of the plate boundaries, it is seismically very active; and
- A number of moderate sized earthquakes have been recorded in the project region during the last 100 years.

Monthly mean maximum temperatures at Mohmand dam site for the period of 2000 to 2006 are varies from 41.1°C in the month of June to 19.8°C in the month of January, whereas monthly mean minimum temperature varies between 26.3°C in June and 7.4°C in January.

The average annual precipitation at Kalam is 945 mm. Maximum monthly precipitation is 189 mm in March, and minimum is 26 mm in June. The data of Kalam station clearly shows that the winter precipitation is more than the summer precipitation. Whereas, the mean annual precipitation at Mohmand Dam Site station is 622 mm. For this station, the maximum monthly precipitation is 157 mm in August, and minimum 11 mm in November.

Daily Pan evaporation data of Mohmand damsite station is available for the period from 2000 to 2006. The same has been collected and computerized to assess the loss due to evaporation. The mean maximum pan evaporation is about 556 mm in the month of June and minimum pan evaporation is 124 mm in December. The average annual pan evaporation is 3786mm.

The stream flows of Swat and Kabul rivers are being observed on daily basis at different gauging stations. Hydrometric stations at Chakdara, Kalam, Warsak, and Nowshera are in operation since 1961. These stations are still being regularly maintained and monitored by SWHP except Warsak that remained in operation only upto 1970. Kalam and Chakdara are located approximately 210 and 85 km upstream of the project site respectively. Data elucidated that the average flows of Swat River at Kalam and Chakdara are about 86 $m^3$/sec and 185 $m^3$/sec respectively. The gauging station record at dam site represented that average flow of Swat is about 239 $m^3$/sec. The period from May to August is high flow season, April and September are average flow months while October to March is generally dry period.

Flood studies are carried out for planning and design of spillway and other outlet structures as well as checking the safety of the dam. There are a number of available methods used for estimating floods such as “At-site Flood Frequency Analysis (with transposition); Regional Flood Frequency Analysis (Index flood); Station-Year Approach; and Deterministic Approach (rainfall-runoff modelling)”. Floods against various return periods for Mohmand dam site are given below:

**Recommended Floods against Various Return Periods at Mohmand Dam site**

| **Sr. No.** | 1. | **Return Period(Years)** | 2 | 10 | 25 | 50 | 100 | 500 | 1000 | 10000 |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2. | **Flood ($m^3$/s)** | 1600 | 3010 | 4000 | 4880 | 5900 | 8960 | 10670 | 18640 |

Mean annual total sediment load is normally estimated by adding unmeasured sediment bed load to the observed suspended sediment load. At Mohmand dam site, the estimated annual sediment load is considered to be 5.17 million tons.

Two rock quarries were identified. The Sappare quarry has two major limestone beds which will yield a quantity of 5 million cubic meters. The Todobo quarry has quartzite and quart mica schist as main rock units. The quartzite has high uniaxial compressive strength ranging from 60 to 170 MPa while the quartz mica schist is weaker with uniaxial compressive strength varying from 9 MPa to 22 MPa. Thus, the limestone and quartzite having the uniaxial compression strengths in the excess of 30 MPa, can be used as the rockfill in the dam. Schist can also be used if proper drainage is provided.

The gross Project command area is about 24450 acres, of which 15038 acres lies on left bank and 9412 acres on right bank of the Swat River Administratively, about 82% of the Project area falls in district Charsadda of KP province. The rest is in Mohmand Agency located in the Northern Zone of Federally Administered Tribal Areas (FATA).

Following are the major functioning irrigation schemes adjacent to the proposed command area.

- LSC System (LSC);
- Doaba Canal System;
- Tangi Lift Irrigation Scheme;
- Palai Dam Irrigation Scheme;
- Warsak Left Irrigation Canal; and
- Private Pumping Schemes.

Target area of new irrigation scheme of Project is the major rain fed farmland extending on both banks of Swat River and extend in the Left Bank area up to Jindai Khawar and on the Right Bank beyond the Subhan Khawar. The GCA and CCA of these irrigation schemes are shown in Project Description.

Purpose of environmental monitoring is to collect data and to provide detailed information about the current environmental conditions in the Study Area. An environmental monitoring and sampling program was prepared to quantify the existing baseline conditions for ambient air, background noise levels and water (surface and groundwater) quality. The sampling and monitoring points in the Study Area (reservoir, command and lower riparian areas) were selected so as to represent the existing environmental conditions.

A water quality / air quality, noise, D.O. heavy metals, pesticides measurement study was undertaken by the Scarp Monitoring Organization (SMO) WAPDA (in association with PCSIR Peshawar) from February through March 2013 under the overall supervision of Mohmand Dam Hydropower Project Consultants.

- Ambient air quality for CO, NO, $SO_2$, PM, $CH_4$ was monitored at six (06) points located in the Study Area;
- The noise level monitoring was carried out in the Study Area at six (06) locations;
- The surface water body in the Study Area are Swat River, Kabul River, LSC & Doba Canal;
- Bacterial analysis was also carried out for surface water. Total thirteen (13) samples were collected and tested. Fecal coliform was detected in eleven (11) samples; and
- Total eighteen (18) samples of groundwater were collected and tested. Fecal coliform was detected in thirteen (13) samples.

**Ecological Environment**

The major Flora of the proposed Project area, Catchment area and Canal area are discussed below:

At higher elevations, sparse pines i.e. Chir Pine (*Pinus roxburghii*) Chilgoza (*Pinus genardiana*) and some Waghz / Walnut (*Juglans regia*) trees are found along with broad leaf species and at the lower elevations it includes the following: -

Palosa / Phulahi (*Acacia modesta*) Kikar / Babool (Acacia nilotica).Ficus species such as Pipal / Barh, Indzar (*Wild Fig / Injeer*). Tut / Mulberry (*Morus alba*), Ghaz / Frash (*Tamarix articulate*), Ber / Berra (*Ziziphus species*) Mesquite (*Prosopis juliflora*), Bakain (*Melia azedarack*), Shisham / Shawa (*Dalbergia sissoo*), Gandeera (*Rhazyastricta*), Gurgura (*Monothecabxifolia*) Castor / Arind (*Ricinus communis*) etc. Groves of Palosa (*Acacia modesta*) are found in graveyards and at inaccessible heights indicating past richness of natural vegetation. Primarily the lower elevations of catchment area contain Kao / Olive (*Olea cuspidate*), Phulahi (*Acacia modesta*) scrub vegetation zone on account of undulations edaphic factors, low rainfall, and arid conditions.

Large scale destruction of forests and overgrazing has adversely affected the faunal population in the proposed Project area, Catchment area and Canal area. The habitat degradation and uncontrolled hunting has also contributed much to the loss of suitable habitat for wildlife. Many wild animals and birds have migrated to higher "safe heavens". This has also upset the breeding behavior of wildlife species. Fauna of the Catchment Area consists of Birds, Mammals, Reptiles and Amphibians.

Avifauna in the proposed Project area, Catchment area and Canal area is in plenty. Birds seen and reported in the area are Chukor (*Alectoris chukar*), Pigeon (*Columba livia*), Quail *(Cotrunix coturnix),* Grey partridge (*Francolinus pondicerianus*), Black partridge (*Francolinus francolinus*), Shikra (*Accipeter badius*), House Crow (*Corvus splendens*), Falcon (*Falco peregrinus) etc.*

Major Mammals include Rhesus Monkey (*Macaca mulatta*), Wild hare (*Lepus nigricollis*), Jackal (*Canis aureus*), Porcupine (*Hystrix indicus*), Jungle cat (*Fellischaus*), Wild boar, and Leopard (*Panthera pardus*) (only rarely seen).

Reptiles reported are Cobra (*Naja naja*), Indian Krait (*Bungarus caerueus*), Spiny Tailed Lizard (*Uromastix hardwickii*), Brown Turtle (*Kachuga smithii*) etc.

Amphibians found in the proposed Project area, Catchment area and Canal area and its nearby vicinity include common Frog (Rana tigrina) and common Toad (Bufo bufo).

Presently fish fauna of the proposed site comprising 16 species have been identified by the JICA Feasibility Study, out of which following fish are of high economic value:

- Tor Putitora (Mahseer);
- Schizothorax Plagiostomus (Asaala);
- Schizopyge Esocinus (Swati); and
- Clupisoma Naziri (Sher-mahi).

**Socioeconomic Environment**

Baseline information was collected from Project affectees through field surveys. Potential affectees are categorized as direct and indirect. The person whose land and houses or any other structure will be directly affected due to proposed Project activity are called direct PAPs while indirectly affected are those people who will have to face impacts of proposed Project indirectly.

The area lying downstream of the Mohmand Dam Axis is fertile except the area extending from Mohmand Dam site to Munda Headworks which is mostly mountainous and barren with only scrub plantation on the hillsides with some terraced agriculture in the lower elevations.

This area is famous for the production of wheat and sugarcane; however, vegetables are also grown. Mango fruit trees / orchards are visible near Munda Headworks. The two main canals which

originate from Munda Headworks i.e. LSC and the Doaba Canal have been used to irrigate this area.

The people of this area are generally poor but very hardworking and hospitable. The majority of the people in this area are Pathans / Pakhtoons mostly Pashto speaking, however the national language i.e. Urdu is also commonly understood. Like other rural areas of the country, the unemployment rate is quite high in this area. Most of the workers are daily wage earners / labourers who depend on their daily earnings for living and farmers who cultivate the little piece of land they own. There are few skilled workers, who own small businesses such as auto repair shops or work as cobblers, masons etc. The average monthly income for the majority (39%) of the respondents was found to be ranging from Rs. 5,000 – Rs. 8,000 per month with the monthly expenditure almost the same and in certain cases, exceeding the monthly income to meet the pressing needs for child education and / or health related expenditure thus putting the poor rural people under debt.

The villagers living on both sides of the River Swat have no access to basic health facilities (except going to either the Tehsil / District Headquarter Hospitals). Only 12% of the surveyed villages had a BHU facility. There are 18 primary schools for young children (boys / girls). But high schools are available in only selected villages. There is no major industry, however a number of molasses mills are found. The main road(s) connecting Tangi, Shabqadar and Charsadda are in fairly good condition but some of the link roads from main road(s) to the villages are either too narrow or not in a satisfactory condition. This is an agricultural area, therefore most of the people own live stock for domestic use as well as for commercial purposes. Goats, cows and buffaloes are the main livestock of the area. Electricity is mostly available in the villages. Out of the total 114 people surveyed in 25 villages, 63 were married and 51 were unmarried. Since most of the people of this area are poor with meagre income, they normally live in semi-pakka houses made of stone / mud. Electricity is available in 88% of the villages. However public water supply system is available in only 4% of the villages.

The major tribes in Mohmand Agency are Mohmand Tarak Zai, Halim Zai, Khwae Zai, Bai Zai, Safi, Qandhari, Gur baz, Mahsud, Shinwari, Utman Khel. The two major tribes inhabiting the Bajaur Agency are Tarkanai and Uthman Khel. Many of the people are aware about the Mohmand Dam Project; due to the fact that project preparation feasibility / investigations in the area have been going on for a long time. Majority of the people in the area support the proposed Dam Project because it is good for the country. However, they want to be judiciously and fairly compensated for any sacrifice they make. Based on the affected survey, most of them supported the construction of the Dam, with some minor exceptions.

**STAKEHOLDER CONSULTATION**

Stakeholders, especially the local population, involvement is an important feature of the EA and can lead to a better and more acceptable decision-making regarding the Project design and implementation. As a part of EIA studies consultations with the Proponent (WAPDA) was carried out at the start of study.

The primary stakeholders include all the project affected households/persons (PAP's) according to their loss of assets and living conditions, local Governments of KP and FATA, Provincial Environmental Protection Agency (EPA), KP, FATA Secretariat, FATA Development Authority, Irrigation Department FATA and District and Agency level line departments of Mohmand Agency and District Charsadda and any international donor agencies, NGO's whereas the secondary stakeholders include the public and private agencies involved in the implementation of the project. Following major stakeholders identified and consulted during the study:

WAPDA; Planning & Investigation Cell;

- WAPDA Environmental Cell (WEC);
- Government of KP;

- FATA Secretariat and its line departments; and
- FATA Development Authority.

Following line departments of the Government of KP and FATA Secretariat;

- Fisheries & Wildlife Department;
- Forest Department;
- Archeology Department;
- Livestock Department;
- Irrigation Department;
- Agricultural Department;
- District Planning Office;
- Revenue Department.
- Political Agent (PA) and Assistant Political Agent(s), Mohmand/ BajaurAgency;
- Environmental Protection Agency, KP
- NGOs; IUCN, WWF etc.
- PAPs of Reservoir Area;
- Fishermen and local residents living on both sides of Swat River downstream of MohmandDam Axis to the confluence of Swat & Kabul River;
- Residents of Lower Riparian Area (Downstream of Kabul River / Swat River Confluence); and
- Project Consultants.

Feedback received during public consultation are related to the willingness of people to accept project, compensation for their effected crops, livelihood, electricity and compensation/relocation/resettlement while concerns include drinking water supply and sewerage, health facilities, road infrastructures, education, women issues, agriculture and security. Project related concerns and feedback by the PAP were mostly related to their privacy, benefits associated with the project, any special provision related to jobs.

**ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION MEASURES**

With the implementation of the proposed Project following major positive impacts are foreseen:

- Provision of Water Storage;
- Energy Production;
- Protection against Devastating Floods;
- New Irrigation Facilities / Canals;
- Agriculture Benefits;
- Provision of Water Supply to Peshawar City;
- Infrastructure Development;
- Fuel Saving Benefits;
- Emission Reduction ($CO_2$) Benefits;
- Employment Opportunities; and
- Socio-Economic Uplift.

Some of the indirect benefits envisaged due to the increase of electricity in the national grid are as follows:

- Due to the construction of the main canals, the head available can be utilized to generate additional power of 19.5 and 17.7 Giga Watts Hours (GWh) by installing low head power generators on the left and Right Bank Main Canals (RBMC);

- The reservoir area i.e. 24 $km^2$ having length of 56 km will itself prove a large habitat for fisheries & wildlife as has been experienced in the case of Tarbela, Mangla & other dams / barrages in the country.
- Enhancement and improvement of the local economy due to enhanced irrigation facilities, and consequent benefits, which will create additional employment opportunities at the local level (for instance mechanics for modern machinery & equipment for irrigation);
- New roads / infrastructure in the form of access roads to the Dam area;
- New recreational facilities due to proposed reservoir and a new recreational park;
- Chances of new employment opportunities for local people during the construction and operation of the Mohmand Dam / Powerhouse and / or related facilities;
- Due to the implementation of the Project, availability of electricity will be increased;
- The increased crop production will stimulate business and employment opportunities for the labor in form of handling, transportation, marketing, processing, etc. of agriculture produce;
- The value of project area lands will be appreciated considerably due to their higher productive potential as a result of additional assured water availability; and
- Due to the availability of canal water on perennial basis, groundwater table will rise considerably.

Potential adverse impacts are also classified based on the anticipated stages of the Project i.e. Pre-construction, Construction and Operational stage. Following are the major adverse impacts of the Project.

- The total land to be acquired for the Project Area structures is about 1,399.6 acres, impounding of 24$km^2$ area. 268.65 acres for the construction of the main canals and about 771 hectares for establishment of contractor camps, storage areas for materials and equipment including vehicles, workshops, stockpile rock excavation, Electrical and Mechanical (E&M) yard and transfer areas. Impounding of reservoir area will affect 21 villages; Fourteen (14) villages are situated on the right bank and seven (07) villages on the left bank. The major impact due to the implementation of the proposed Project will be the loss of land and the land based assets in the reservoir area. These include land such as agricultural, rangeland and barren, private properties like residential houses, shops, trees, private infrastructure like sheds for livestock (animal penning area), open surface wells, irrigation water courses etc. Land to be lost in the reservoir area is classified into four categories i.e. Agricultural Land, Range Land, Barren Land, and River Bed.
    - Permanent land will be acquired as per LAA. It is recommended that existing market price of the land should be paid to the landowner. In this regard, proper RP should be prepared and implemented prior to the construction of the proposed Project. Owners of the lands under built-up residential/ commercial structures and similar other assets will be paid land compensation at current open market values, or negotiated with or decided by the Jirga of tribal elders and FATA Administration office.

      The land for construction camps and other related facilities should be selected and leased prior to the start of construction phase. Land will be directly rented from the private landowners by the Contractors. The provisions of the LAA will not be involved as the acquisition of the land will be temporary and will be covered by short-term lease agreements between the landowners and Contractor. Rental terms should be negotiated to the satisfaction of the concerned landowners and the agreement should be in local language to make the process clear.
- Based on the ecological surveys and processed satellite imageries, In an area of 5756 acres, 0.435 trees per acre were considered which is about 20% of average trees 4.35 per

acre. Total number of estimated trees to be removed for the reservoir area is about 5810. Moreover about 1000 Nos. of estimated trees to be removed within ROW of 40 meters, during the construction of the main canals on the left and right banks with a length of 12.37 and 14.7 km were estimated. About 146 Nos. of estimated trees to be removed in Project Area.

  - The loss of trees will be mitigated through plantation of native species in the adjoining areas in clusters. The lost trees will be replaced at a minimum ratio of 1:4. For timber trees: trees grown and/or used for timber then compensation is to reflect the market value of tree's wood content, based on the wood measurement survey of forest department.

- Infrastructure in twelve (12) villages will be submerged in reservoir due to impounding. A graveyard located within Katwi village will be submerged, due to the impounding of the reservoir.
  - Equivalent replacement infrastructure cost will need to be provided to ensure that no person is worse off as a result of the loss due to the proposed Project. In order to restore the access in better condition a new bridge will be constructed after the negotiation with tribal/village elder's Jirga and by the FATA secretariat officials by following the principle of negotiation. The relocation of graveyards is a sensitive issue and the demands or willingness of the custodian family members should be given preference.
- Development of construction camps in the project area will generate a significant quantity of liquid waste. The proposed area of 67,800 $m^2$ is available for Contractor's camp. The sufficient number of construction personnel is considered for the project, the building area per capita is $8m^{2.}$ Approximate proposed strength of the population is about 8,475 at this stage. As a general rule the water consumption will be about 30 gallon/capita/day (113.4 liter/capita/day). Hence water demand, on average, will be 951 $m^3$/day for construction camp during the construction stage and estimated generated wastewater will be about 720.8 $m^3$/day. Disposal of wastewater without treatment will pollute the soil and groundwater.
  - Domestic and chemical effluents from the construction camp should be disposed by the development of on-site sanitation systems i.e. septic tank along with soakage pits, prior to discharge to Swat River as Lower Riparian are taking water for drinking purpose from Swat River. Septic tank will be located adjacent to the construction camp. Proper monitoring to check the compliance of NEQS will be carried out. The domestic sewage will be treated with biological treatment technology and will be discharged as per NEQS. Toxic waste will be handled, stored, transported and disposed separately.
- Camps will generate about 0.5 kg/person/day domestic solid waste comprising kitchen waste, garbage, putrescible waste, rubbish, and small portion of ashes and residues. Estimated quantity of solid waste will be about 4,237.5 kg/day. Improper waste management activities can increase disease transmission, contaminate ground and surface water and ultimate damage to the ecosystem.
  - All the solid waste from the camps should be properly collected at source by placing containers and disposed of through proper solid waste management system. The Contractor will coordinate with local representatives and concerned authorities, if any, for the disposal of solid waste. Solid waste will be segregated at source so that it can be re-used or recycled. Toxic waste will be handled, stored, transported and disposed separately.
- During construction activities, lot of noise and noxious gases will be produced from the heavy construction vehicles, machinery and other activities which will scare away birds,

wildlife, rodents and reptiles. Some of the reptiles and small mammals may get killed during movement of the machinery. Labor force working in the area will have tendency to catch or kill the wildlife, especially the avifauna, which visit the area in search of food.

  - To minimize the loss of wildlife and avifauna during construction stage, over speeding shall be prohibited. Construction machinery, vehicles and equipment shall remain confined within their designated areas of movement to avoid accidental killing of fauna. Noise control measures can be enforced during the construction phase. Hunting, poaching and harassing of wild animals and birds should be strictly prohibited and the Contractor shall be held responsible for any such act of his staff, conduct awareness campaigns among staff, labor and community on the need to conserve nature.

- Construction activities, machinery operation and blasting, movement of equipment, vehicles and other anthropogenic activities will disturb the scenic view and cause deterioration of the ambient air quality due to the dust and emissions as well as noise and vibrations.
  - Constant sprinkling of water on the service roads and dirt tracks to avoid the deterioration of air quality in reservoir area, project area and main canal areas. Concrete batching plants should be equipped with dust control equipment such as fabric filters or wet scrubbers to reduce the level of dust emissions. Choice of technology to be adopted to mitigate the dust emission will be finalized by the contractor. Quarry development plan for each site will be prepared prior to the start of construction stage. Material crushing plants at quarry sites should be sited at least 500 m away from main noise sensitive areas so that the noise generated by these operations does not have any significant adverse impact on the community. Heavy duty machinery should be provided with mufflers in order to reduce the noise to within acceptable limits
- Existing drainage pattern will be changed during the construction and especially during floods.
  - To reduce the impact of the attenuated floods, diversion dams, weir schemes and other drainage structures should be proposed in the lower riparian area at appropriate locations.
- As the Project activities, will be carried out within the residential/agricultural areas of the local community, as a result various activities in the field may be affected during the construction stage.
  - The contractors would be aware of the possibility and risks of miscommunications between local residents and workers, a situation which easily could lead to social unrest. This would be prevented by raising awareness and implementation of a Code of Conduct for the workers. Complaints from the local community will be addressed by the grievance redress mechanism.
- The induction of outside labor may create social and gender issues due to the unawareness of local customs and norms. It will also cause hindrance to the mobility of the local women. There could also be theft problems for the community due to contractor's workers and vice versa.
  - The Contractor will be required to maintain close liaison with the local communities to ensure that any potential conflicts related to the common resource utilization for the Project purposes are resolved quickly.
- Surface water quality of the natural streams / nullahs and the other water bodies may get damaged due to the construction activities.
  - The excavated material will be managed by ensuring proper storage areas located far away from the water bodies. It will not cause the siltation of the Swat River. The

blasting operations should be planned/ designed in such a way that all the standard procedures should be followed. The proper quarry development plan will be developed to cater the quarry site impacts Wastewater effluent from the Contractors 'workshops and equipment washing-yards should be passed through gravel/sand beds to remove oil/grease contaminants before discharging into the natural streams. Sewage after treatment is to be discharged on to the land it should meet the requirements of the NEQS for disposal of wastewater.

- During the construction phase, the general mobility of the local residents and their livestock in and around the Study Area is likely to be hindered.
    - The contractor will ensure that the mobility of the local communities and their livestock is not hindered by the construction activities. The contractor will provide temporary crossing points at appropriate places to facilitate the people for going across the main canals for their daily works and having free access to the natural resources. The contractor will always consider the local sensitivities while performing the project activities.
- The Sappare quarry has two major limestone beds which will yield sufficient quantity. The Todobo quarry has quartzite and quartz mica schist as main rock units. Huge quantity of rock fill material is required for the construction of dam. Development, excavation, loading and transportation of material from each site will create various adverse impacts on the existing environment.

  Transportation of material from the quarry sites to the dam site will be a major task involving movement of heavy vehicles. Development, excavation, loading and transportation of material from each site will create various adverse impacts on the existing environment and nearby population including workers.
    - Proper quarry development plan for each identified quarry area should be made prior to the execution of work. Plan will include all the infrastructural requirements of each site and implementation plan for the development of each quarry site in an environmental friendly manner. Blasting operations be carried out in a controlled manner to avoid any danger or damage to human life and / or property.
- Usage of community common resources like potable water, fuel wood etc. by Contractor workforce may create conflicts between the community and the Contractor.
    - This potential impact would be mitigated by requesting the contractors to procure their supplies in a manner not significantly affecting the availability of essential commodities in the area for the residents. Contractor should setup their own shops, shopping areas and availability of other commodities. Grievance redress mechanism will be established to address community complaints and grievances.
- Due to the impounding of the reservoir, an old pathway through the river will be lost forever and the locals may have to travel long distance as an alternative.
    - The access road to the dam site and along the reservoir rim will be constructed to give an access to the nearby villages affected by loss of access
- Currently, the water of Swat River is being used for various purposes such as irrigation, livestock and human consumption. This water also recharges the groundwater table of the lower riparian area along with other hill torrents. Due to the construction of the dam, supply of water to the lower riparian area will be attenuated. Peaks will be flatter hence water might not reach the areas where water reaches under current situation.
    - A Drinking Water Management Plan, based on separate water supply and sanitation for the work force, will have to be prepared by the contractor. In designing such a plan, it is important to maintain and safeguard the water supply and sanitation facilities for the local population

- Fish population will be adversely affected, resulting in partial reduction in species and their number.
    - Overall impact on the lower riparians will be a decrease in the fish production. Lake/ Reservoir created by reservoir can be beneficially harnessed for protein rich fish for which adequate technical know-how and infrastructure is available with the Directorate of Fisheries FATA, Secretariat.
- It is anticipated that due to the impounding of reservoir, some areas in the immediate vicinity of the reservoir may be prone to water logging and salinity.
    - The potential impact of water logging and salinity in the command area needs to be verified through sub-surface hydrogeological studies and suitable remedial measures.
- During operation stage, hazard of landslide are the main problems in the reservoir include: direct damage to civil structures of dam, landslide dam-break flooding and reduction of reservoir capacity.
    - Any blasting activities in these areas will be controlled and contained within defined limits. Pro-active measures will be implemented to stabilize and protect slopes and to protect workers' safety. Early warning systems will be introduced that will indicate when cracks appear and allow any widening to be monitored.

**ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)**

Environmental Management and Monitoring Plan (EMMP) has been developed. The main objectives of the EMMP are:

- Provide the details of the Project impacts along with the proposed mitigation measures and the corresponding implementation activities;
- Define the role and responsibilities of the Project Proponent, Contractor, Supervisory Consultants (SC) and other role players and effectively communicate environmental issues among them;
- Define a monitoring mechanism, reporting frequency and identify monitoring parameters to ensure that all the mitigation measures are completely and effectively implemented; and
- Identify the resources required to implement the EMMP and outline the corresponding financing arrangements.

An Environmental Mitigation & Management Matrix (MMM) for the proposed Project are attached in the EMMP, which establishes the linkages between the environmental and social impacts, mitigation strategy and the agencies responsible for execution.

Major role players for the implementation of EMMP are WAPDA (through WEC), Project contractor, supervisory consultant, EPA, KP and local government and non-government organizations. Roles and responsibilities along with their existing setup and capacity and recommendations for further capacity enhancement and training needs are also suggested. It is highlighted that although the responsibilities for executing and monitoring the mitigation measures have been delegated to different organizations, WAPDA will hold the primary responsibility for ensuring the full implementation of EMMP.

EMMP includes the Monitoring Mechanism, Monitoring Plan, Site Restoration Plan Guidelines, Solid and Hazardous Plan Guidelines, Chance Find Procedures, Tree Plantation Plan, Documentation Plan, which will ensure that the proper results are achieved by the implementation of measures from concerned entities. The monitoring of environmental and social activities will be carried out by WAPDA through Environmental and Social Experts from their Environmental Cell or hired staff by WAPDA Internal Monitoring agency. The Environment and Social Expert working under the WAPDA

field staff will supervise all the activities in the field and will provide assistance to the WAPDA staff in this regard. He will also ensure public participation. Monitoring and Evaluation (M&E) is also proposed in the EMMP.

The resettlement/compensation costs relate to the compensations for acquisition of land in the reservoir, project area and main canals due to the loss of trees, structures, infrastructure etc. The cost of land was calculated based on the discussions with stakeholders, PAPs and market rates of the area.

To assess the replacement cost of the structures, similar newly constructed structures were considered and the cost assessed by consultation with the owners of these structures.

The cost for environmental monitoring is based on the sampling, transportation and analysis of the samples by EPA approved private laboratory along with the security cost.

Cost for training is based on training workshops both on environmental and social issues and the hiring of services of Environmental and Social Consultants and developing reading materials required for distribution amongst the participants of the workshop.

The total estimated cost for the environmental and social management, monitoring and auditing comes to about Rs. 10,560 Million.

**CONCLUSION AND RECOMMENDATIONS**

Based on the available data, assessed impacts and the proposed mitigation and compensation measures to alleviate the adverse impacts, management and monitirng plans, it can be safely concluded that “Mohmand Dam Project” will bring economic improvement for the locals especially to the cultivators of new and existing command areas and mitigate the destruction of floods in the lower reparin/downstream areas, help to overcome the electricity crisis and overall development of the country. RP Planning studies are required which are covered as a PRF report. Adequate provision has been made in the Project to compensate for the shortfall of flows to Swat River and to cater for the water rights of the lower riparian. Hence Mohamnd Dam Project is recommended for early implementation.

**This Space has been Left Intentionally Blank**