P E D O

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZA

Government of Khyber Pakhtunkhwa

No. ***1132****/ PEDO / PD I JB*
Dated Peshawar the ***22 / 05 /2017****.*

To

The Registrar
National Electric Power Regulatory Authority (NEPRA)
NEPRA Tower
G-5/1, Islamabad.

Subject: **Application for Grant of Generation Licence**

I, Mustafa Kammal Khan, Project Director Jabori Hydropower Project (10.2MW) being the duly Authorised Representative of Pakhtunkhwa Energy Development Organization (PEDO) by virtue of authority letter No. 1098/PEDO/PD/JB dated 25/04/2017 here by apply to National Electric Power Regulatory Authority for the grant of a Generation Licence to PEDO for Jabori Hydropower Project (10.2 MW), pursuant to the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999 and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

It is respectfully requested to your good office that fee amount of Pak Rupees two hundred eleven thousand four hundred and sixty four (Rs. 211,464) was paid through bank draft no BBB 11048974 drawn on Allied Bank, ABL Tower Branch, Hayatabad, the same amount is with NEPRA as the application dated January 25, 2016 was returned un admitted vide NEPRA letter NEPRA/R/LAG-30/4307 dated April 04, 2016. It is humbly requested that the same amount of fee already paid be considered as deposited. In addition to above a bank draft No.BBB-12690978 drawn on ABL Tower Branch Hayatabad Phase-V, Peshawar to the amount of Pak Rupees Thirteen Thousand Seven Hundred and Eighty Eight (Rs. 13, 788) being the balance to match applicable fee for May, 2017 being the non-refundable licence application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Project Director
Jabori HPP, PEDO,
Peshawar.

Check List for Examination of
New Generation Facility (Hydel) - License Application

Name of Company: Pakhtunkhwa Energy Development Organization (PEDO)
Capacity: 10.20 MW
Prepared/Updated on: _____

Regulation	Information/Documents Required	Compliance		Remarks
		Yes	No.	
3(1)	Authorization from Board Resolution / Power of Attorney	Yes		Attached
3(3)	Application fee (including Indexation)	Yes		Draft Attached
3(4)	Three copies of Application	Yes		Complied
3(5)(a)(i)	Certificate of incorporation		No	PEDO is a public sector organization constituted under SHYDO Act 1993 and is Exempt under Section 24 of NEPRA Act and thus not required
3(5)(a)(ii)	Memorandum and articles of association	Yes		PEDO is a public sector organization constituted under SHYDO Act 1993.Notification for renaming to be provided by PEDO.
3(5)(a)(iii)	Annual Return statements or in lieu thereof		No	PEDO is a public sector organization constituted under SHYDO Act 1993 and therefore, not required to submit annual Return Statement
3(5)(b)	Profile of experience of the applicant its management, staff and its members in power sector.	Yes		Attached
3(5)(c)	CVs of applicant's Senior Management and Technical professionals	Yes		Provided
3(5)(d)(i)	Cash balance & bank certificates		No	PEDO is a public sector organization constituted under SHYDO Act 1993 and therefore, it is not required
3(5)(d)(ii)	Expression of interest to provide credit or financing along with sources and details thereof		No	Project is funded by PEDO from its own resources and ADP and therefore not required .(To be confirmed from PEDO)
3(5)(d)(iii)	Latest financial statements		No	PEDO is a public sector organization constituted under SHYDO Act 1993 and therefore, not required to submit annual Return Statement
3(5)(d)(iv)	Employment records of Engineers & Technical Staff	Yes		Provided
3(5)(d)(v)	Profile of Sub-contractors	Yes		Attached
3(5)(d)(vi)	Verified references w.r.t. experience of the Applicant and its sub-Contractors	Yes		EPC awarded under PEC rules after ICB and complete verification of contractors. Arranged by MC
3(5)(e)	Encumbrances on assets	Yes		N/A

3(5)(f)	Technical and financial proposal for Operation, maintenance, planning and development of the generation facility.	Yes		EPC Contract has been awarded to GRC JV whereas O&M will be done by PEDO through its own staff.
3(5)(g)(a)	Type of Technology	High head Hydel		Provided
3(5)(h)	Feasibility Report	Yes		Provided
3(5)(i)	Prospectus	Yes		Provided

Cont'd....P/2.

Schedule II				
1.	Location (location maps, site maps) land	District Mansehra		Provided
2.	Plant: run of river, storage, weir	Run of River		Provided
3.	Head: Minimum, maximum			Maximum Net Head-148m Minimum Net Head-146m
4.	Technology: Francis, Pelton, etc. Size, number of units.	Francis		Francis,2x5.1 MW
5.	Tunnel (if proposed): length, diameter	Yes		L-2895m Dia-2.65m
6.	ESSA (Environmental and Social Soundness Assessment)	Yes		Provided
7.	Detailed feasibility report	Yes		Provided
8.	Resettlement issues	No		Settled
9.	Consents			EIA and land acquisition already approved. Customs and other duties at concessionary rates will be applicable as per GOP/GoKPK Policy.
10.	Infrastructure development			Included in EPC
11.	Interconnection with National Grid Co. distance and name of nearest grid, voltage level (single line diagram)	Yes		Consent Letter from PESCO. The interconnection scheme for the Power dispersal from Jabori Hydro Power Plant would be through 132 Kv transmission Line to PESCO, Battal Grid station in District Mansehra
12.	Project cost, information regarding sources and amounts of equity and debt.	Yes		Estimated Project Cost-Rs3798.260 million, funding provided by PEDO
13.	Project schedule, expected life			Constperiod:30 months,Project life 30 years, can be extended to 50 years.

14.	Peaking/base load operation			No peaking
15.	Plant characteristics: generation voltage, power factor, frequency, automatic generation control, ramping rate, control metering and instrumentation			Generating Voltage -11 KV Frequency --50 Hz Power Factor - Leading 0.95 & Lagging 0.8 Automatic Generation Control --No Ramping Rate -10 minutes Alternative Fuel -No Auxiliary Consumption -0.306 MW (3% of installed capacity) Time required to Synchronise -5 minutes
16.	System studies load flow, short circuit, stability	Yes		Attached with the Application
17.	Training and development			Details provided in the EPC Contract

PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

Government of Khyber Pakhtunkhwa

No. 1098 / PEDO / PD / JB
Dated Peshawar the 25 / 04/ 2017

To

The Registrar
National Electric Power Regulatory Authority (NEPRA)
NEPRA Tower
G-5/2, Islamabad

Subject: **Authority Letter.**

Mr. Mustafa Kammal S/O Muhammad Ayaz Khan Bearing CNIC No. 17301-1679845-9 is hereby appointed as authorized representative of Pakhtunkhwa Energy Development Organization (PEDO), for the purpose of filing an application for determination of tariff for Jabori Hydropower Project (10.2 Mw) and to submit before NEPRA, an application for grant of Generation License for the said project. He is also authorized to attend any meeting(s) and discussions related to the determination of tariff and grant of generation license and to provide any information and grant of generation license to provide any information & documents needed in this regard.

Akbar Ayub Khan
Chief Executive Officer
Pakhtunkhwa Energy Development Organization (PEDO), Peshawar

Article – 1

Definitions

(1) **In this Licence:**

a. "Act" means the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 (XL of 1997);

b. "Authority" means the National Electric Power Regulatory Authority constituted under Section 3 of the Act.

c. "Licensee" means Paktunkhwa Energy Development Organization (PEDO) Jaboori Hydropower Project

d. "Rules" mean the National Electric Power Regulatory Authority Licensing (Generation) Rules, 2000.

(2) Words and expressions used but not defined herein bear the meaning given thereto in the Act or in the Rules.

Article – 2

Application of Rules

This Licence is issued subject to the provisions of the Rules, as amended from time to time.

Article – 3

Generation Facilities

(1) The location, size, technology, interconnection arrangements technical limits, technical functional specifications and other details specific to the generation facilities of the licensee are set out in Schedule - I to this Licence.

(2) The net capacity of the generation facilities is set out in Schedule - II hereto.

(3) The Licensee shall provide the final arrangement, technical and financial specifications and other details specific to generation facilities before commissioning of the generation facilities.

Article – 4

Term

(1) The Licence is granted for a term of ***thirty (30) years*** after the commercial operation date.

(2) Unless revoked earlier, the licensee may, ***ninety (90) days*** prior to the expiry of the term of the licence, apply for renewal of the Licence under the Licensing (Application and Modification Procedure) Regulation, 1999.

Article – 5

Licence Fee

The Licensee shall pay to the Authority the Licence fee in the amount and manner and at the time specified in the National Electric Power Regulatory Authority (Fee) Rules, 2002.

Article – 6

Tariff

The Licensee shall charge from its consumers only such tariff which has been approved by the Authority.

Article – 7

Competitive Trading Arrangement

(1) The Licensee shall participate in such measures as may be directed by the Authority from time to time for development of the Competitive Trading Arrangement. The Licensee shall in good faith work towards implementation and operation of the aforesaid Competitive Trading Arrangement in the manner and time period specified by the Authority:

Provided that, any such participation shall be subject to any contract entered into between the Licensee and another party with the approval of the Authority.

(2) Any variation and modification in the above mentioned contracts for allowing the parties thereto to participate wholly or partially in the Competitive Trading Arrangement shall be subject to mutual agreement of the parties thereto and such terms and conditions as may be approved by the Authority.

Article – 8

Maintenance of Records

For the purpose of sub-rule (1) of Rule 19 of the Rules, copies of records and data shall be retained in standard and electronic form and all such records and data shall, subject to just claims of confidentiality, be accessible by the authorized officials of the Authority.

Article – 9

Compliance with Performance Standards

The Licensee shall conform to the relevant NEPRA rules on Performance Standards as may be prescribed by the Authority from time to time.

Article – 10

Compliance with Environmental Standards

The Licensee shall conform to the environmental standards as may be prescribed by the relevant competent authority from time to time.

Article – 11

Provision of information

(1) The obligation of the licensee to provide information to the Authority shall be in accordance with Section 44 of the Act.

(2) The licensee shall be subject to such penalties as may be specified in the relevant rules made by the Authority for failure to furnish such information as may be required from time to time by the Authority and which is or ought to be or have been in the control or possession of the licensee.

Schedule – 1

It contains the following information / drawings / sketches relating to the Power Plant Equipment and related System which are attached here with:

Plant Details

- General Information
- Plant Configuration
- Fuel Details
- Emission Values
- Installed Capacity
- Derated Capacity
- Expected Life
- Operation Record
- Cooling System
- Plant Characteristics
- Other details specific to the generation facility of the licensee such as:
    - Technical Limits of the Plant
    - Site Plan of Ranolia Power Plant
    - General Layout of entire Ranolia Power Plant
    - Interconnection Arrangements with National Grid

Plant Details

1. General Information

- Name of Applicant: Paktunkhwa Energy Development Organization (PEDO) , Jabori Hydropower Project

- Address of the registered office : PEDO House,38-B2,Phase-5
- Plant Location : Jabori, District Mansehra , Province of Khyber Pakhtunkhwa

- Type of Facility : Run of River Hydropower Project

Plant Configuration

- High Head Hydropower turbines
- Capacity of the Power Plant (Net Power Output)
- Type of Technology : High Head Hydropower

- Number of Units / Capacity - : Two units / 5.1 MW each
- Power Plant Make and Model –Francis turbine and Horizontal Generators
- Commissioning Date ----26 May,2017

Fuel Details

- Type of Fuel : Hydropower Project
- Fuel (Imported / Indigenous) NA
- Fuel Supplier NA

- **Emission values**

- SOx ---------- NA
- NOx ---------- NA
- CO ---------- NA
- PM10 ---------- NA

- Installed Capacity –10.2 MW

2. Derated Capacity **No Derating as compared to ISO**

3. Expected Life of the Facility ---------- 30 years

7. Operation Record ----------New Plant to be commissioned by May 2017.

4. Plant Characteristics

- Generating Voltage ---------- 11 KV
- Frequency ---------- 50 Hz
- Power Factor ---------- Leading 0.95 & Lagging 0.8
- Automatic Generation Control ---------- No
- Ramping Rate ---------- 10 minutes
- Alternative Fuel ----------No
- Auxiliary Consumption ----------0.306 MW (3% of installed capacity)

Time required to Synchronise ---------- 5 minutes

SCHEDULE – II

The Net Capacity of the Licensee's Generation Facility

- Gross Installed Capacity of the Plant (ISO) ---------- 10.20 MW
- De-rated Capacity of the Plant ---------- 9.894 MW
- Auxiliary Consumption of the Plant ---------- 0.306 MW
- Net Capacity of the Plant ---------- 9.894 MW
- Construction Period ---------- 30 months
- Expected date of Commercial Operation of the Plant – **May 2017**

Note: These are indicative figures provided by the Licensee.

The Net Capacity of the Plant available for dispatch to Power Purchaser will be determined through procedures contained in the EPC Agreements or Grid Code

Interconnection Arrangement with National Grid for Power Dispersal of the Plant

The interconnection scheme for the Power dispersal from Jabori Hydro Power Plant would be through 132 Kv transmission Line to PESCO, Battal Grid station in District Mansehra

KHYBER PAKHTUNKHWA HYDEL DEVELOPMENT ORGANIZATION

1. Introduction

Khyber Pakhtunkhwa Province of Pakistan is blessed with huge hydropower potential. This potential remained focus of interest to private investors and international funding agencies. Most of the hydel projects of Pakistan including Tarbela and Warsak hydropower stations are located in KP.

Pakhtunkhwa Energy Development Organization (PEDO), since its inception in 1986, has been instrumental in identifying and exploiting hydel potential in Khyber Pakhtunkhwa. The organization is under the administrative control of Energy and Power Department of Provincial Government and is governed by the Board of Directors. PEDO has so far identified a number of promising hydel potential sites of more than 6000 MW capacity, which can be developed in a systematic manner either through Public sector or Private sector.

i. Objectives of the Organization

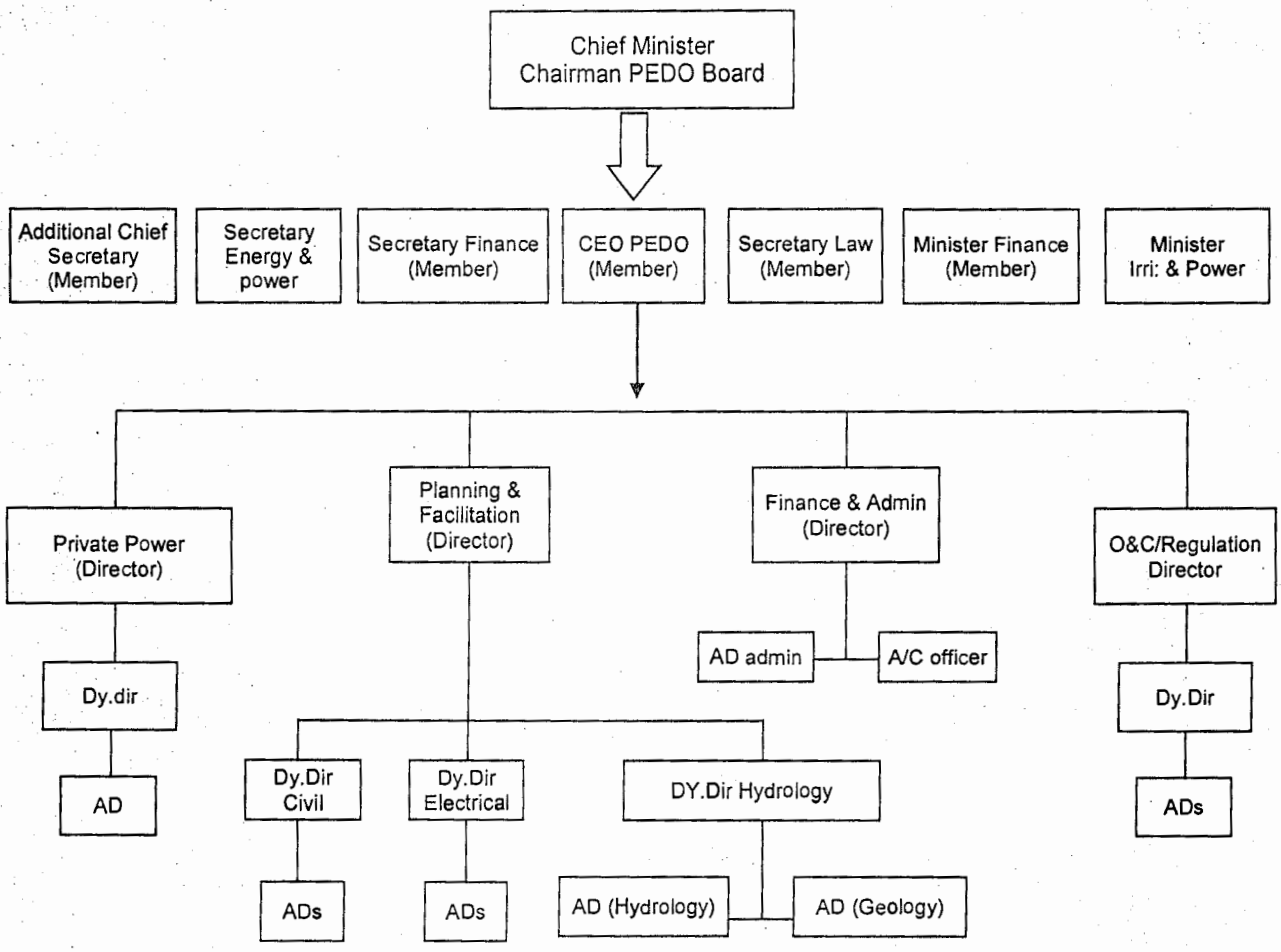
- Prepare comprehensive plan for development of the power and energy resources of the province.
- Frame schemes related to Generation, Transmission and Distribution of power, construction, maintenance and operation of powerhouses.
- Advisory body for the Government of KP in power sector matters regarding hydropower development.
- Conducting feasibility studies, surveys of hydel potential sites etc.
- Implementation of Provincial Hyde-l Power Policy to promote private sector investment in generation, transmission and distribution of power.

ii. Role of PEDO

The Provincial Government has entrusted a dynamic role to PEDO, which mainly oriented towards private sponsors participation in power sector projects besides developing projects in public sector. PEDO has established a dedicated Directorate to provide one window facility to private sponsors.

iii. PEDO Organization

An eight member Board of Directors under the chairmanship of the Chief Minister of Khyber Pakhtunkhwa governs affairs of PEDO. The members include Minister Energy & Power, Minister Finance, Additional Chief Secretary, Secretary Irrigation & Power, Secretary Finance, Secretary Law and Chief Executive Officer PEDO. The head office of the Organization is at Peshawar.



2. Achievements by PEDO

PEDO, with the assistance of GTZ (German Agency for Technical Cooperation), has compiled a Master Plan for rural electrification in the Northern mountainous areas of KP with particular emphasis on those areas which were not connected to the National Grid System. The Master Plan entails a total potential of more than 6000 MW that has been identified for public and private sector development. The hydropower potential sites are mainly located in the Northern districts of K.P i.e. Chitral, Dir, Swat, Indus Kohistan and Mansehra.

i. Small Hydel Potential Sites

The Master Plan envisages small scale potential sites having total capacity of about 240 MW, comprising 53 hydel potential sites. These sites are suitable for regional supply to isolated communities in the mountainous areas of KP. The district wise breakup of sites is as follows:

Sr. No.	Region	Nos. of Sites	Power Potential (MW)
1	Upper Chitral	12	80
2	Lower Chitral	10	68
3	Kohistan	4	6

Sr. No.	Region	Nos. of Sites	Power Potential (MW)
4	Swat	5	5
5	Mansehra \Vest	2	19
6	Kaghan Valley	3	13
7	Dir	17	50
TOTAL:		53	241

ii. Medium /Large Hydropower Systems

During field investigations, some very attractive sites of medium and large hydropower potential were also identified by PEDO.

Sr. No.	Name of Project I Location	Capacity (MW)	Remarks
1.	Kandiah System, Kohistan a. Karang Scheme, 454 MW b. Kaigah Scheme, 548 MW	1002	Private sector is developing these sites under Federal Power Policy
2.	Swat System, Swat a. Upper Scheme Al, 101 MW b. Middle Scheme Bl, 410 MW c. Lower Scheme Cl, 148 MW	659	-do-
3.	Spat-Gah, Kohistan a. Upper Scheme 200 MW b. Middle Scheme 550 MW c. Lower Scheme 500 MW	1250	WAPDA has undertaken the feasibility study through KfW, Germany
4.	Chor Nala System, Kohistan a. Scheme C-II, 700MW b. Scheme C-L 650 M\V c. Scheme K-II, 150MW	1500	-do-
5.	Kunhar River System, Mansehra a. Naran, 215 MW b. Suki Kinar, 840 NW	865	Private sector is developing these sites under Federal Power Policy

iii. Feasibility Studies Completed

Out of the identified sites, PEDO has completed feasibility studies of the following potential sites. These schemes are in various stages of implementation.

Sr. No.	Pro] ect / Location	Capacity (MW)	Remarks
1.	Daral Khwar HPP, Swat	36	Under imp implementation through ADB Loan
2.	Ranolia HPP, Kohistan	17	-do-
3.	Pehur HPP, Swabi	18	Under construction by

Sr. No.	Pro] ect / Location	Capacity (MW)	Remarks
			PEDO
4.	Summar Gah HPP, Kohistan	28	Suitable for private sector
5.	Batal Khwar HPP, Swat	8	Suitable for private sector
6.	Matiltan HPP, Swat	84	Under public sector tendering stage
7.	Khan Khwar HPP, Besham	72	Picked up by WAPDA for implementation
8.	Duber Khwar HPP, Kohistan	130	
9.	Allai Khwar HPP, Batagrarn	120	

3. Hydropower Projects Completed

PEDO, after successful completion of following four small and medium size hydel projects with its own resources is planning to launch number of small, medium and large hydropower projects in view urgency for combating energy crises in the country.

Projects Completed by PEDO

Sr. No.	Name of Scheme	Location	Capacity in MW
i	Malakand-III HPP	Malakand	81
ii	Pehur HPP	Swabi	18
iii	Shishi HPP	Chitral	1.8
iv	Reshun HPP	Chitral	4.2
		Total Installed Capacity	**105**

These projects are not only contributing towards the reduction in load shedding but also generating annual revenue of Rs. 2 to 3 billion for the province.

Besides the above completed Hydropower Projects, PEDO is implementing following projects with the assistance of Asian Development Bank (ADB) for the development of Hydropower Potential in Khyber Pakhtunkhwa Province which will be completed within three years;

Projects under construction:

Sr.No	Name of Scheme	Location	Capacity in MW
i	Daral Khwar IIPP	Swat	36.6
ii	Ranolia HPP	Kohistan	17.0
Iii	Machai HPP	Mardan	2.60
		Total Capacity	**56.20**

The Honorable Chief Minister has issued special directives for the implantation of hydel projects to address the acute energy crises in the country. In this regard, PEDO prepared all ACTION PLAN which has been approved by the Provincial Government of Khyber Pakhtunkhwa, under which following project are under construction/tendering stage.

Under Construction/Tendering stage Projects

Sr.No	Name of Scheme	Location	Capacity in MW	Status
1	Matiltan HPP	Swat	84	Tendering Stage
2	Koto HPP	Dir	31	Under Construction
3	Karora HPP	Shangla	11.8	Under Construction
4	Jabori HPP	Mansehra	10.2	Under Construction
5	Lawi HPP	Chitral	69	Tendering Stage
		Total Capacity	**206**	

In addition to construction projects, PEDO has also completed feasibility study of 13 Hydel Power Projects with potential of 1322 MW under the same ACTION PLAN. The construction of these projects will be achieved during the period 2011-2021.

Projects under Feasibility Studies

Sr.No	Name of Scheme	Location	Capacity in MW
1	Gahrit-Swir Lasht HPP	Chitral	377
2	Jamshail-Toren More HPP	Chitral	260
3	Toren More – Kari HPP	Chitral	350
4	Laspur Marigram HPP	Chitral	230
5	Arkari Gol HPP	Chitral	99
6	Istaru-Buni HPP	Chitral	72
7	Mujigram Shogo HPP	Chitral	64.26
8	Barikot Patrak HPP	Dir	47
9	Patrak Shringal HPP	Dir	22
10	Shigo Kach HPP	Dir	102
11	Ghor Band HPP	Shangla	20.6
12	Nandihar IIPP	Batagram	12.3
13	Naram Dam HPP	Mansehra	188
14	Balakot HPP	Mansehra	300
15	Shushai-Zhendoli HPP	Chitral	144
16	Shogo Sin HPP	Chitral	132

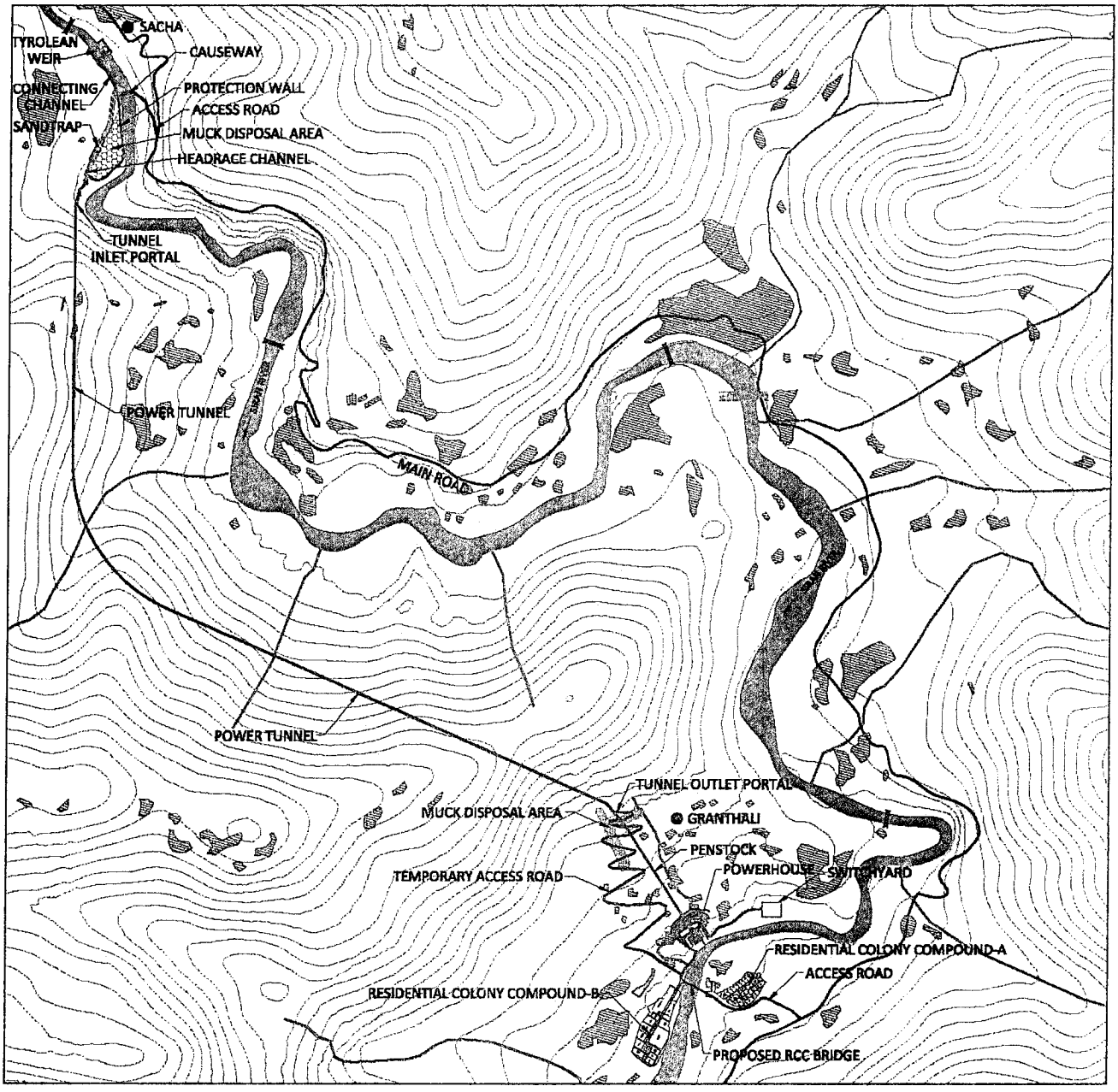
17	Batakundi HPP	Mansehra	99
Total Installed Capacity			**2519.16**

In order to facilitate the private sector, PEDO has also conducting Pre-Feasibility study of 10 raw sites in various districts of Khyber Pakhtunkhwa province having capacity and these sites have been offered to private sector for development.

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

ENERGY AND POWER DEPARTMENT, GOVERNMENT OF KHYBER PAKHTUNKHWA

JABORI HYDROPOWER PROJECT (10.2 MW)
DISTRICT MANSEHRA



PROSPECTUS

Consultants AGES

AL-KASIB GROUP OF ENGINEERING SERVICES

AGES House 34, Street No. 03, Sector G-1, Phase-2, Hayatabad,
Peshawar Khyber Pakhtunkhwa Pakistan
Tel: +92 91 5823117 Fax: +92 91 5823118, E-mail: ages@ages.com.pk

Hydro Consult

IDC

PROJECT INTRDODUCTION

The project is located on Siran River, a tributary of Indus River near Jabori Village, about 20 KM from Shinkiari and 40 KM from Mansehra City in District Mansehra, Khyber Pakhtunkhwa Province. Siran River flows next to Kaghan Valley in the East and crosses through rock sequences of Cambrain Mansehra Granite and Pre-Cambrain Tanawal formation, consisting of medium to coarse grained metaquartzites.

Mansehra District is located at 34° - 12' to 35° - 10' N latitude and 72° 42' to 74° 12' E longitudes. Mansehra city is 234 km from Peshawar and 143 km from Islamabad while the Project area is about 40 km from Mansehra City. Geographically Mansehra district is bordered to the North by Kohistan and Battagram districts, to the South by Abbotabad & Haripur districts, to the West by Buner and Shangla districts in Malakand Division, and to the East by Azad Kashmir (AJK). The project area is located almost in the central part of Mansehra District. Location Map has been attached as Figure-1.

Project area is accessible from Mansehra city through the KKH up to Khanpur from where an off-taking road leads to the proposed project location. The road from Shinkiari is recently rehabilitated and now all-weather metalled road is available for access up to the diversion weir.

PROJECT HISTORY

To explore and develop the hydropower potential on provincial level, the Government of the then NWFP (now Khyber Pakhtunkhwa Province) created Small Hydel Development Organization (SHYDO) in 1986-87 which was later on converted to Sarhad Hydel Development Organization (SHYDO), under the SHYDO Act 1993. After the change of province name, the name of SHYDO was changed to PHYDO i.e. Pakhtunkhwa Hydel Development Organisation which further renamed to PEDO(Pakhtunkhwa Energy Development Organization) which could implement power project up to 50MW only. However, as result of 18th amendment in the constitution of Pakistan in year 2011, the provincial governments were allowed to develop electricity above 50 MW also in their jurisdictions.

The PEDO in collaboration with GTZ identified a number of small/medium size hydel schemes. The Jabori Hydropower Project was identified during the Identification of Hydropower Development Potential in Khyber Pakhtunkhwa by PEDO-GTZ IN 1998.

Later on the task of conducting Feasibility Studies of Jabori Hydropower Project was awarded to Associated Consulting Engineers – ACE (Pvt.) Ltd. in August, 2008 who submitted the Feasibility Report in May 2011.

After completing necessary formalities on 22nd October, 2013,the Management Consultancy of Jabori HPP was awarded to the Joint Venture of AGES (Pakistan), IDC (Pakistan) and HCE (Nepal) Consultants with AGES Consultants as the lead partner. The consortium started its activities on 23rd October, 2013.

PROJECT OBJECTIVE

Primary objective of the Project is to generate 10.2MW hydropower; with average annual energy production of 71.1 GHz.

PROJECT COMPONENTS

The project components consist of, construction of diversion weir (Tyrolean type), a connecting channel leading the diverted discharge to sand trap from where the sediments free discharge will be collected by means of power channel which will ultimately enter into the power tunnel. A surge shaft has been provided at the end of power tunnel. The tunnel is connected with a steel penstock proposed on slope of the hill. A surface powerhouse is proposed which has two Francis units. Tailrace channel is provided at the downstream of powerhouse to carry the outflow back into the Siran River .Switchyard is being located at the right side of Siran River to evacuate the power to national grid located at Battal through 120kv transmission line.

ENVIRONMENTAL ASPECT OF THE PROJECT.

Electricity, generated from Jabori hydropower will be quite useful in minimizing the energy crisis in Pakistan. This will also help in meeting the electricity requirement of the local population. The availability of alternative source to meet the energy requirement will reduce consumption of timber and other fossil fuels. JHPP will also provide job opportunities to the unskilled people of the locality at general during the construction phase and a limited number of jobs once it is operational.

The climate of the district is warm in summer and cold in winter. Since the district is at an elevation of 2000 to 4500 meters thus the winter season remains extremely cold in the upper half of the district while in the lower half it remains moderate. Snow fall generally starts by the end of November on the high peaks of the mountains and descends downwards as the temperature falls further.

The Mansehra District is rich in natural vegetation. Besides the scattered vegetation in almost the entire area, the hills are covered with forests of broad leaf and pine trees in accordance with the altitude. Fruit trees are very rare. These are generally found in the courtyards of the farming communities.

Project area is home of a diverse group of people including different tribes and clans, amongst whom Swati are dominant with a percentage of 73.2. Remaining population belongs to Yousaf zai (15%), Tanoli (8.2%), Gujiiar (3.1%), Awan (2.4%) and Quraishi (2.1%) tribes. Community, on the whole, is socially cohesive with minor conflicts which are resolved locally by the elders

Hydropower is a clean and renewable source of energy and avoids contributions to pollution loads, which would result from the alternative use of thermal electricity generation. Hence, it is environment friendly. Thermal power generation plants are known for a large variety of toxic emissions i.e. carbon dioxide (CO2), particulate matter (PM), sulphur dioxide (SO2), carbon monoxide (CO) and Oxides of Nitrogen (NOx) etc.

JHPP has almost no negative socio-economic and environmental impact on the locality. Similarly there are no impacts on wildlife or sites of historic or archaeological importance. However, the main impact identified in the environmental examination is the consumption of land based resources. It is estimated that the Project will consume about 270 Kanals of agriculture land and one household will be affected. To neutralize the Project impact on the aquatic life in the Siran River, about 314 litter of water will be made available in the Siran River round the year. This Environmental residual flow will further be supplemented by the contributing perennial streams downstream of the weir. This provision will also allow the cleansing of the river bed and negation of any harmful effects of sewage and rubbish concentrating in the river system.

EXECUTING AND FINANCIAL AGENCIES

Executing Agency (EA) for implementation of the Project is Pakhtunkhwa Energy Development Organization (PEDO) of KP Province headed by Chief Executive Officer, PEDO. The Authorized Representative of EA is the Project Director, Jabori Hydropower Project (PEDO), assisted by the MC.

The project is being financed by the Government of Khyber Pakhtunkhwa from its own resources. The Project was included in ADP 2014-15 with ADP No. 203 and code 100174(10% ADP (local) and 90% HDF).

PROJECT IMPLEMENTATION ARRANGEMENTS

Executing Agency : Pakhtunkhwa Energy Development Organization (PEDO)

Consultants : A Joint Venture of :

1. AGES Consultants Peshawar, Pakistan (Lead Firm)
2. Infra-D Consultants Islamabad (Pakistan)
3. Hydro Consult Pvt. Ltd. (Nepal)

SALIENT FEATURES

Following are the key parameters of the Project.

Location	Jabori (District Mansehra333), Khyber Pakhtunkhwa, Pakistan
UTM Co-ordinates	43 S, Easting = 338482.00 m Northing = 3831554.0 m
River	Siran
Type	Run-of-River
Purpose of Project	Supply electricity to National Grid
Hydrology	
Catchment Area	236 km^2
Normal Reservoir Level	1413.75 masl
Design discharge for Power	8.00 m^3/s
Selected design flood for Weir	100 years frequency
Flood Discharge (Q_{100})	686 m^3/s
Flood Discharge (Q_{1000})	1144 m^3/sec
Diversion Weir / Dam	
Type	Tyrolean
Crest level of Tyrolean section	1413.50 masl
Crest of flow section	1414.00 masl
Minimum Head on Crest	0.25 m
Length of Weir	45.0 m
Design Flood	100 years frequency
Flood discharge	686 m^3/s
Surcharge due to design Flood	3.38 m
Total Height of Weir	3.00 m above river bed

Stilling Basin	USBR Type II
Size of Basin	45.0 x 18.0 m
Intake gate size	Vertical lift gate 2.3 x 2.2 m
Embedded Channel design	25% extra over discharge (8.00 m^3/s)
Size of embedded Channel	2.35 x 2.0 m
Water level in embedded channel	El: 1412.58 masl

Connecting Channel (Trapezoidal Section)

Design discharge	25% extra over discharge (10.00 m3/s)
Invert Level	El: 1410.82 masl
Water level at start	El: 1412.23 masl
Bed Width	2.00 m
Flow depth	1.41 m
Side slope	1.50:1.00 (V: H)
Bed slope	1.0 in 1000 m
Free board	0.3 m
Flow velocity in channel	1.7 m / sec
Total Length	150 m
Total friction losses	0.15 m

Sand Trap (Two Chambers)

Limit particle size	0.2 mm
Average velocity in chamber	0.216 m/ s
Length of chamber	65.0 m
Length of U/S transition	10.0 m
Length of D/S transition	10.0 m
Freed board	0.40 m
Size of chamber at start	B = 4.5 m, D = 4.5 m
Size of chamber at end	B = 4.5 m, D = 5.8 m
Inlet gates	Two lift gate with hoisting (2.1m x 1.8m)
Outlet gates	Two lift gate with hoisting (2.0m x 1.3m)
Flushing arrangement	Two rectangular gates (0.8m x 0.55m)
Flushing discharge	2.0 m^3/si.e 25% of design discharge
Spillway Section	Overflow type
Crest le3vel of spill section	EL: 1412.10 masl
Length of spill section	22.0 m
Surcharge due to overflow	0.2 m
Head losses in Sand trap	0.04 m

Headrace Channel (Rectangular Section)

Design discharge	8.0 m3 / s
Invert Level	El: 1410.40 masl
Water level at start	El: 1412.07 masl

Size of Channel	3.0 x 1.9 m
Bed slope	1.0 in 1000 m
Free board	0.3 m
Flow velocity in channel	1.67 m / sec
Total Length	94 m
Total friction losses	0.15, including 10 m long Aqueduct

Aqueduct

Design discharge	8.0 m3 / s
Length of throat	10.0 m
Dimensions of turf	3.0 x 1.90 m (B x D)
Free board	0.30 m
Head losses	0.046 m
Bed Slope	1.0 in 1000 m

Intake Portal

Invert elevation at start	EL: 1410.00 masl
Invert elevation at Tunnel inlet	EL: 1405.60 masl
Water level at intake	EL: 1411.74 masl
Freeboard	0.60 m
Min: submerged provided	3.25 m
Spillway section	Overflow sharp crested at EL: 1411.85 masl
Length of spillway section	25.0 m
Surcharge due to design discharge	0.34 m

Power Tunnel

Type	Horseshoe shape concrete lined
Height and Width	2.50 m and 2.30 m
Invert elevation of tunnel	EL: 1405.90 masl
U/S Water level at design discharge	EL: 1411.50 masl
Flow area	5.51 m^2
Bed slope	1.0 in 1000 m
Average flow velocity	1.50 m / s
Equivalent diameter of Tunnel	2.65 m
Length of Tunnel up to Surge tank	2895 m
Bed level at Surge tank	EL: 1403.17 masl
Total loss in Tunnel	2.76 m

Surge Tank

Type	Simple orifice type
Maximum surge level	EL: 1421.1 masl
Minimum surge level	EL: 1401.6 masl

Head losses	0.05 m
Diameter of surge tank	5.0 m
Height of surge tank	25.0 m

Penstock

Material	Steel
Invert level	EL: 1395.3 masl
Total length	548 m
Diameter	1.6 m
Thickness	14 ~16 mm
Average velocity	3.98 m/s
Gross Head	155.8 m
Head losses	3.81 m
Invert level at Powerhouse	EL: 1256 masl
Bifurcation length	Two pipes 50 m each
Dia of bifurcation	1.1 m

Power Facilities

Powerhouse	Surface Powerhouse
Size of Powerhouse	43 x 21 m
Turbine type	Horizontal Francis
Units	Two
Turbine Capacity	4.0 m^3 / s
Generator Capacity	6 MVA
Gross Head	156.75 m
Net Head	148.00 m
Net Head losses	8.75 m
Installed Capacity	10.2 MW
Average annual energy	71.10 GWh
Plant Factor	79.57 %

Tailrace Channel

Type	Rectangular Concrete channel
Dimensions	3.5 x 1.7 m
Average velocity	1.7 m / s
Flow depth	1.38 m
Length of Channel	30.0 m
Freeboard	0.32 m

Switchyard

Size of Switchyard area	50 x 36 m

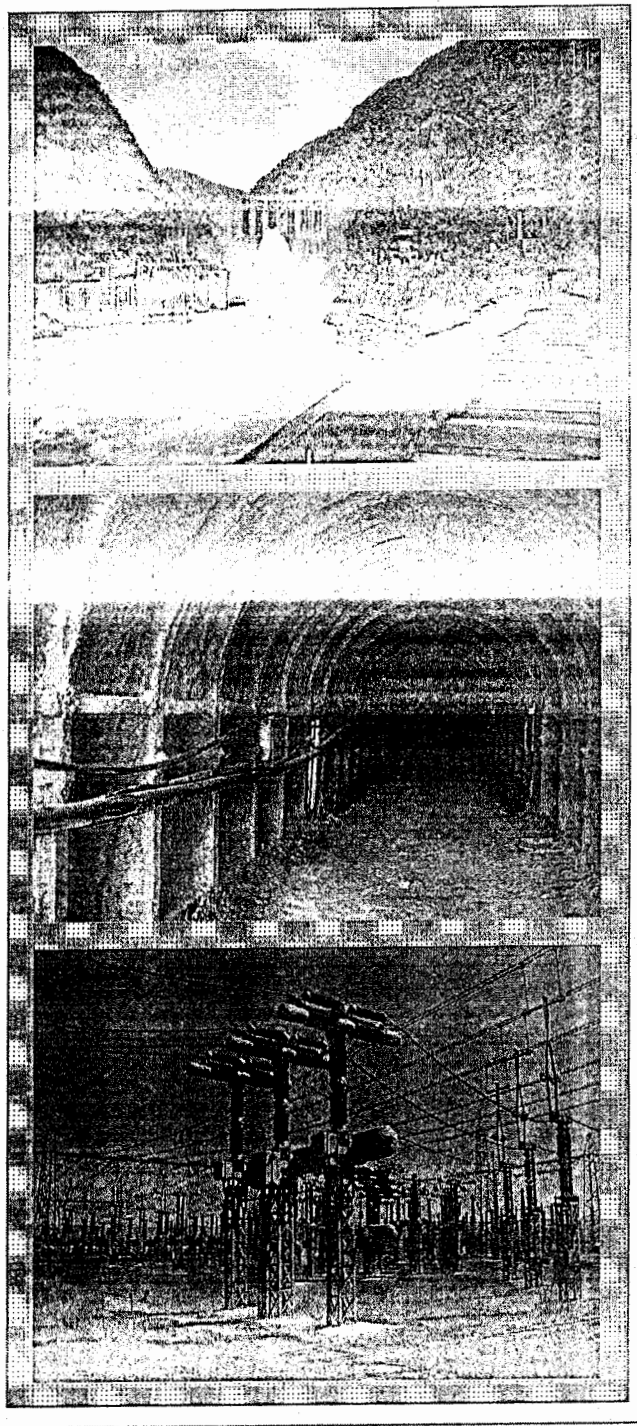
Transmission Line

Transmission Line	132 KV – 20 Km (From Jabori to Batal)

Other Components

Employer's Colony	
Access Roads	
RCC Bridge on Siran River.	01 No. Near Powerhouse Site
Protection Works for Structures	

GOVERNMENT OF KHYBER PAKHTUNKHWA
PAKHTUNKHWA HYDEL DEVELOPMENT ORGANIZATION (PHYDO)



OUTLINE DESIGN REPORT

MANAGEMENT CONSULTANCY SERVICES FOR CONSTRUCTION OF JABORI HYDROPOWER PROJECT (10.2 MW) DISTRICT MANSEHRA

MARCH 2014

Consultants AGES

AL-KASIB GROUP OF ENGINEERING SERVICES

AGES House 578, Street No 17, Sector E-6, Phase-7, Hayatabad,
Peshawar Khyber Pakhtunkhwa Pakistan
Tel: +92 91 5890501 Fax: +92 91 5890502 E-mail: ages@ages.com.pk

Hydro Consult

IDC

TABLE OF CONTENTS

CHAPTER– 1

INTRODUCTION

1. INTRODUCTION

1.1 GENERAL BACKGROUND

Hydropower development is among the prime factors for improving the socio-economic conditions of the people of Pakistan. This homeland is blessed with abundance of natural available water resources upon which the development of this sector depends. The Government of Pakistan and that of the Khyber Pakhtunkhwa are making & should make every endeavour to explore and harness the available water resources to achieve the goal of socio-economic development. The much awaited and the dire needed Jabori Hydropower Project is an extremely lauded initiative of the PHYDO and a step in the right direction towards sustainable economic development.

To explore and develop the hydropower potential on provincial level, the Government of the then NWFP (now Khyber Pakhtunkhwa Province) created Small Hydel Development Organization (SHYDO) in 1986-87 which was later on converted to Sarhad Hydel Development Organization (SHYDO), under the SHYDO Act 1993. After the change of province name, the SHYDO was changed to PHYDO i.e. Pakhtunkhwa Hydel Development Organisation. The PHYDO could implement power projects up to 50 MW only according to its charter. The PHYDO in collaboration with GTZ identified a number of small/medium size hydel schemes. The Jabori Hydropower Project was identified during the Identification of Hydropower Development Potential in Khyber Pakhtunkhwa by PHYDO-GTZ IN 1998. As a result of 18th amendment in the constitution of Pakistan in year 2011 the provincial governments were allowed to develop electricity above 50 MW also in their jurisdictions.

Later on Associated Consulting Engineers – ACE (Pvt.) Ltd. had been assigned the task of conducting Feasibility Study for the Jabori hydropower project in August, 2008 who submitted the Final Feasibility Report in August 2011.

After completing necessary formalities PHYDO has selected Consultants for 3 Management Consultancy Projects i.e. Jabori HPP, Karora and Koto HPP. The management consultancy of Jabori HPP is awarded to the consortium of the AGES (Pakistan), IDC (Pakistan) and HCE (Nepal) Consultants with AGES Consultants as the lead partner. After signing Consultancy Services Agreement between PHYDO and the Consultants on 22nd October,

the services were started from October 23, 2013.

After the initial study and presentation to the Secretary Energy and Power KPK, it was directed to reduce the project completion time both for design review and construction supervision phases. The Consultants presented a working paper to highlight the pron and cons of the reduction in time. Accordingly the time was reduced time from 50 months to the 40 months. The review and tendering stage will be completed in eight months whereas the construction period will be 30 months. A two months gape is proposed for the transition period where the contractor will establish site offices.

1.2 PROJECT IMPLEMENTATION ARRANGEMENT AND TIMINGS

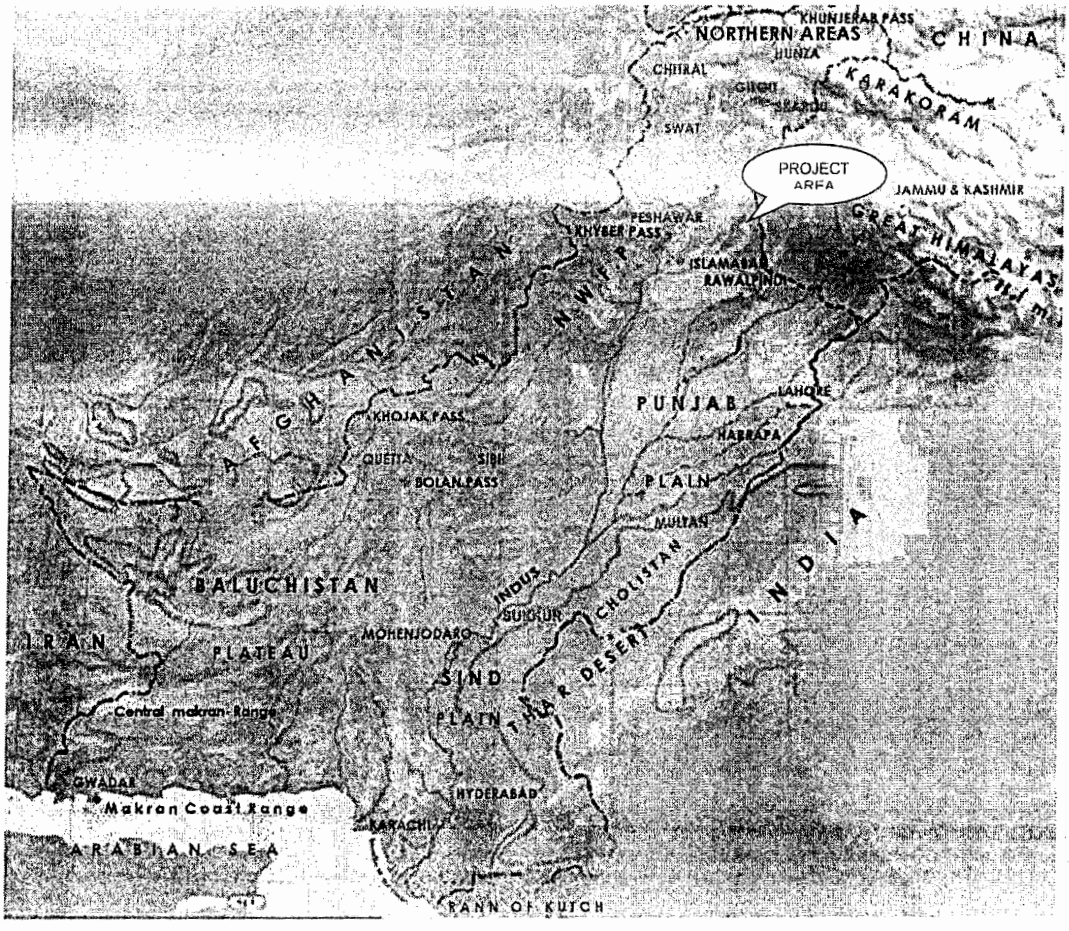
Funding Agency	:	Government of Khyber Pakhtunkhwa
Executing Agency	:	Pakhtunkhwa Hydel Development Organization (PHYDO) Government of KPK represented by Managing Director PHYDO.
Authorized Representative	:	The Project Director (PD) Jabori Hydropower Project (PHYDO)
Consultants	:	A Joint Venture of • AGES Consultants Pakistan. • IDC Consultants Pakistan • HCE Consultants Nepal
Proposal Submission	:	August 2012
Signing of Contract	:	November 22, 2013
Start of Activities	:	November 23, 2013
Completion of Phase-1	:	February 22, 2015 (15 months) – Original June 23, 2014 (8 months with 2 months transition period) – Revised
Completion of Phase-2	:	January 23, 2018 (35 months) - Original March 22, 2017 (30 months) – Revised

1.3 PROJECT LOCATION AND ACCESSIBILITY

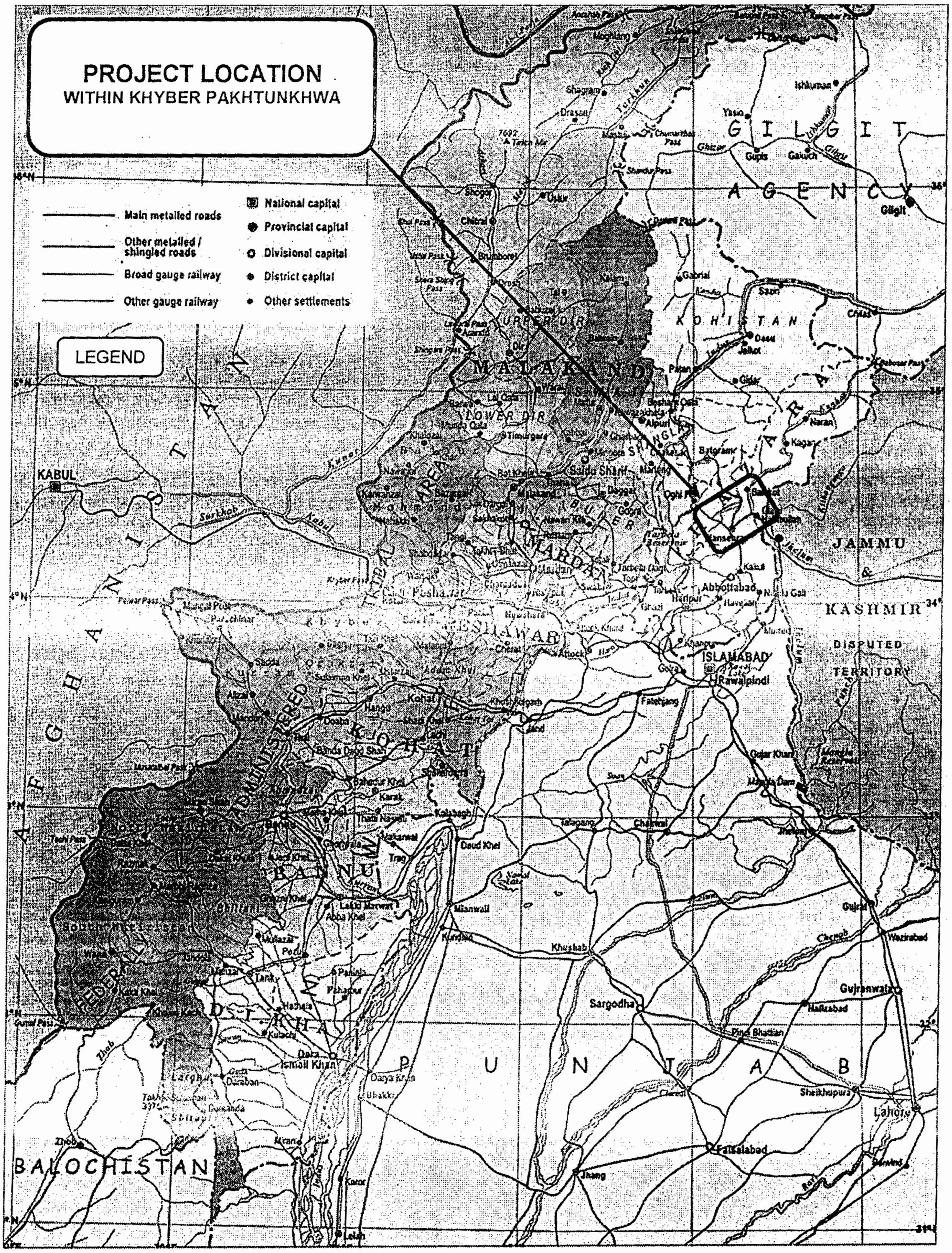
Mansehra District is located at 34° - 12' to 35° - 10' N latitude and 72° 42' to 74° 12' E longitudes, 150 km to the east of the Peshawar and 90 km to the north of Islamabad.

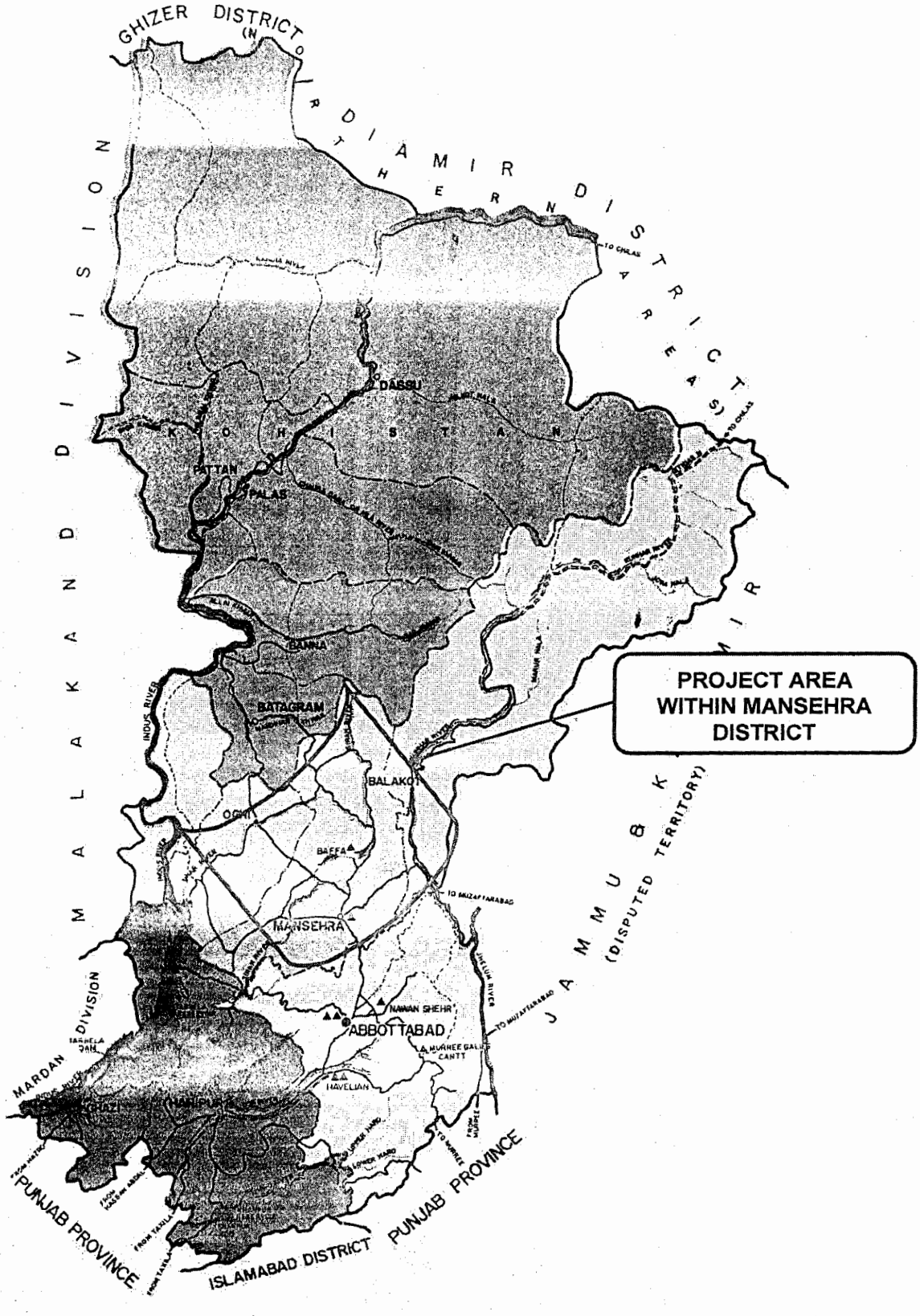
Geographically it is bordered to the North by Kohistan and Battagram districts, to the South by Abbotabad & Haripur districts, to the West by Buner and Shangla districts in Malakand Division, and to the East by Azad Kashmir (AJK). The project area is located almost in the central part of Mansehra District.

District Mansehra, the land of grassy fields & lakes, became a separate district from Hazara in 1976. Presently, the district consists of Frontier Region (F.R.) Kala Dhaka, Mansehra, Balakot and Oogi, comprising of 59 Union Councils in total. The famous Resham Avenue passes through this district. From historical point of view, Mansehra is famous due to Balakot war of Syed Ahmed Shaheed. Despite being progressive in every field of life, the main source of income of people is still the agriculture with 80,747 hectares of agricultural area. Tourism is also one of the profitable industries of this area. Overall area of the District Mansehra is 4579 sq. kms with a population density of 296 persons per sq. km. Population of the Mansehra District is about 1.15 million and language is Hindko 73%; Pushto 26.6% and others.



Project area is accessible through the KKH upto Shinkari from where an offking road leads to the proposed project location. The road from Shinkiari is recently rehabilitated and now all-weather metelled road is available for access upto the intake. However the Powerhouse needs access road and a bridge across Siran River during the construction phase.




GHIZER DISTRICT (N
NORTHERN AREAS
KOHISTAN
DASSU
PATTAN
PALAS
BATAGRAM
BALAKOT
OGHI
MANSEHRA
ABBOTTABAD
HAVELIAN
HARIPUR
MALAKAND DIVISION
MARDAN DIVISION
PUNJAB PROVINCE
ISLAMABAD DISTRICT
PUNJAB PROVINCE
JAMMU & KASHMIR
(DISPUTED TERRITORY)
PROJECT AREA
WITHIN MANSEHRA
DISTRICT

1.4 SALIENT FEATURES OF THE PROJECT

S. No	ITEM	DESCRIPTION
1	**GENERAL**	
	Location	Jabori Village Distt. Mansehra, KPK, Pakistan
	UTM coordinates of weir	43 S, Easting = 338482.00 m Northing = 3831554.0m
	Hydropower type	Run off River
	River Name	Siran River
	Purpose of the Project	Supply of electricity to the National Grid
2	**HYDROLOGY**	
	Catchment area	236 km^2
	Normal Reservoir Level	1413.75
	Design discharge for power	8.00 m^3/sec
	Selected Design flood for weir	100 year frequency
	Flood discharge 100yr	686 m^3/sec
	Flood discharge 1000 yr	1144 m^3/sec
3	**DIVERSION WEIR**	**Tyrolean Weir type**
	Crest level of Tyrolean section	1413.5 m asl
	Crest of overflow section	1414.0 m asl
	Min. Head on crest	0.25m
	Length of weir	45m
	Design Flood	100 year frequency

S. No	ITEM	DESCRIPTION
	Flood discharge	686 m³/sec
	Surcharge due to design flood	3.38 m
	Weir height	3.0 m from river bed
	Stilling Basin	USBR Type II
	Size of basin	45 x 18 m
	Embedded channel design	25% extra over discharge (8.00 cumecs)
	Size of embedded channel	2.35 x 2.0 m
	Size of intake gate	Lift gate (2.2 x2.3m)
	Water level in embedded channel	1412.58 m asl
4	CONNECTING CHANNEL	Rectangular covered channel
	Design discharge	Designed for 25% extra discharge
	Dimensions	2.35 x 2.0m waterway
	Freeboard	0.27m
	Total length	140 m
	Average flow Velocity	2.50 m/sec
	Water level at start	1412.58 m asl
	Water level at end of channel	1412.23 m asl
5	CONNECTING CHANNEL	Concrete lined trapezoidal section
	Design discharge	Designed for 25% extra discharge (10 m³/sec)
	Invert level	1410.82 m asl
	Water level at start	1412.23 m asl

S. No.	ITEM	DESCRIPTION
	Bed width	2 m
	Flow depth	1.41 m
	Side slope	1.5: 1 (H:V)
	Bed slope	1 in 1000 m
	Free board	0.3 m
	Flow velocity in channel	1.7 m/sec
	Total length of Trapezoidal channel	150 m
6	SAND TRAP	Two chambers
	Limit particle size	0.2 mm
	Average velocity in chambers	0.2.16 m/sec
	Length of chamber	65 m
	Length of upstream transition	10.0 m
	Length of downstream transition	10.0 m
	Freed board	0.4 m
	Size of Chamber at start	B = 4.5 m , D = 4.5 m
	Size of Chamber at end	B = 4.5 m , D = 5.8 m
	Inlet gates	Two lift gates with hoisting (2.1m x 1.8m)
	Outlet gates	Two lift gates with hoisting (2.0m x 1.3m)
	Flushing Arrangement	Two rectangular gates (0.8x0.55m)
	Flushing discharge	2.0 m^3/sec, i.e. 25% of design discharge
	Spillway section	Overflow type

S. No.	ITEM	DESCRIPTION
	Crest level of spill section	1412.10 m asl
	Length of spill section	22 m
	Surcharge due to overflow	0.2 m
	Total head losses in the sand trap	0.04 m
7	**HEADRACE CHANNEL**	**Concrete lined Rectangular section**
	Design discharge	8.00 m^3/sec
	Invert level	1410.40 m asl
	Water level at start	1412.07 m asl
	Size of channel	3 x 1.9 m
	Bed slope	1 in 1000 m
	Free board	0.3 m
	Flow velocity in Headrace channel	1.67 m/sec
	Total length of Headrace channel	94 m, including 10 m long Aqueduct
8	**AQUEDUCT**	
	Design discharge	8.00 m^3/sec
	Length of throat	10 m
	Dimensions of turf	3 x 1.9 m (BxD)
	Free board	0.3 m
	Bed slope	1 in 1000 m
9	**INTAKE PORTAL**	
	Invert elevation at start	1410.0 m asl

S. No	ITEM	DESCRIPTION
	Invert elevation at tunnel inlet	1405.6 m asl
	Water level in intake	1411.74 m asl
	Freeboard	0.6 m
	Minimum submergence provided	3.25 m
	Spillway section	Overflow sharp crested at 1411.85 m asl
	Length of spillway section	25 m
	Surcharge due to design discharge	0.34 m
10	POWER TUNNEL	
	Type	Horseshoe shape concrete lined
	Height and width	2.5m and 2.3m
	Invert elevation of Tunnel	1405.9 m asl
	Upstream water level at design discharge	1411.5 m asl
	Flow area	5.51 m^2
	Bed slope	1 in 1000 m
	Average flow velocity	1.5 m/sec
	Equivalent diameter of tunnel	2.65 m
	Length of tunnel upto surge tank	2730 m
	Bed level of tunnel at surge tank	1403.17 m asl
	Total losses in tunnel	2.76 m
11	SURGE TANK	Simple orifice type
	Maximum Surge level	1421.1 m asl

S. No	ITEM	DESCRIPTION
	Minimum Surge level	1401.6 m asl
	Head losses	0.05 m
	Dia meter of surge tank	5.0 m
	Height of surge tank	25 m
12	**PENSTOCK**	**Steel**
	Invert level of Penstock	1395.3 m asl
	Total length of Penstock	548 m
	Diameter of penstock	1.6 m
	Thickness of penstock	14 ~16 mm
	Average velocity in penstock	3.98 m/sec
	Gross head at penstock	155.8 m
	Head losses in Penstock	3.81m
	Invert level of penstock at powerhouse	1256 m asl
	Bifurcation length	Two pipes 50m each
	Diameter of Bifurcation	1.1 m
13	**POWER FACILITIES**	
	Powerhouse	Surface powerhouse
	Size of Powerhouse	43x21 m
	Turbine	Horizontal Francis
	Number of Units	Two
	Turbine Capacity	4.0 m^3/sec

S. No	ITEM	DESCRIPTION
	Generator Capacity	4 MVA
	Gross Head	156.75 m
	Net Head	148.00 m
	Net head losses	8.75 m
	Installed capacity	10.2 MW
	Average annual energy	71.10 GWh
	Plant Factor	79.57 %
14	TAILRACE CHANNEL	Rectangular concrete channel
	Dimension	3.5 x 1.7 m
	Average velocity	1.7 m/sec
	Flow depth	1.38 m
	Length of channel	30 m
	Free board	0.32 m
15	SWITCH YARD	
	Size of switch yard area	50 x 36 m
16	TRANSMISSION LINE	
	Transmission line	132 kV – About 20 km (From Jabori to Batal Grid Station)
17	OTHER COMPONENTS	
	Employer's Colony	
	Access Road	
	RCC Bridge on the main Siran	1 No. near powerhouse site

S. No	ITEM	DESCRIPTION
	River	
	Protection Works for Weir Channel, Sandtrap , Powerhouse and buildings	

1.5 OUTLINE DESIGN REPORT

This Outline Design Report is presented in light of the consultancy scope of work as given in the terms of reference. Report highlights the basic studies and parameters of the project components.

The project was initially envisaged as 6.5 MW in the feasibility study. However during the review phase, it was found that there are some problems in the original concept and a revised proposal was initiated by the Management Consultants. The same was discussed and agreed by the concerned authority. The new size of the project is 10.2 MW instead of 6.5 MW. However due to the time limitations and limited scope of the MC, it was not possible to redo the entire feasibility study. An initial concept has been developed and the drawings were developed to the extent that the EPC contractor can foresee the scope and prepare a responsible bid.

This report mainly covered the hydrological aspects, hydraulic design criteria and description for the civil components including diversion weir, gravel trap, sandtrap, connecting channel, aqueduct, tunnel, surge tank, penstock and powerhouse. The electromechanical components are presented in the separate section.

1.6 RELEVANT STUDIES IN THE FEASIBILITY REPORT

Relevant studies in the feasibility report that may helpful in conjunction with this report are highlighted here. The contractor should, however, visit the site prior to the submission of the bid.

- Topographic survey has been cone during the feasibility stage (Chapter-2). MC took the same Bench Marks for additional survey for the area not covered in the feasibility study. Therefore for any detail about the survey, the basis can be taken from the FS. The EPC Contractor shall, however, conduct a detail survey of the site including the confirmations of previous BMs and erection of new BMs prior to the start of any design or construction work.

- A detail geology and geotechnical investigations study (Chapter-3) is presented in the FS report that may provide a general idea of the regional and local geology with rock types. As the location of new weir is about 1.5 km upstream of the previous weir, the FS weir geology is not relevant. However the geology of powerhouse area, penstock alignment, surge tank and lower half of the tunnel can be judged from the report as the locations changes are not significant.

- A detail seismic hazard analysis (Chapter 5) of the scheme is conducted in the FS. Although the basis may be helpful but the findings are changed by the MC at review stage. The value of "g" will be 0.29 instead of 0.22 as suggested in the FS to make it consistent with the "Building Code of Pakistan".

- An initial environmental and social impact is presented in the FS as Volume-II. The same may be helpful for the detail design stage if required.

- The parameters of layout and design alongwith electro-mechanical are given in the FS report but due to change in the project layout, the entire concept is changed. Therefore these studies are not helpful.

CHAPTER – 2

HYDROLOGICAL ASPECTS

2 HYDROLOGICAL ASPECTS

2.1 GENERAL

Hydrological & sedimentation studies of Jabori Hydropower project was conducted by ACE and submitted as part of Feasibility Study Report of Jabori Hydropower Project in August, 2011. The hydrological part of the feasibility study was revised after flood event of 29th July, 2010. The hydrological part is updated in currently studies.

2.2 CATCHMENT CHARACTERISTIC

The proposed Jabori HPP is a run-of-river scheme. The proposed weir site is located at latitude 34°-36'-49" North and longitude 73°-14'-15" East and power house is latitude 34°-35'-12" North and longitude 73°-15'-22" East. The catchment area of the proposed project is 236 km ^{2} and for proposed power house location is 275 km^2.

2.3 UPDATION OF HYDROLOGICAL STUDIES

2.3.1 Water Availability

Daily flow records of Siran River for period of 1969-2012 at Phulra and Jabori for period of 2005-2013 were collected from SWHP, WAPDA & PHYDO. 10-Daily flow series at Phulra and Jabori are given in **Table-2.1 & 2.2.** Daily flow data of Siran River at Jabori is attached as **Annexure-A.** Average 10-Daily flows of Siran River at Jabori for period 2005-2013 are shown in **Figure-2.1.** Mean 10-daily flow varies from 4.0 cumec in December to 13.0 cumec in April. During September to February, flow remains above 4 cumec and below 7.0cumec respectively. From second 10-daily of March till earlier of August flow remain above 8.0cumec.

Long term flow availability for period of 1969 to 2013 was estimated from correlating 10-daily flow record of Siran River at Phulra and Jabori for concurrent period of 2005-2012.

The equation derived from regression model is:

$$Q_{weir} = 2.0 \left(Q_{phulra}\right)^{0.45}$$

Simulated/generated series and observed are plotted and shown in **Figure-2.2.** 10-daily flow at Jabori from Phulra flow series have been estimated from above mentioned equation (Table-2.2).

Figure - 2.1 Average 10-Daily Flow of Siran River At Jabori (Period-2003-2013)

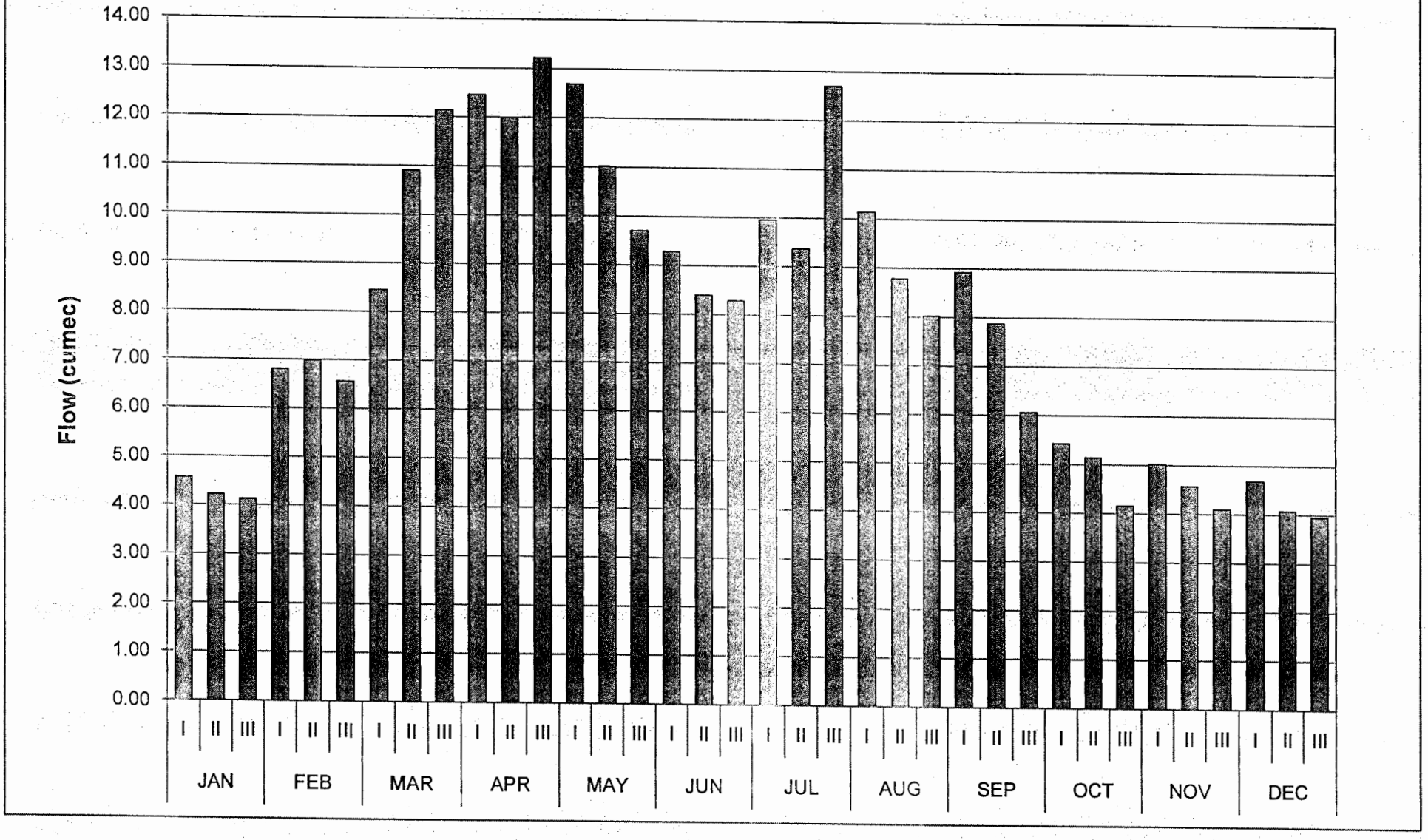
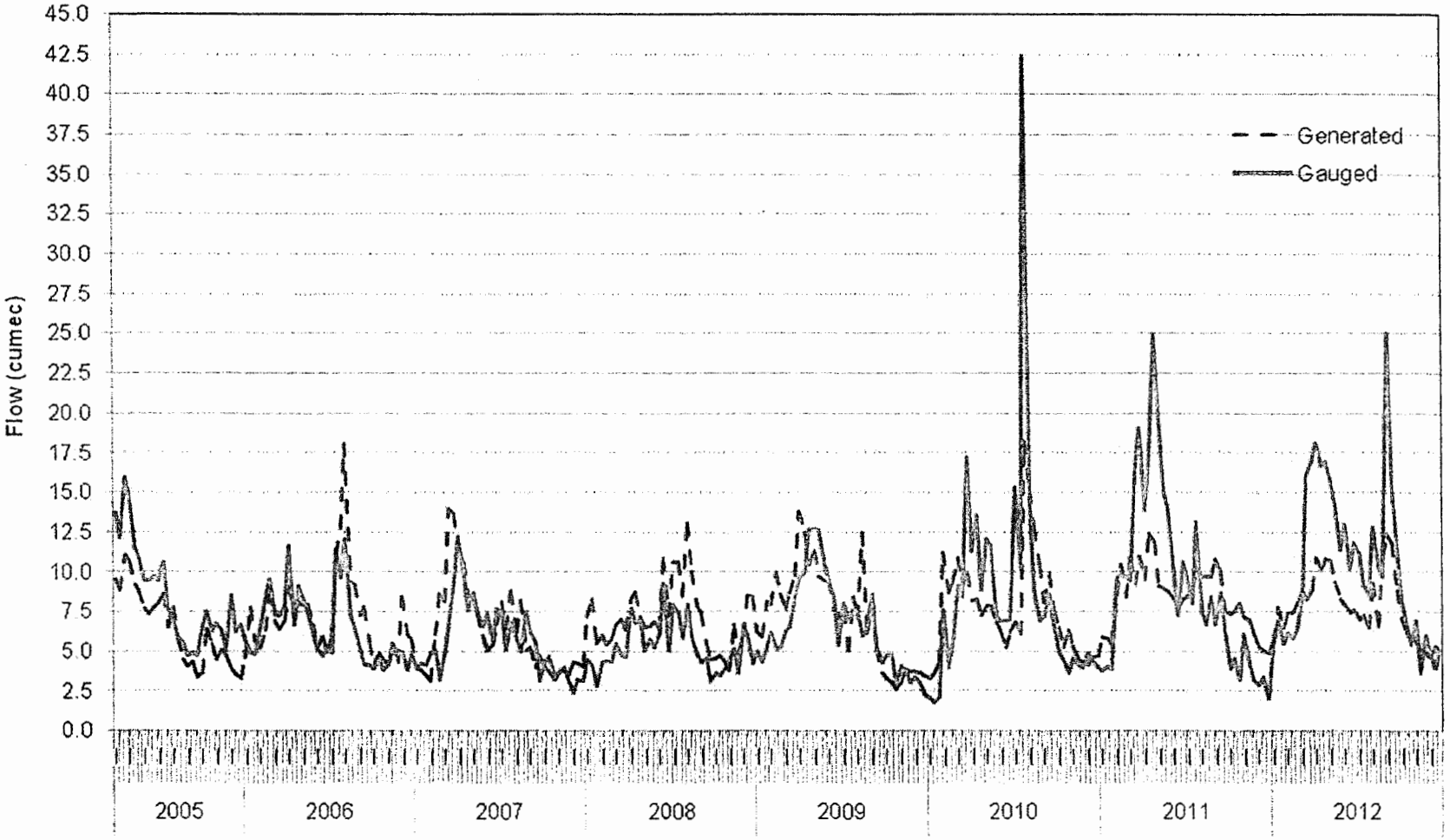


Figure - 2.2 Observed Vs Simulated 10-Daily flow at Jabori gauge Site (2005-2012)



2.3.2 Flow Duration Curve

A flow-duration curve (FDC) provides the percentage of time (duration) a daily or 10-daily / monthly stream flow is exceeded over a historical period for a particular River. FDC may also be viewed as the complement of the cumulative distribution function of the considered stream flows. Daily flow observed for period of 2005-2013 and 10-daily generated series for 1969-2013 have been plotted against exceeding probability **(Figure-2.3).** The summaries of results extracted are given **Table-2.3.**

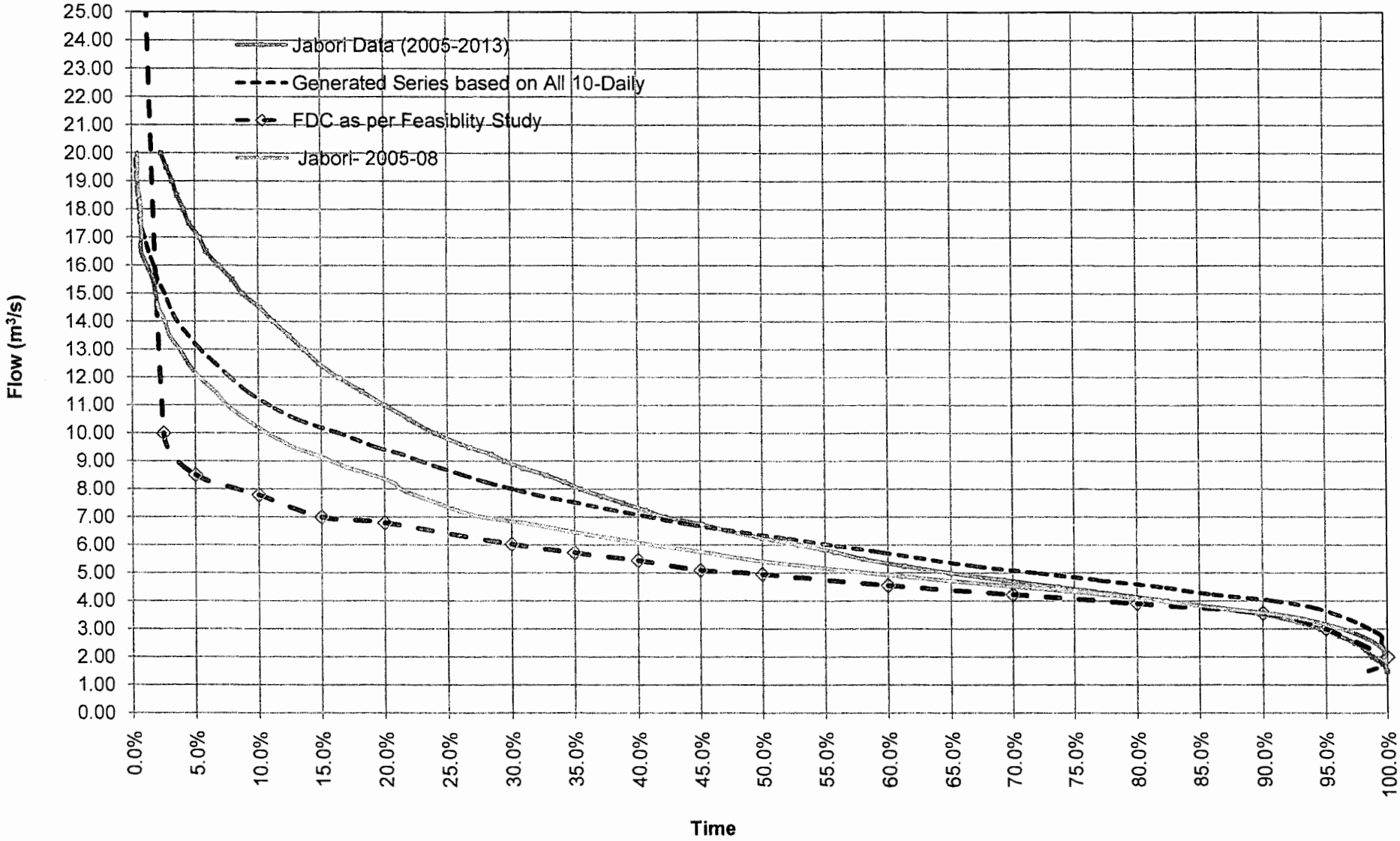
Table-2.3 Flow Availability Against Different Probabilities of Exceedence

Prob. Exceed. (%)	Design Flow (cumec)			
	Feasibility Study (August,2011)	Only Jabori Data (2005-2013)	Only Jabori Data (2005-2008)	Generated Series (1969-2013)
10	7.79	14.50	10.25	11.25
20	6.79	11.00	8.25	9.40
25	--	9.75	7.35	8.65
30	6.03	8.92	6.85	8.00
35	5.72	8.10	6.45	7.50
40	5.45	7.40	6.10	7.10
50	4.96	6.25	5.45	6.30
60	4.55	5.35	4.92	5.80
70	4.23	4.6	4.55	5.15
80	3.91	4.15	4.10	4.60
90	3.56	3.5	3.60	4.00
	Note: Generated Series includes observed data for period of 2005-2013			

2.3.3 Design Flood Studies

The historical data series for estimation of design floods for the Siran River at Jabori are rather short, covering an observation period of 2005 to 2012. The flood event of 29th July, 2010 is part of data collected from PHYDO for mentioned period. The amount of data from such a short period is not sufficient for a reliable flood estimate based on a common

Figure -2.3 Flow Duration Curves at Weir Site



frequency analysis. In the updation Studies two approaches are considered in detail for estimation of design flood at weir and power house site.

- Derivation of flood flows for different return periods on the basis of observed flood Series of similar catchments in the region having longer historic records than Siran River at Jabori.
- Application of a rainfall-runoff model to convert maximized storm rainfalls to flood Hydrographs by using catchment parameters and the unit hydrograph concept.

2.3.3.1 Regional Approach

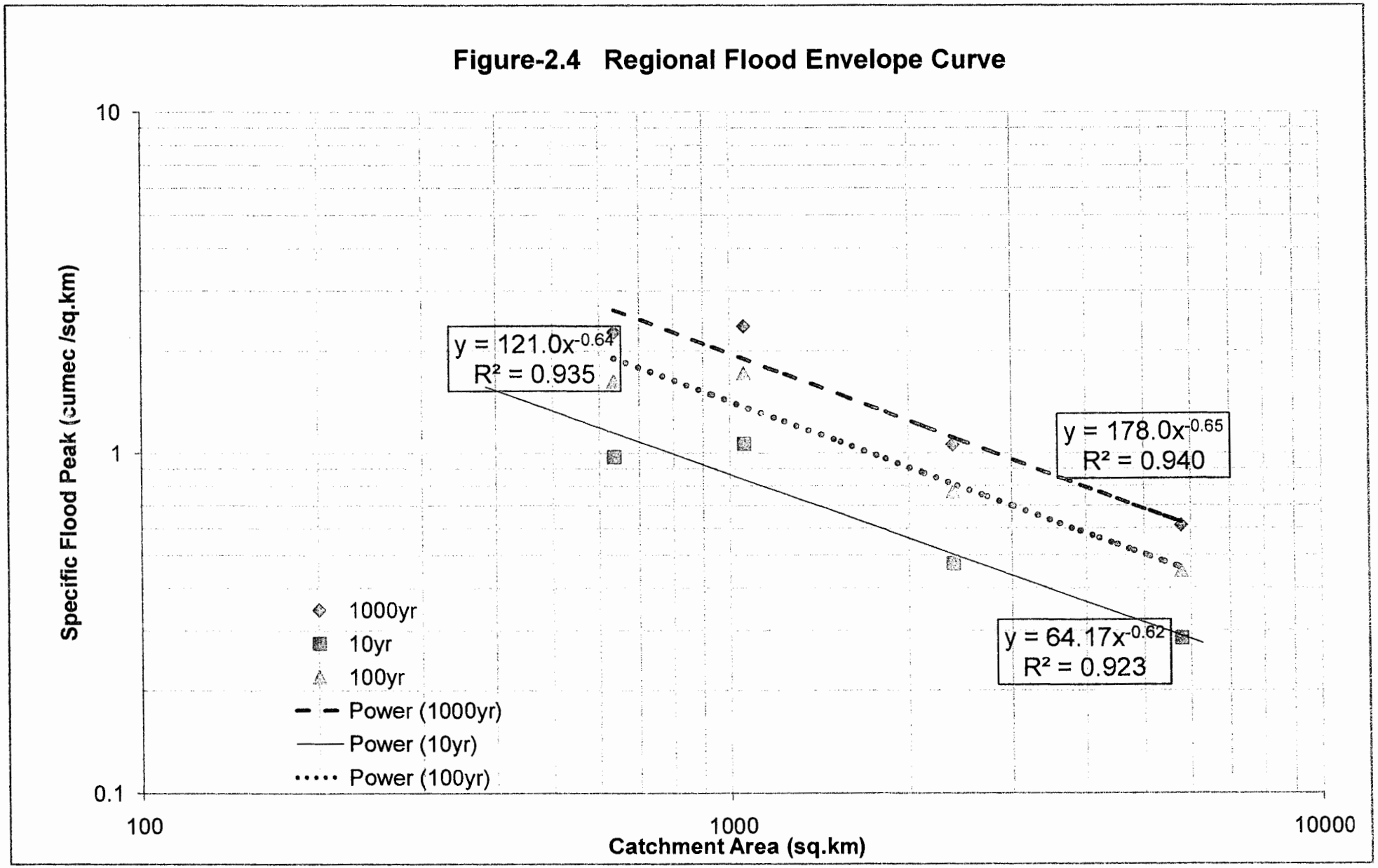
In this approach available flood peak data of the gauging stations located on different Rivers in the vicinity are collected. To enable a comparison between floods originating from different drainage areas, their specific flood discharges in terms of cumec/km² were calculated. By means of a number of probability distribution functions, a frequency analysis was performed on all available series of maximum peak discharges. The Rivers, gauging stations, period of record, catchment area and peak flood are given in Table-2.4 & Figure-2.4.

Table-2.4 Regional Flood Peaks(cumec)

River	Gauging station	years of Record	catchment area	Return Period (yr)		
			sq.km	10	100	1000
Siran	Phulra	43 (1969-2012)	1057	1127	1820	2500
Kunhar	Garhi HB	44	2383	1128	1833	2525
Gorban	Korora	29	635	619	1035	1442
Swat	Chackdara	45	5776	1642	2597	3535
	Kalam	48	2020	536	716	893
Siran River	Weir Site	-	233	509	861	1199
	Power House	-	275	543	914	1271

Specific Discharge (cumec /sq.km)						
River	Gauging station	years of Record	cathment area	Return Period (yr)		
			sq.km	10	100	1000
Siran	Phulra	43	1057	1.07	1.72	2.36
Kunhar	Garhi HB	44	2383	0.47	0.77	1.06
Gorban	Korora	29	635	0.98	1.63	2.27
Swat	Chackdara	45	5776	0.28	0.45	0.61
	Kalam	48	2020	0.27	0.35	0.44
Siran River	Weir Site	-	233	2.19	3.70	5.15

Figure-2.4 Regional Flood Envelope Curve



Power House		275	197	332	362

2.3.3.2 Rainfall-Runoff Modeling Approach

Design flood for Siran River at Jabori weir / power house sites were estimated indirectly through Unit hydrograph method. 1-Day maximum rainfall data for Jabbar for 1969-2004 & Oghi for period of 2005-2012 has been collected from SWHP, WAPDA. GEV-I distribution is fitted on the data and results against different return periods worked out (**Table-2.5**).

Table-2.5 1-Day Max. Rainfall Frequency Analysis

Return Period (yr)	Rainfall (Inches)
2	81
5	112
10	132
100	197
500	242
1000	261

Estimation of Design Flood

Design flood was estimated using Hydrological model HMS. HMS is rainfall-runoff model in which catchment area, characteristics in terms of loss rate, time of concentration and time distribution of rainfall is assigned as input and flood hydrograph at different junctions as output. Different parameters used for Hydrological model HMS for used as input in Basin Model Formulation is derived as under:

Time of Concentration

US SCS and USBR recommended Kirpich's equation from California Culverts Practice, California Highways and Public Works, September 1942. The equation is:

$$Tc = 0.0195*L^{0.77}*S^{-0.385}$$

Where

L = Length of channel in m

S = Slope (m/m)

Time of Concentration & lag at weir and power house site are **Table-2.6**.

Table-2.6 Time of Concentration & Lag				
Gauge Site				
Length (m)	28221.0	Tc	113	min
		Tlag	79	min
Weir Site				
Length (m)	24221.0	**Tc**	96	min
		Tlag	67	min
Power house site				
Length (m)	31321.0	**Tc**	131	min
		Tlag	91	min

Derivation of Unit Hydrographs

Synthetic unit hydrograph for the catchment has been developed using SCS triangular hydrograph parameters and curvilinear dimensionless unit hydrograph. Computer model HEC-HMS of US Army Corps of Engineer has been used for the derivation of unit hydrograph.

Estimation of Excess Rainfall

Excess rainfall, also called the effective rainfall, is the difference between the rainfall and the basin retention loss and produces the surface runoff to the streams of the basin. The basin retention loss is the sum of losses due to interception, infiltration and depression storage (detention loss).

For estimation of direct runoff from rainfall, Design of Small Dams gives curves of rainfall-runoff relationships developed by Soil Conservation Service from analyses of

rainfall and respective runoff records of numerous watersheds. The SCS curves are obtained using the equation:

$$Q = (P-0.2S)^2 / (P + 0.8S)$$

Where,

Q = direct runoff in inches

P = storm rainfall in inches, and

S = maximum potential difference between P and Q, in inches, at the beginning of storm.

SCS curve number of 77 is used for the watershed.

Temporal Distribution of Rainfall

As hourly data of Jabbar are not available, hourly data of extreme event of 8-10 September, 1992 at Oghi were collected and used as input in HEC –HMS model. Against 6, 12, 18, 24 & 33 hours, about 39.2, 61.3, 78, 90.1, 98.5 & 100% cumulative rainfall occur (*Referred p-4-9 of Chapter-04 of Feasibility Report August, 2011*). About 44% of 24 hour rainfalls occur within six hours. As further distribution of rainfall is not available hourly distribution pattern of rainfall within six hour have been adopted from SCS six hourly distribution (*Referred; Introduction to Hydrology Fifth Edition Warren Wiessman, JR. Gary. L. Lewis p-565 Figure-13.18*)

HEC-HMS Calibration / Design Flood Estimation

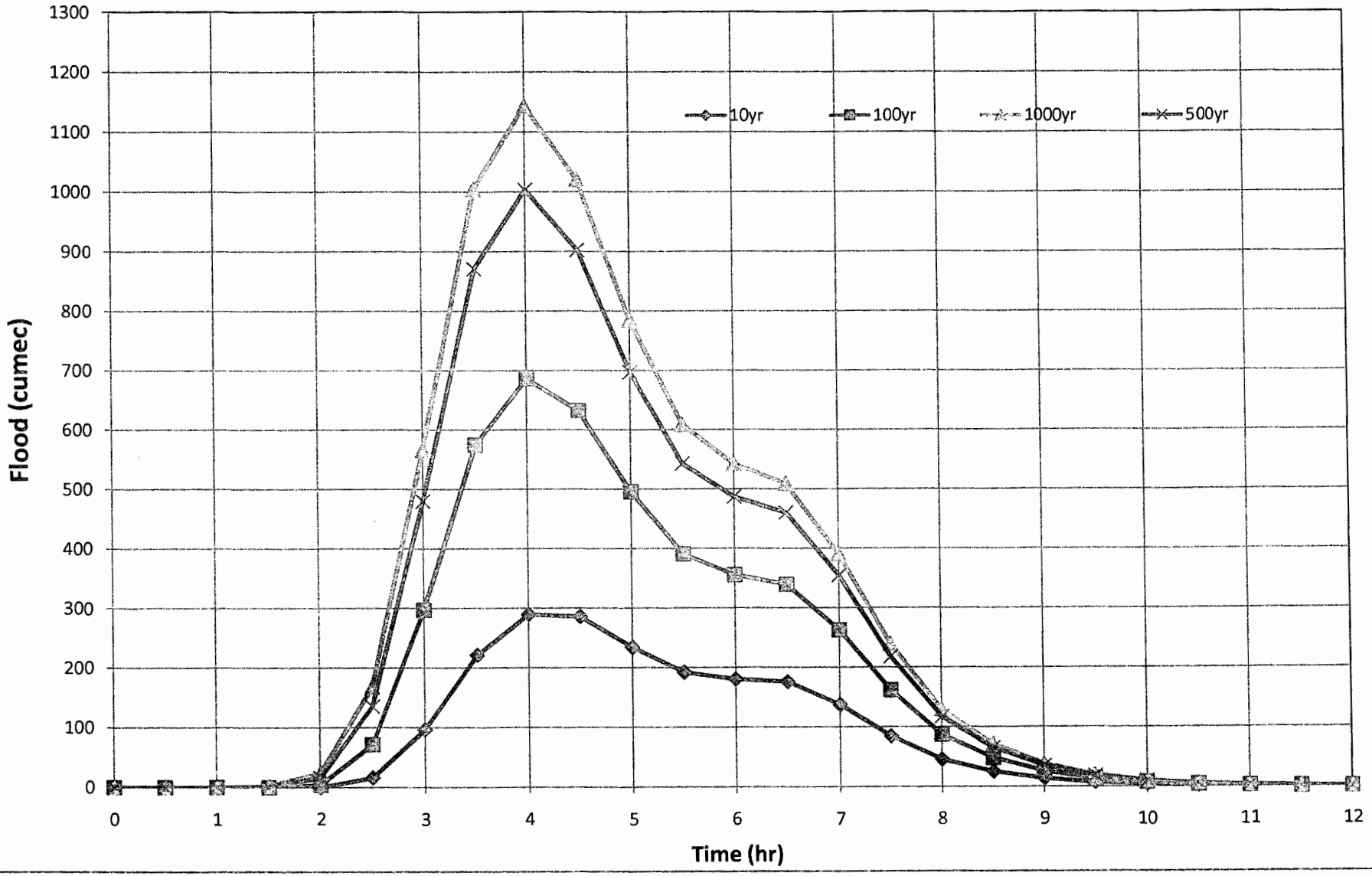
Basic parameters like initial loss rate, curve number are adopted from calibrated model for the extreme event of 29th July, 2010. Flood Peak of Siran River at Jabori gauge site has been collected from PHYDO. The flood peak at gauge site near Jabori village is 208cumec as per record provided by PHYDO. Similarly rainfall data from 27th July to 30th July, 2010 have been collected from SWHP, WAPDA & Meteorological Department Lahore. Summary of rainfall occur during the storm event at different stations in project area / vicinity are given below (Table-2.7).

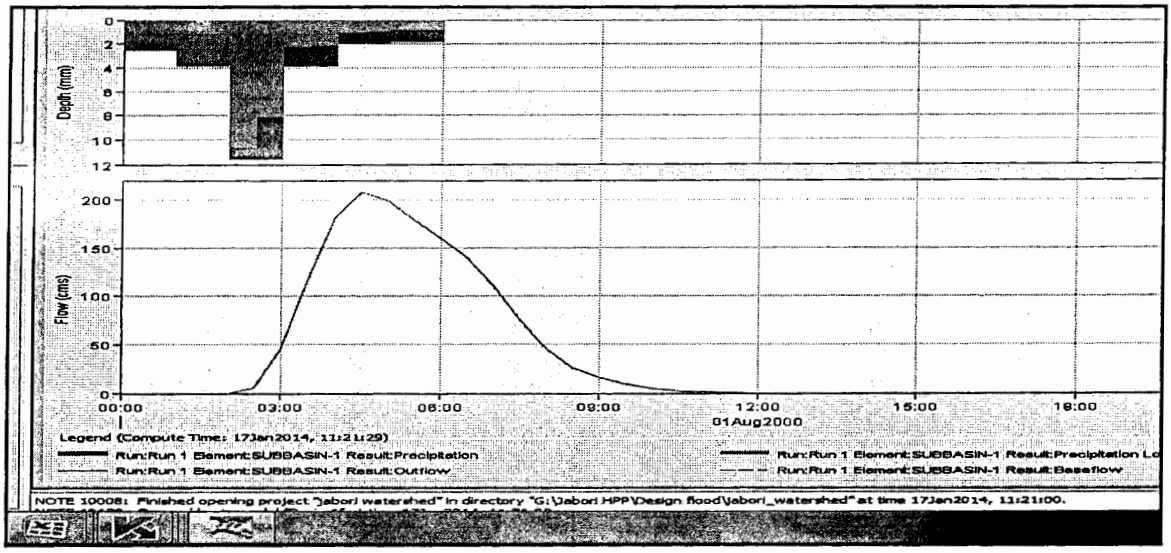
Table-2.7 Storm Event of July,2010				
Station	27th July	28th July	29th July	30th July
Oghi	1	38	117	109
Balakot	71	45	45	90
Kakul			124	
Besham Qila	5	98	127	93
Saidu Sharif	4	44	187	103
Risalpur	9	5	280	121
Note: Storm is dominant in Peshawar and Swat valley				

117mm rainfall was recorded at Oghi which is closed station to the project area as compared with other meteorological stations mentioned above. The data is used as input in the model and basic parameters like curve number and initial loss rate varied. After carrying out sensitivity analysis curve number of 77 has been selected. The resultant flood peak at gauge site is 208cumec as compared with 208cumec (Figure-2.5). Using hourly distribution of September,1992 storm , curve number -77 and lag time upto weir / power house sites , peak flood against rainfall event of 10, 100, 500 & 1000 years return periods have been worked out. The flood hydrographs at weir site are shown in Figure-2.6. The summary of peak flood against different return periods are given below (Table-2.8).

Figure-2.5 HMS model Results (29th July, 2010)

Figure -2.6 Design Flood Hydrographs at Weir Site





Concluding Remarks

Finally recommended design discharges are based on hydro-meteorological approach. Hydro-meteorological Approach is better than regional as it is based on Rainfall –Runoff modeling of the storm event of 29th July, 2010. The physical parameters of watershed are also calibrated against available flood peak and rainfall event of that storm. Summary of results of both approaches are given in **Table-2.9.**

Table-2.9 Summary of Design Peaks From Different Approaches

Return Period (yr)	Regional	Hydro-Meteorological
	Flood Peak (cumec)	
10	100	686
100	500	1003
1000	1000	1144

CHAPTER – 3

OUTLINE DESIGN OF CIVIL COMPONENTS

3. OUTLINE DESIGN OF CIVIL COMPONENTS

3.1 PROJECT LAYOUT

The project layout has been planned on the right bank of Siran River. Flows of Siran River would be diverted through Tyrolean weir, connecting channel and sandtrap into 2.9 km long power tunnel followed by a surge tank, 550 m long embedded penstock and a surface powerhouse.

The design discharge is selected as 8 m^3/s based on the optimisation in the feasibility study which reflects 30% available discharge as the optimum. With gross head of 156.75 m and net head of 148m on full plant capacity, two Francis turbines have been proposed.

Diversion weir is located at the shortest possible width of the Siran River, where a 45m long and 3.0m high Tyrolean weir is proposed. The diversion weir comprises two overflow sections; left side 23m length section is at EL. 1414.0 while on the right side, a 20m long trash rack section is 0.5m at EL. 1413.5m asl. The Side walls are provided at elevation of 1419.0m asl to pass the flood of 1000 year frequency. The River bed at the upstream is at EL. 1410.50m asl. USBR type II stilling basin is provided for energy dissipation.

The design discharge passing over the Tyrolean rack will be collected in an embedded channel provided in the weir body. The flow will be laterally released into the connecting channel proposed in sidewall of the weir.

The total length of connecting channel is 290m upto Sandtrap intake, out of which in 140m length rectangular cut and cover conduit is proposed, remaining 150m length of the channel has trapezoidal section. The connecting channel in its initial 140m reach passes closer to river in steep terrain therefore rectangular cover section is adopted. After 140m channel, trapezoidal section with concrete lining is adopted in the relatively flat area.

The channel is designed to accumulate 10 m^3/sec discharge i.e. 25% extra discharge than design discharge of 8.00 m^3/sec. Connecting channel has concrete rectangular section 140m long having bed width 2.35m and total depth of 2.0m. The design discharge will be diverted from Siran River which carries high sediment load during flood season. Sediments finer than Trash rack's opening will directly enter into the embedded channel. Therefore, to remove

fine bed load from diverted flow, a 10m long gravel trap is provided in rectangular reach of channel to evacuate the coarse sand and fine gravels.

At a distance of 140m from weir, about 150m reach of connecting channel has been designed as trapezoidal section with discharge capacity of 10 m^3/s. The channel has concrete lined trapezoidal section having 1.5H: 1.0V side slope, bed width 2.00m and total depth including free board is 1.7m at maximum capacity. The bed slope of 1:1000 is maintained over entire length of the channel.

The connecting channel will release flows into the Sandtrap having two chambers, proposed for the removal of sediments up to 0.20mm size. It has two 65m long concrete chambers, each chamber having dimensions of 4.5 x 4.5m at start and 4.5 x 5.8m at end. The bed slope of sandtrap is kept 2% for the proper flushing of the deposited sediments. For smooth flow, upstream and downstream transitions are provided. Flushing of the sediments will be done by means of two flushing gates provided at the end of each chamber. The flow in the Sandtrap will be controlled by vertical lift gates provided at the entrance and outlet section. A 22m long spillway is provided in left side wall for extra flow in case of male function of the intake gate which may release higher discharge.

The sediment free flow from Sandtrap will be controlled by means of two gates provided at end of sandtrap. The headrace channel is designed to cater design discharge 8.0 cumecs. It is rectangular section having bed width of 3m with 1.9m depth. Thickness of wall is 0.3m. The channel will collect discharge from sandtrap and will convey it through an aqueduct to the tunnel inlet portal. About 45m before reaching to intake portal area, a nullah from right side of the valley is crossing and joining the Siran River. An aqueduct is proposed to pass the flow over the nullah. Length of aqueduct is 10m with rectangular shaped having same dimensions as the approach channel.

The Inlet portal for power tunnel is about 465.00 m from the diversion weir at sufficient height from the river flood level. At this location rock is exposed providing ample reasons for placement of tunnel inlet portal. The power tunnel is a low pressure concrete lined structure. To provide adequate submergence for the power tunnel, a pond has been developed in front of tunnel inlet portal.

It is a 28m long rectangular concrete structure having bed width of 3.0m at start expending to 4.0 m at the tunnel portal. The invert level of structure has been fixed at EL. 1410.0-m while bed level at inlet portal has been lowered to EL. 1405.6m, to provide appropriate submergence of 3.25m for headrace tunnel. The water level is at EL. 1411.67m in front of inlet portal.

Layout of waterway tunnel has been adopted by considering the geological parameters. The alignment of the tunnel is fixed considering the surge tank and powerhouse location. The rock support system will provide structurally safe waterway. However for better hydraulic performance and to reduce head losses in tunnel, a 0.15m thick lining is provided in the tunnel section. The total length of the tunnel is 2895 m. The power tunnel has horseshoe section and its internal finished equivalent diameter becomes 2.65 m. Invert level of the tunnel has been fixed at EL. 1406.0m. The level of the tunnel has been fixed so as to provide minimum submergence and to prevent air entering in the tunnel. The excavated cross section type was adopted as modified horse shoe considering workability of tunnel excavation.

A 25m high surge tank with internal diameter of 5m is provided near the outlet of headrace tunnel for surge control. The calculated maximum surge level is at El.1421.1 m while static water level is at EL. 1411.6m. It is a concrete structure having 0.3m thick R.C.C. A 1m diameter orifice is provided at the bottom of surge tank at El. 1399.5m. The surge tank is connected with tunnel through orifice section which is 1.9m deep. The junction of tunnel with penstock is concrete encased.

To convey the design discharge to powerhouse, a 1.6m diameter embedded steel penstock pipe has been proposed. The flow in the penstock is pressurized; therefore its thickness would vary depending on pressure at different elevations. Pipe thickness varies from 14–18 mm in the three sections of 14mm, 16mm and 18mm.

Starting invert level of penstock has been fixed at EL. 1395.3m while its total length is 548 m. The length of main penstock (1.6m dia.) up to bifurcation is 448m, with two bifurcations (1.1m each) in 50m length. It will lead the design discharge to the turbines. Average velocity in the penstock is 3.94 m/sec at design discharge and head losses are 3.81m.

The powerhouse is located on right bank of river Siran in a slopping area about 90 m upstream of the existing bridge. The building is of RCC frame structure.

Turbines will release discharge through draft tube into the tailrace channel, which will ultimately drop back into the river. Rectangular tailrace channel has been provided downstream of the Powerhouse. The tailrace is 3.5 m wide with 1.7 m deep with 1.38m flow depth.

Some of the key parameters of the Jabori Hydropower projects are as under:

• Design Discharge	8.00 m^3/s
• Gross Head	156.75 m
• Net Head	148.0 m
• Installed Capacity	10.2 MW
• Mean Annual energy	71.10 GWh
• Plant Factor	79.57%
• Weir crests elevation	1414 m.a.s.l.
• Connecting channel length	250 m
• Sandtrap length	65 m
• Power Channel	94 m
• Surge tank height	25 m
• Penstock length	550 m
• No of Turbine	Two Francis
• Capacity of each turbine	5.1 MW
• Powerhouse	Surface, 43 m x 21 m
• Transmission length	About 20 km

3.2 POWER AND ENERGY

To meet the power demand, the project has been planned with a design discharge of 8.00 m^3/s available during 30% time of the year. With net head of 148 m, the installed capacity would be 10.2 MW and it would generate annual energy of 71.10 GWh with plant factor 79.57%.

3.3 MAIN COMPONENTS

Siran River is considered as potential stream for harnessing indigenous hydropower generation as it has steep river gradient and perennial flows. The upper areas of catchment are covered with snowfall during winter months and rainfall over the year provides adequate run-off in the River. At the vicinity of project area, Siran River is meandering with comparatively steep slope. Mainly the components of the Jabori HPP can be divided into following three categories:

- From weir upto Tunnel Inlet Portal
- Headrace Tunnel and Surge Tank
- Penstock, powerhouse and Allied Facilities

3.3.1 From weir upto Tunnel Inlet Portal

The weir site area will comprise the following civil work components:

- Access Road
- Diversion Weir
- Connecting channel
- Sandtrap
- Headrace channel
- Aqueduct
- Inlet Pond

3.3.2 Headrace Tunnel and Surge Tank

The second component of the selected layout is headrace tunnel through the hill till it daylights near the powerhouse area. The headrace tunnel is a low pressure tunnel connecting headrace intake and the penstock. Considering the hydraulic, structural stability and economic efficiency, its type has been adopted as reinforced concrete lined. This portion will comprise the following civil work component:

- Power Tunnel.
- Surge Tank

3.3.3 Penstock, Powerhouse and Allied Facilities

The third and final portion of Jabori HPP comprises the following open civil work components:

- Penstock
- Powerhouse
- Access Bridge
- Access Road
- Tailrace Channel

3.4 HYDRAULIC DESIGN OF DIVERSION WEIR

Diversion weir is located at the shortest possible width of the Siran River where a 45m long and 3.50 m high Tyrolean weir is proposed. The diversion weir comprises two overflow sections. From left side wall in 23m length, section is at EL. 1414.0 while 20m long trash rack section is to the right side, 0.5m below with crest at EL. 1413.5m asl.

3.4.1 Tyrolean Intake

Tyrolean weir intake is appropriate diversion structure for a Run-off River Project due to ample advantages and simple design. It can prove its worth owing to maintenance-free operation. The diversion of river flow for hydropower generation will take place through an embedded canal which will be covered with a screen constructed into the main weir.

The bars / plates of the screen are laid in the direction of the flow current and inclined in the direction of the tail water so that coarse bed load is kept out of the collection canal and transported further downstream. Particles which are smaller than the inside width between the screen bars, enter into the embedded channel with the water and these later on be separated from the water for power by suitable flushing devices.

It has been considered in the planning of Tyrolean intake that the whole discharge of the River will be diverted until the capacity limit of the screen is reached. If this maximum possible draw-off amount is greater than the lowest discharge, there will be no tail water. If the River inflow exceeds the screen's capacity limit (e.g. during flood events), the surplus

amounts will go to downstream. To fulfil the requirements of the environmental releases, an overflow section at Tyrolean crest level is provided.

3.4.2 Hydraulic Design of Tyrolean Weir

In the case of a vertical approach to a Tyrolean intake, amounts of water partially obstructed by the trash rack - fall into a collection canal which is intended to evacuate the water laterally. With this, a minimum water level is formed above the trash rack provided in main weir. The following weir formula is used for the design of Tyrolean intake.

$$Q = \frac{2}{3}.c.\mu.b.L\sqrt{2gh}$$

where

Q = Discharge to be diverted and

$$c = 0.6.\frac{a}{b}.Cos^{\frac{3}{2}}.\beta$$

$h = k \cdot h_{limit} = 2/3\ k\ h_E$ = "initial water height"

a = inside width between trash rack bars

d = centre distance of the trash rack bars

b = angle of inclination of the trash rack with respect to the horizontal in degrees,

β = discharge coefficient for the trash rack,

b = width of the Tyrolean intake in m,

L = length of the trash rack

The design discharge will be collected from depressed portion at 1413.5m, followed by embedded channel provided laterally in the weir body. The ogee shaped crest has been designed to pass 100 year return period flood with discharge 686 cumecs which results a 3.38m surcharge on the crest. The rating curve of flood discharge passing over weir is shown in figure 3.1 below.

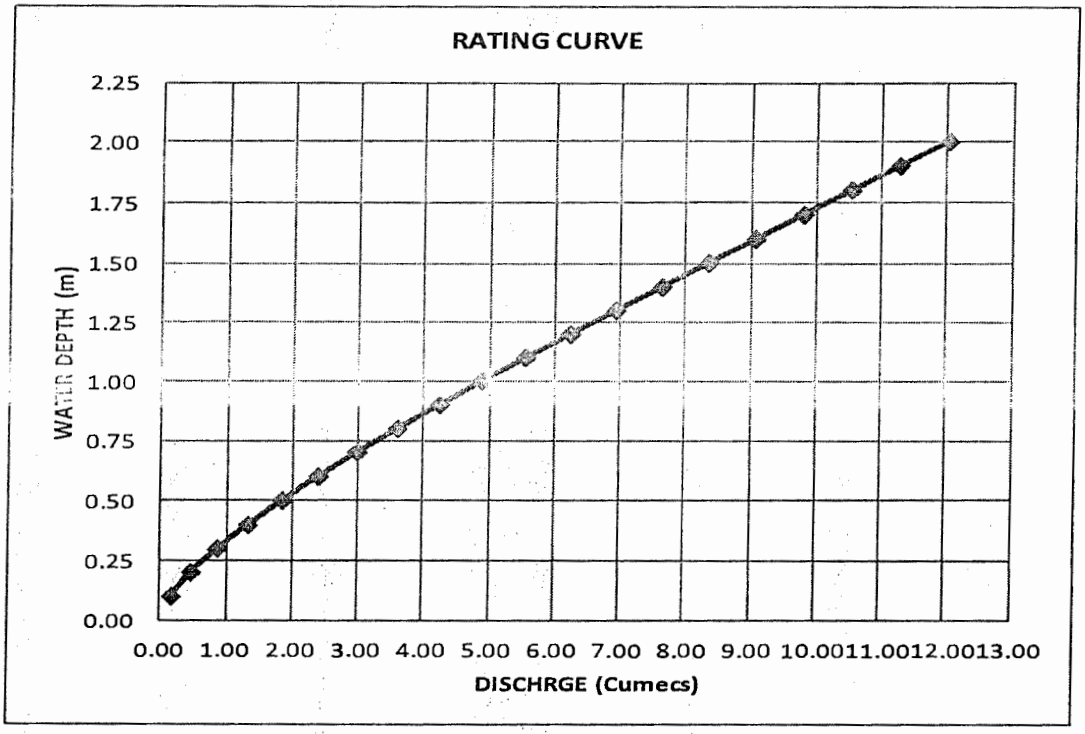


Figure 3. 1 : Discharge Rating Curve of Overflow Weir

The weir has been checked to safely pass 1000 year frequency flood without overtopping of the side walls. The design flood of 100 year frequency results in upstream water level at 1416.88m asl while the Side walls are provided at elevation of 1419.0m asl to accommodate the higher flood during operational life of project. The River bed at the upstream is at EL. 1410.50m asl which creates a 3.0m deep approach channel for sooth flow over the weir crest.

3.4.3 Trash rack Design

The oblique arrangement of the trash rack prevents it from being clogged by bed load or floating matter and the intake from being obstructed.

The Tyrolean intake is particularly suitable as an intake structure in streams transporting bed load like Siran River. In order to guarantee the diversion of the required amount of water when stones become wedged in the trash rack, or branches and leaves remain on the trash rack at low water levels, the inclination of rack provide self-cleaning opportunity. A trash rack of 2.5m wide and 20 m long has been provided for diversion of desired discharge to the collection channel. Inclination angle of the trash rack is 20 degree with horizontal plane. The

thickness of steel bars / plates and spacing is 2 cm to allow only 2 cm and lower particles to get into the embedded channel. The length of trash rack has been selected keeping a safety factor of 20%. The final length of trash rack has been calculated using following equation.

$$L = 1.2 \cdot L_{calculated}$$

3.4.4 Abutment Walls

Abutment walls are provided to serve as a watertight barrier between the pond and the impervious backfill zone. The top of side wall from overflow crest elevation (1414.0m asl) is 5.0 m high at elevation i.e. 1419.0 m asl to prevent overtopping in case of extreme flood condition (1000 years return period). Similarly, the side walls at upstream and downstream of weir are extended into the abutments to minimize seepage around the ends.

3.4.5 Embedded Channel Design

The design discharge passing over the trash rack will be collected in an embedded channel provided in the weir body. Flow will be laterally diverted into the connecting channel proposed on outer side of right sidewall of the weir. The embedded channel has capacity to cater 25% additional discharge from the designed discharge of 8.00 cumecs. Therefore, the discharge carrying capacity of the channel is 10.0 cumecs with 1.73m depth of flow. It is a 2.35m wide concrete channel having bed slope fixed as 1%. The invert level is fixed at 1410.90m asl. The channel can carry the design discharge with 1.73m depth having 0.2m freeboard. The velocity in the embedded channel is 2.46 m/sec. The channel is designed for high velocity to avoid the deposition of sediments in bed during flood season. The discharge collected in the embedded channel will be regulated through a steel lift gate (2.4m x 2.2m) provided at the end of channel, at outer side of right side wall. The channel width corresponds approximately to the length L of the trash rack.

$$B = L \cos b$$

b = angle of inclination of the trash rack bars with respect to the horizontal.

$t \sim B$

The channel depth has been so determined that a freeboard of approx. 0.2m • t (t = water depth necessary for the evacuation of the water) remains up to the lower edge of the rack

bars.

3.4.6 Hydraulic Design of Stilling Basin

Terminal structures are provided to safely deliver the spillway discharge into the outlet channel. Typical types of energy dissipaters used at the downstream of weir include a hydraulic jump stilling basin. Downstream of the terminal structure, riprap is ordinarily provided to protect the outlet channel from erosion.

Design of stilling basin is governed by several parameters such as:

- Nature of foundation
- Approach Froude number
- Impact angle of flow with respect to stilling basin floor
- Tail water level and
- Economic considerations.

In general, a hydraulic jump stilling basin is used where the energy of the flow must be dissipated prior to returning the discharge into the downstream channel.

To avoid scouring at the downstream, stilling basin is provided which accommodates the hydraulic jump within the cistern. Therefore stilling basin of type II has been adopted with end sill. It is 45m wide, 20m long and 0.5m thick concrete floor. The design flood passing over weir emerges from the weir chute attains velocities of 10.88 m/sec and the resulted Froude No is 2.94. A complete hydraulic jump will be formed. The elevation of the cistern is 1409.0m asl and the resulted tail water level is at 1414.16m asl. However, there is nominal submergence of weir crest during high flood but it doesn't affect the discharge capacity of weir.

Side wall of the stilling basin are at EL.1415.0m. The downstream floor level has been fixed at 1409.50m asl. The level is fixed keeping in view the retrogression expected and has been checked for the sequent depth at various flows. On the right and left abutment the weir will be connected to exposed rock, while in the river bed grouting is proposed in 20m depth to connect the weir with bed rock to discard the seepage flow.

The principle of conservation of linear momentum results in the classical hydraulic jump

equation

$$D_2 / D_1 = \frac{1}{2} [(1+8F^2)^{1/2} - 1]$$

$$D_2 = - D_1/2 + (2V_1^2 D_1/g + D_2/4)^{1/2}$$

The Froude No. at the toe i.e., before the jump is

$$F1 = V_1/(gD_1)^{1/2}$$

To ensure that a stilling basin performs its function efficiently (i.e. dissipation of energy is occurred properly) basin has been designed in such a way that the elevation of tailwater depth in the downstream channel not be much less than the elevation of conjugate depth of jump. Otherwise sweep out of the jump from the basin takes place and as a result scouring of downstream riverbed will occur. If the conjugate depth is too low the jump will be drowned. As a result, it will lose its function as an energy dissipater.

3.4.7 Fish Ladder

Fish Ladder or Fish ways are required on rivers where one or several important fish species need to migrate upstream as part of their life cycle requirements. A fish way provides a means for fish to bypass a diversion dam which in other circumstances would be a barrier to fish migration. At diversion weir fish way is provided for travelling of fishes to upstream area during low flow season.

Fish ways are usually planned according to the following principles:

- The layout is designed so that there is a significant velocity in the area approaching the fishway. In their upstream migration fish use the current as a direction guide, so if the entrance to the ladder is located in a dead area the fish may not find it.
- The upstream exit for fish from the fishway should be in a quiet area well away from the overflow section or sluiceway otherwise the fish may be carried back downstream.
- Maximum velocities in the fishway should not exceed the burst speed (or darting speed) for the fish. This is the speed that the fish can swim for a few second and is in the order of 8 to 12 body lengths per second. A typical velocity is 2.5 m/s. At this velocity the drop in elevation between pools is limited to about 0.3m.
- Average velocities in the fishway should be about 0.30 to 0.45 m/s.

- Minimum depth of water opposite the entry to fishway is 0.6m to 0.9 m and at the exit 0.6m.

Based on the above mentioned criteria, 1m wide and 18m long pool fish ladder is provided at weir for migration of fishes to upstream. The invert of first pool is fixed at 1413.6m while length of each pool is 1m and drop between adjacent pools is 0.1m, the thickness of side walls is 0.5m.

3.5 GRAVELTRAP

The embedded channel laterally off takes from right flank of weir into connecting channel which leads the flow to graveltrap provided at 30m distance from its intake. The connecting channel flows adjacent to right sidewall of weir parallel to the River flow.

The design discharge will be diverted from Siran River which carries high sediment load during flood season. Although trash rack is provided over the weir but the sediments finer than trash rack's opening will directly enter into the embedded channel. It is preferable to remove fine bed load from diverted flow. Therefore, a graveltrap is provided to evacuate the coarse sand and fine gravels from diverted flow.

Tyrolean intake is designed on Siran River in order to eliminate possible floating debris and bed load transport. However, it cannot prevent the entrance of suspended sediment transport. For this reason, a graveltrap is provided downstream of intake in connecting channel. The main objective of trap is not only to avoid sedimentation of downstream structures but also to limit the possible damages due to sediments on the hydro mechanical equipment.

A trap is based on the principle of diminishing the flow velocities and turbulence. This results in a decantation of sediments in the trap. This diminishing is obtained by an enlargement of the canal, controlled by a downstream weir.

$$L \geq \frac{Q}{V_D B}$$

The necessary length of a sediment trap is defined by the equipped discharge of the intake and by the chosen efficiency of the trap (grain diameter that still deposits inside the trap). The length of gravel trap chamber is 10m so that all grains have the time to deposit before

leaving the trap. This happens when the deposition time t_D equals the transfer time t_T. The former is defined as h/v_D and the latter as L/v_T. Hence, the minimum length required to deposit a grain of diameter d_D is calculated by using:

The deposition velocity v_D is defined by the Newton or Prandtl formula for spherical particles and under ideal conditions, i.e. pure water, no turbulence and no wall effects. It depends on the form drag of the particle, which on its turn depends on the Reynolds number. For real situations, no formula exists and experiments should be carried out. For practice, the empirical formula of Zanke is used as a first hand approach in still water flow conditions

$$V_D = {}^{100}\!/_{9d}\left(\sqrt{1+1.57\,d^3}-1\right)$$

Finally, for appropriate design, the critical transfer velocity of the trap has to be defined. This critical velocity in gravel trap becomes 1.53 m/sec which defines the limit between the suspension regime and the deposition regime. If the velocity is high, deposited sediments risk to be entrained again by the flow. For a Manning-Strickler roughness value of K = 60 $m^{1/3}/s$ (K = 1/n, average value for concrete) and for a grain-to-water density ratio of 2.65 the following formula is used for design:

$$V_{cr} = 13R_H^{1/6}\sqrt{d}$$

The calculated length of gravel trap becomes 10m from its start to invert of downstream channel. Invert of graveltrap is fixed at El.1410.77m asl while depth of water at start is 1.73m and corresponding water level becomes El. 1412.50m. There is 0.3m freeboard provided in gravel trap section and 2.35m base width at start which becomes 2.75m at the end. The flushing arrangement is provided for evacuation of settled particles. For this purpose 0.8 x 0.55m steel lift gate has been provided in the left side wall of the graveltrap. The invert level of the gate is at El. 1410.0m asl while the floor level at this location is at El. 1409.95m asl.

3.6 CONNECTING CHANNEL

The total length of connecting channel is 290m upto sandtrap intake, out of which in 140m length rectangular cut and cover conduit is proposed, remaining 150m length of the channel has trapezoidal section. The connecting channel in its initial 140m reach passes closer to River in steep terrain in rectangular covered section. After a 100m distance from the weir,

the River has an outer bend. As a result, the River main stream moves away from channel. This is a relatively flate section and therefore trapezoidal section with concrete lining is adopted in this reach of connecting channel.

The discharge after removal of coarser particles will enter into connecting channel which leads the flow to sandtrap for fine sediments removal. The channel has been designed to accumulate 25% extra discharge than design discharge of 8.00 m^3/sec. The Siran River flows in a straight reach at the location of connecting channel.

3.6.1 Hydraulic Design of Connecting Channel (Rectangular Section)

Connecting channel hydraulic design is based on the following criteria:

Design flow (Q_d) = Turbine flow (Q_T) + Sandtrap flushing flow (Q_F).

The flow conveyed by a channel is a function of its cross-sectional profile, its slope, and its roughness. In hydropower schemes the flow in the channels is generally in rough turbulent zone. Therefore the channel has been designed on the bases of Manning equation. The design parameters have been adopted to maintain non-silting velocity in the channel at design discharge as well as at minimum discharge.

$$V = \frac{1}{n} S^{1/2} R^{2/3}$$

Top cover is provided to avoid any rolling material to be fall in. The whole channel reach has been made in the cuttings which follow in most part of length the natural contour. A sufficiently high velocity is provided to prevent deposition of sediment within the canal. Connecting channel has concrete rectangular section 140m long having bed width 2.35m and flow depth 1.73m at maximum design capacity. The bed slope of 1:400 is maintained over entire length of the channel. The adopted Manning's n value is 0.016 for concrete finished section. The flow velocity in the section is 2.50 m/sec and the freeboard of 0.27m at channel design capacity has been given all along the channel to avoid any over flow during operation.

The walls are vertical having internal height of 2.0 m and wall thickness is 0.3 m from top to bottom; the top cover slab is 0.2m thick. The thickness of base is 0.3 m. A 0.05 m thick PCC layer has been provided under the base of the channel to give the structure smooth surface

and to transfer the load to the ground uniformly.

The length of covered portion of connecting channel is 140m after that, it emerges into a Trapezoidal section in 150m length. The invert level of the covered reach is 1410.85m and corresponding water level is 1412.58m. Channel bed levels and water levels at the end are at El. 1410.50m and 1412.23m respectively.

Expansion joints are given at regular interval of 25 m to accommodate the expansion and contraction of concrete due to temperature variations, whereas PVC construction joints are also provided as per requirement of the section. The connecting channel has been protected by providing minimum one meter top soil cover and towards river side gabion protection has been provided.

3.6.2 Hydraulic Design of Connecting Channel (Trapezoidal Section)

The 150m reach of connecting channel has been designed as trapezoidal section with discharge capacity of 10 cumecs, i.e 25% extra discharge than design discharge of 8.00 m^3/sec. The channel has been designed by using Manning equation. The design parameters have been adopted to maintain non-silting velocity in the channel at design discharge as well as at minimum discharge. The channel is passing through overburden in this reach; therefore flatter side slope has been made in the cuttings which follow in most part of length the natural contour.

A sufficiently high velocity has been provided to prevent deposition of sediment within the canal. This (scouring) velocity has been determined from the following formulae:

$$S_c = 0.66 \frac{d^{9/7}}{q^{6/7}}$$

The channel has concrete lined Trapezoidal section having 1.5H: 1.0V side slope, bed width 2.00m and flow depth 1.41m at maximum design capacity. The bed slope of 1:1000 is maintained over entire length of the channel. The adopted Manning's "n" value is 0.016 for concrete finished section and resultant flow velocity is 1.7 m/sec. At 10 cumecs discharge, total depth of channel is 1.7m including freeboard of 0.29m along the channel to avoid any over flow during its operation.

The thickness of concrete lining contains two layers. The upper layer is 75mm thick P.C.C. 1:2:4 and the lower layer is 75mm thick P.C.C 1:4:8 provided under the base of the lining to give the structure smooth surface and to transfer the load to the ground uniformly.

The invert level of the trapezoidal reach of connecting channel is 1410.82m and corresponding water level is 1412.23m. Corresponding bed levels and water levels at the end of channel are at El. 1410.67m and 1412.08m respectively. The trapezoidal section has been designed by using Manning's equation.

The Trapezoidal section of connecting channel terminates in sandtrap at a distance of 290m from weir. Before entering into sandtrap, a smooth transition is provided to connect the trapezoidal section to rectangular section. The length of transition is 7.55m with bed width 2m at upstream and 4.6m at the connection with sandtrap inlet. The depth of flow in trapezoidal section is 1.41m in the transition and resultant velocity is 1.5m/sec.

3.7 SANDTRAP

Sediment transported in the flow especially particles of hard materials such as quartz can be harmful to turbine components. The severity of damage to equipment is a function of several variables, notably: sediment size, sediment hardness, particle shape, sediment concentration and plant head. The control of turbine wear problems due to silt erosion requires a comprehensive design approach in which sediment properties, turbine mechanical and hydraulic design, material selection and features to facilitate equipment maintenance are all considered (Naidu, 2004). The connecting channel will release flows into the Sandtrap having two chambers, proposed for the removal of sediments up to 0.20mm size.

3.7.1 Design Criteria

The principle design criteria adopted for Sand trap design are:

- The target size for removal (d): d = 0.20 mm is recommended
- Flushing flow: $Q_F = 0.2\ Q_P$ is recommended

- Total (design) flow: $Q_T = Q_P + Q_F = 1.2\ Q_P$.

Where Q_P is plant flow capacity i.e. 8.0 m^3/sec.

3.7.2 Hydraulic Design of Sandtrap

A Sandtrap consist of the following structural elements:

- Inlet section
- Settling tank
- Outlet section
- Flushing system

The average velocity of settling partials has been calculated by using equation

$$U \leq a\sqrt{d}$$

Average velocity in the chamber has been kept as 0.168 m/sec which is sufficient to settle and remove the desired sediments of 0.2mm. Moreover, an inclined trash rack at the start of sandtrap is provided to restrict the debris entry.

The length of chamber has been calculated using

$$L = \frac{v_d H}{v_s - 0.04 v_d}$$

The Sandtrap has upstream transition section provided at the junction of connecting channel and Sandtrap. The sandtrap invert, where it joins the connecting channel is at El. 1410.67m. There is transition on the sides as well as on the bed. The side transitions on both sides flare at an angle of 20°. Width between the two transition walls will be 8.7 m. The transition length is 10 m. In the same length, the bed will slope downward up to El. 1404.5 m and the sides and bed will attain full width and depth.

The provided length of Sandtrap chambers is 65m. The dimensions of the chamber at start are 4.5m wide and 4.5m deep with trapezoidal bed. The chambers have a bed slope of 2.0% which increase the depth of chamber to 6.45m at the end. The Sandtrap invert is at El. 1410.67m and corresponding water level at start is 1412.08m. The chambers are

separated by 0.3m thick wall. The height of wall varies along chamber length and the height of divide wall varies between 4.2 m and 6.5 m.

The freeboard in the sandtrap is provided as 0.4m. The total length of Sandtrap including upstream transition, chambers length and downstream transition becomes 80m. The outflow to the downstream headrace channel will be regulated by two gates provided at the end of Sandtrap chambers.

3.7.3 Flushing Arrangement

The flushing discharge for removal of sediment has been calculated by using

$$Q_f = 0.53 \times (W_{FG} \times H_{FG}) \times \sqrt{2gW_{fc}}$$

There will be two deep channels in chambers bed so that the settled particles of the sediments will be collected in the deep section and will be easily flushed. The removal of settled sediments from chamber will be done by means of flushing channel provided at the end of each chamber at 1404.45m asl. The chambers are equipped with two sliding steel gates (0.8 x 0.55m). The discharge capacity of the flushing gates is 20% of design discharge.

3.7.4 Spilling Arrangement

To ensure that the sandtrap never overflows, endangering the slope stability and in addition to provide a generous freeboard, a lateral spillway is provided on left side wall. A 22m long overflow spillway section towards river side is proposed. The spilling section has been designed to cater 50% of design discharge which result in 0.2m surcharge on the overflow crest (El. 1412.12m asl).

3.7.5 Trash racks

One of the major functions is to minimize the amount of debris and sediment carried by the incoming water, so trash racks are placed at the entrance to the Sandtrap to prevent the ingress of floating debris and large stones. A trash rack is made up of one panels, fabricated from a series of evenly spaced parallel metal bars. If the watercourse, in the flood season, entrains large debris, it is convenient to install, in front of the ordinary grill.

The trash rack is designed so the approach velocity (V_0) remains between 0.60 m/s and 1.50 m/s. The maximum possible spacing between the bars is generally specified by the turbine manufacturers. Typical values are 20-30 mm for Pelton turbines, 40-50 mm for Francis turbines and 80-100 mm for Kaplan turbines.

The water level at the end of Sandtrap is 1412.07m before entering into transition between Sandtrap and downstream channel. The friction head losses in the chamber have been calculated by using Manning's equation.

$$h_f = n^2 \frac{V^2 L}{R^{4/3}}$$

3.8 HEADRACE CHANNEL

The sediment free flow from Sandtrap will be controlled by means of two gates provided at end of Sandtrap chambers. Therefore the headrace channel is designed to cater design discharge of 8 m^3/s only. The channel will collect discharge from sandtrap and will convey it to aqueduct and finally tunnel inlet portal. It is a concrete lined rectangular channel starts from Sandtrap downstream transition.

3.8.1 Hydraulic Design of Headrace Channel

The flow conveyed by a channel is a function of its cross-sectional profile, its slope, and its roughness. Natural channels are normally very irregular in shape, and their surface roughness changes with distance and time. The application of hydraulic theory to natural channels is more complex than for artificial channels where the cross-section is regular in shape and the surface roughness of the construction materials - earth, concrete, steel or wood is well documented, so that the application of hydraulic theories yields reasonably accurate results the flow in the channels is in general in the rough turbulent zone and the Manning equation can be applied:

$$Q = \frac{A \cdot R^{2/3} \cdot S^{1/2}}{n} = \frac{A^{5/3} \cdot S^{1/2}}{n \cdot P^{2/3}}$$

where n is Manning's coefficient, which in the case of artificial lined channels may be estimated with reasonable accuracy, adopted as 0.016 for concrete, and S is the hydraulic gradient, which normally is the bed slope which has been taken as 0.001m/m. The above equation shows that for the same cross sectional area A and channel slope S, the channel with a larger hydraulic radius R, delivers a larger discharge. That means that for a given cross sectional area, the section with the least wetted perimeter is the most efficient hydraulically.

Actual dimensions have to include a certain freeboard (vertical distance between the designed water surface and the top of the channel bank) to prevent water level fluctuations overspilling the banks. The total depth of the Headrace channel is 1.9m with 1.6m flow depth, Minimum freeboard for headrace channel is adopted as 0.3 m.

The bed width of the headrace channel is 3m having side slopes at 1.5H:1V. The channel has been designed by using Manning's criteria and the adopted value of Manning's "n" is 0.016 for concrete lining which results in average velocity of the channel as 1.67 m/sec. The water level at the start and end of head race channel are 1412.07 and 1411.91 respectively. The total length of headrace channel before entering into intake pond is 94m which include a 10m long Aqueduct at distance of 40m from its start.

3.9 AQUEDUCT

The crossing of a stream or a ravine requires the provision of a flume, a kind of prolongation of the canal, with the same slope of connecting channel, supported on concrete or steel piles or spanning as a bridge. Steel pipes are often the best solution, because a pipe may be used as the chord of a truss, fabricated in the field. The only potential problem is the difficulty of removing sediment deposited when the canal is full of still water.

In Jabori Hydropower project the diverted flow for power generation after removal of sediment will pass through an RCC aqueduct.

3.9.1 Hydraulic Design of Aqueduct

Aqueducts are typically required where canals pass over a gully or side stream valley. If the length of the aqueduct is relatively short, the same channel dimensions as for the canal can be retained and there would be no change in hydraulic design.

About 45m before reaching to intake portal area, a nullah from right side of the channel is crossing and joining the Siran River. Therefore, in this section an aqueduct is planned to pass the Headrace channel over nullah.

The changes in invert elevation across the entry and exit structures are calculated by using Bernouli's equation as below:

$$Z_1 + D + \frac{V_1^2}{2g} = Z_2 + d + \frac{V_2^2}{2g} + hL$$

Head losses at upstream transition has been calculated by using equation below

$$h_L = 0.10\left(1 - \frac{b}{B}\right)\frac{V_2^2}{2g}$$

An upstream and downstream transition is provided. The throat section of aqueduct is rectangular having 2m width and 1.6m flow depth. The slope of the flume section is determined from Manning's equation. Total depth of this section is 1.9m with 0.3m freeboard and average velocity is 2.11 m/sec. The water level at the start of aqueduct is at 1412.0m while the corresponding bed level is at 1410.4m.

3.10 INTAKE PORTAL AND POND

An intake must be able to divert the required amount of water into a power tunnel or into a penstock without producing a negative impact on the local environment and with the minimum possible head losses. A well-designed intake should not only minimize head losses but also preclude vorticity, which can appear for low-head pressurized intakes (power intakes) and should be avoided because it interferes with the good performance of turbines - especially bulb and pit turbines. Vortices may effectively:

- Produce non-uniform flow conditions
- Introduce air into the flow, with unfavourable results on the turbines: vibration, cavitation, unbalanced loads, etc.
- Increase head losses and decrease efficiency

3.10.1 Hydraulic Design of Intake Pond

The criteria to avoid vorticity are not well defined and there is not a single formula that adequately takes into consideration the possible factors affecting it. According to the ASCE Committee on Hydropower Intakes, disturbances, which introduce non-uniform velocity, can initiate vortices include:

- Asymmetrical approach conditions
- Inadequate submergence
- Flow separation and eddy formation
- Approach velocities greater than 0.65 m/sec
- Abrupt changes in flow direction

Lack of sufficient submergence and asymmetrical approach seem to be the most common causes of vortex formation. An asymmetric approach is more prone to vortex formation than a symmetrical one. When the inlet to the penstock is deep enough and the flow is undisturbed, vortex formation is unlikely.

Empirical formulas exist that express the minimum degree of submergence of the intake in order to avoid severe vortex formation. Nevertheless, no theory actually exists that fully accounts for all relevant parameters. Therefore the intake pond has been designed to provide minimum submergence for the proper functioning of the Power tunnel and Penstock. The submergence of the power tunnel has been calculated by using following formulae.

$$S_{min} = D\left(1 + 2.3\frac{V}{\sqrt{gD}}\right)$$

The Inlet portal for power tunnel is about 465.00 m from the Diversion weir, the portal is

provided at sufficient height. At this location rock is exposed which is suitable for placement of tunnel intake portal. The power tunnel is a low pressure concrete lined structure. To provide adequate submergence for the power tunnel, a pond has been developed in front of tunnel inlet portal. The water level in the pond area created for inlet portal has been lowered by 0.3m then upstream to accumulate backwater effect due to overflow spillway provided at the right side wall of pond.

It is a 28m long rectangular concrete section having bed width at start is 3.0m and final width at portal is 4.0 m. The invert level of structure has been fixed at EL. 1410.0-m while bed level at inlet portal has been lower to EL. 1405.6m, which will provide appropriate submergence of 3.25m for headrace tunnel. The water level at design discharge is at EL. 1411.67m in front of inlet portal.

3.10.2 Spilling Arrangement

A 16m long overflow spillway is proposed in intake pond towards river side at elevation 1411.85m which results in 0.34m surcharge on spill sections crest. The portal has semi bell-mouth inlet. An inclined trash rack is provided at the inlet portal. The size of the trash rack will be 3.50 m x 5.0 m.

3.11 HEADRACE TUNNEL

The alignment of the tunnel is fixed considering the surge tank and powerhouse location. The outcropping rock gives good tunnelling conditions for construction. The tunnel alignment has kept away from populated areas on the top of the hills so that to avoid any disturbance due to blasting during construction of tunnel. Minimum Rock cover over the tunnel along its route is 90m while maximum rock cover is 180m.

The optimum design of the waterway tunnel has been performed thorough review of the topographical and geometrical conditions, the powerhouse direction and the hydraulic conditions such as water hammer and surging phenomenon. The waterway tunnel should be structurally stable against the internal and external water pressures, to provide the high water-tightness. Tunnel support system including steel ribs, Rockbolts and Shortcrete will be provided according to rock condition along tunnel alignment.

The rock support system will provide structurally safe waterway. However for better

hydraulic performance and to reduce head losses in tunnel, a 0.15m thick lining is provided to tunnel section. The total length of the tunnel is 2895 m having gentle bed slope of 1 in 1000. The calculated velocity is 1.5 m/sec at design discharge and cross sectional area becomes 5.51 m2. The power tunnel has horseshoe section and its internal finished equivalent diameter becomes 2.65 m. As the power tunnel will be concrete lined, therefore the Manning's 'n' value used for calculation of head loss is 0.014. Invert level of the tunnel has been fixed at EL. 1406.0m while the corresponding water level is at EL. 1411.67m which provides 3.5m submergence to the tunnel. The invert level of the tunnel has been fixed so as to provide minimum submergence so as to prevent air entering in the tunnel.

The cross section type was adopted as modified horse shoe considering workability of tunnel excavation. The horse shoe shape of inner cross section will provide stable section for hydraulic and structural performance. The tunnel while traverse through the hill has one smooth bend. When the tunnel daylights near the powerhouse, it will be connected to steel penstock at the outlet of tunnel.

The rated discharge for will be 8.00 cumecs when both the units at full capacity will be working. The velocity in the power tunnel will depend on the discharge passing through the tunnel.

3.12 SURGE TANK

The headrace tunnel is a pressure type and as its length becomes very longer, abnormal pressure rise or reject happens by surging and water hammer by the sudden start or stop during the turbine and pump operation. A water tank called surge tank is installed in the headrace tunnel for fluent flow & absorption taking control of the load increment to ensure structural stability of headrace tunnel against the water hammer according to the pressure variations. If surge tank is installed, pressure vibration is reflected from the surface of water tank by the water hammer during the maximum upsurging. The pressure increase does not reach the pressure tunnel and a discharge is temporarily supplied into the surge tank during the maximum down surging. Therefore, abnormal drop is prevented.

3.12.1 Hydraulic Design of Surge Tank

A surge tank provides a reliable solution that controls excessive water hammer pressure rises and provides good speed regulation characteristics as well. The main functions of a surge

tank are:

- To reduce the magnitude of water hammer pressures at the turbine by reflecting incident water hammer waves at the surge tank, thus limiting the play of water hammer to the section between surge tank and powerhouse rather than between reservoir (intake) and powerhouse.
- To improve the regulating characteristics of a hydraulic turbine. With a surge tank, the length of water column initially accelerated (or decelerated) is limited to the portion of conduit downstream of the surge tank junction to the powerhouse which is typically much shorter than the full length from intake to powerhouse.

- A surge tank provides storage for excess water on load rejection while during load acceptance water can initially be drawn from this storage. This permits water in the upstream conduit to be accelerated without excessive drop in pressure in the penstock supplying the turbine.

Simple orifice type surge tank is provided for Jabori hydropower Project to protect the low pressure conduit system from high internal pressure and to minimize the possible risk of water hammer due to pressure change in closed pipes.

3.12.2 Location of Surge Tank

The surge tank is located 30m upstream from tunnel outlet portal with 35m rock cover, sufficient height to prevent overflow for all conditions of operation unless an overflow spillway is provided. The bottom of the surge tank is at El.1396.9m which is low enough that during its operation the tank will not drain and admit air into the turbine penstock.

3.12.3 Design of Surge Tank

The surge chambers are designed to meet the following conditions.

- The surge chamber must be so located that pressure variations caused by water hammer are kept within acceptable limits.
- The chamber must be stable, i.e. the surges resulting from small partial load hanges must be naturally damped and must not under any condition be sustained or

malified.

- The chamber must be of such size and so proportioned that it will contain the maximum possible upsurge (unless a spillway is provided). The lowest down surge will not allow air to be drawn into the tunnel. The range of surges must not be great enough to cause undesirably heavy governor movements or difficulty in startup load

Design parameters of the surge tank are given below

Design discharge	= 8 cumecs
Headrace water level	= 1411.67 m asl
Headrace tunnel equivalent diameter	= 2.65m
Headrace tunnel length	= 2890m
Headrace tunnel slope	= 0.0038 m/m
Headrace tunnel material	= Concrete lined

Using the above mentioned parameters a 25m high surge tank with internal diameter of 5m is provided in Headrace tunnel. The calculated maximum and minimum surge levels are El.1421.1 m and El. 1401.0m respectively, while static water level is at EL. 1411.6m. It is a concrete lined structure having 0.3m thick R.C.C, 1m diameter orifice is provided at the bottom of surge tank at El. 1399.5m. The surge tank is connected with tunnel through orifice section which is 1.9m deep. The centreline of the headrace tunnel at the junction of surge tank is at EL. 1396.25m.

3.13 PENSTOCK

A penstock is a steel pipe to convey the water from surge bay to powerhouse. Its function is to deliver water to power units from the tunnel through the manifold block. The penstock is to withstand full thrust of water, corrosion resistant and to prevent seepage leading to powerhouse which will be detrimental to the components of the powerhouse.

To convey the design discharge of 8.0 m^3/s, embedded penstock pipe has been proposed. The flow in the pipe is pressure flow; therefore pipe thickness would vary depending on pressure.

3.13.1 Hydraulic Design of Penstock

Penstock starts from 35m downstream of surge tank. Initial 20 m of penstock which is horizontal portion would be encased in tunnel and the rest of length would be embedded. Penstock is characterized by materials, diameter, wall thickness and type of joint:

- The material is selected according to the ground conditions, accessibility, weight, jointing system and cost.
- The diameter is selected to reduce frictional losses within the penstock to an acceptable level.
- The wall thickness is selected to resist the maximum internal hydraulic pressure, including transient surge pressure.

The diameter is selected as the result of a trade-off between penstock cost and power losses. The power available from the flow Q and head H is given by the equation

$$D = 2.69\left(\frac{n^2 Q^2 L}{H}\right)^{0.1875}$$

The resulted diameter from relation becomes 1.6m which has been selected for Penstock diameter. The thickness of the steel pipe has been calculated by considering the water pressure over and above the gross head.

The wall thickness required depends on the pipe material, its ultimate tensile strength (and yield), the pipe diameter and the operating pressure. In steady flows (discharge is assumed to remain constant with time) the operating pressure at any point along a penstock is equivalent to the head of water above that point. The wall thickness in this case is computed by the

$$e = \frac{P_1 \cdot D}{2\sigma_f}$$

equation

15 % pressure rise has been taken in design calculations. The thickness of pipe varies from 14–18 mm plate thickness depending on pressure.

Invert level of penstock has been fixed at EL. 1395.3m while its total length is 548 m. The

length of main penstock upto bifurcation is 448m, with two bifurcations in 50m length. It will lead the design discharge to turbine, before entering into power house it bifurcates to dia 1.1 m and finishes at the spiral case level of the turbine. Average velocity in the penstock is 3.94 m/sec at design discharge. The Manning's 'n' value used for calculation of head loss is 0.012.

Actually the main head losses in a penstock are friction losses. The head losses due to turbulence passing through the trash rack, in the entrance to the pipe, in bends, expansions, contractions and valves are minor losses. Consequently a first approach will suffice to compute the friction losses, using for example the Manning equation.

$$\frac{h_f}{L} = 10.3\frac{n^2 Q^2}{D^{5.333}}$$

The usual limit of head losses in penstocks is 4% of gross head from economic point of view. The total losses in the penstock are calculated by using above equation becomes 3.81m are about 2% of the gross head i.e. well in permissible limits.

3.14 POWERHOUSE AND TAILRACE

Turbines will release discharge through draft tube into the tailrace channel, which will ultimately drop back into the river. Rectangular tailrace channel has been provided downstream of the Powerhouse. The draft tubes will open in the tailrace channel which will join the river with proper transition on the sides as well as on the bed. Practically, there will be no loss of head because the velocity in the tailrace is low and it will be turbulence free flow. Sufficient submergence will be provided to the turbines for their efficient running. For tailrace, a concrete structure with gates and stoplogs is proposed alongwith an open channel. Rectangular tailrace channel is proposed at the downstream of the powerhouse. The tailrace is 3.5 m wide with 1.7 m deep with 1.38m flow depth and average velocity of 1.4 m/sec while value used for Manning's 'n' is 0.016.

The invert level of tail race is at El. 1255.6m and corresponding water level at 8 cumec design discharge is at El. 1257.0m, the length of tailrace channel is 30m.

3.15 ACCESS ROADS

Overall access is easy by existing main road from Mansehra. A truckable access road 400m long will be constructed to connect the weir with existing road on left side of river.

Access to the powerhouse area will be through an access bridge constructed across Siran River. At surge tank area, a temporary access road will be constructed to connect the surge tank with outlet portal and powerhouse site.

A new temporary road of approximately 2.0 km length has to be constructed from existing road in the area to surge tank. The maximum gradient should not be more than 10 %. Excavating the road, steep rock walls, talus cones, screes and blocky material have to be crossed, resulting in partly difficult excavations, retaining walls and other protection measures, such as rock bolts, mesh wire, shotcrete and anchors respectively.

3.16 PROTECTION WORKS

In project areas, the river has high gradient / velocity flows. There, it is not practicable to provide stone protection against bank erosion. For such locations like connecting channel first 100m reach the most stable structural measure is the provision of Gabions (stone crates) retaining walls. Gabions are well suited for retaining walls because of their flexibility and also to make full use of readily available local stone. Gabions retaining walls are designed as gravity walls and their layout, geometry and stability should be checked by the applicable design criteria. The walls will be well extended landward into the bank line, at both ends, to avoid any outflanking during high flood. Similarly in Sandtrap are towards river side 3.5m plum concrete wall along the main course of river is provided. Because that are is identified as good mucking area.

Some additional slope protection works are adopted along right side of the conveyance system. The slopes will be stabilized by providing toe wall, toe drains, stone pitching and anchoring.

In powerhouse area, protection wall at upstream of the powerhouse is proposed at higher elevation to protect the powerhouse area from nallah. In tailrace area, the side slopes and river protection is provided for powerhouse and tailrace channel.

3.17 CUT/ FILL SLOPES

Cut/fill slope designs are normally based on geo-technical parameters, such as soil and rock properties, terrain slope, water tables and height of cut slope. However, for simplicity, the following slopes as indicated in the design manual have been used in this design:

- Cut slope for hard rock = 1H : 4V
- Cut slope for Weathered rock = 1H : 2V
- Cut slope for soil = 1H : 1.5V
- Normal embankment slope in filling = 1.5H : 1V
- Maximum embankment slope in filling = 1 : 1 with plantation

3.18 RIVER DIVERSION WORKS

The diversion facility size varies depending on the magnitude of diversion flood; however, the diversion facilities in general are very important in terms of construction process and it tends to affect the construction costs as well. Thus, the workability and economic efficiency should be carefully considered in order to have maximum effects from the diversion works themselves. An economic efficiency and safe facilities is adopted considering topography, geology, river-bed configuration, the design flood and construction scale.

The diversion works consist of partial cofferdam to isolate the construction area by providing semicircular earthfill Dam. Earthen diversion channel on left bank of river is provided to safely divert the river flow and to protect the back water from construction area. The design flood is adopted by comparing the costs for diversion work and the damage expected in a situation without such diversion facilities. Generally, diversion flood is planned suitable for flood frequencies according to weir types, which suggested by Dam Design Criteria (KWRA, 2011). Two years frequency flood based on the frequency analysis results is selected considering the weir is concrete type for construction of Jabori weir.

3.18.1 Diversion Type

For a safe construction process an appropriate type of the diversion arrangement should be adopted for rivers diversion during the construction of the weir. Generally, River diversion

types can be divided into overall cofferdam and partial cofferdam. The overall cofferdam creates working spaces by blocking the entire river flow by installing dams at the upstream of construction area, while the River flows are diverted by providing diversion tunnel or by means of placing pipes. Moreover this type is the most suitable method in the case of a narrow river.

In case of partial coffer dam the construction area is partially cordon off by providing a coffer dam and dewatering is done by means of pumping. This type of diversion scheme is suitable to rivers with moderate floods, sufficient space available for construction of diversion channel and economic reasons. Therefore for Jabori Hydropower Project Partial coffer dam has been selected due to topography, river bed and the type of weir.

3.18.2 Design Flood for Diversion

Generally, the design flood for river diversion are planned which are suitable for flood frequencies according to the type of weir, suggested by Dam Design Criteria (KWRA, 2011) are shown in table below.

Sr. No	WEIR TYPE	DESIGN FLOOD
1	Concrete Gravity Dam (CGD)	1~2 years frequency
2	Concrete Faced Rockfill Dam (CFRD)	2~5 years frequency
3	Earth Core Rock fill Dam (ECRD)	20~25 years frequency

1~2 year frequency flood is selected for the design flood for a concrete weir because the overflow during construction generally does not cause fatal damages apart from special cases. Therefore, two years frequency flood based on the frequency analysis is selected as diversion flood of Jabori HPP considering the weir is concrete type.

3.18.3 Determination of Optimal Size

The diversion arrangement for Jabori Hydropower Project consists of cofferdam. The size and type cofferdam is based on the resulted flood water level done by hydraulic calculation for flood routing. The optimum height is determined considering the workability and site

conditions. The crest elevation of the cofferdam is calculated by routing the flood of 2 year frequency. Suitability by size was reviewed considering the workability and site conditions.

3.18.4 Coffer Dam

Stability analysis will be required for the review of the sliding possibility of cofferdam. The analysis of seepage and slope stability was carried out at diversion flood water level. The properties of construction materials are adopted based on available fill material for construction. The strength parameters of roller compacted weathered rock and compacted random fill are obtained from the references.

3.18.5 River Diversion Scheme

Two stage river diversions Scheme is selected based on the type of weir, period of construction and due to economic considerations. Due to presence of the major structures along right bank of the river, in first stage right bank and part of river flow area will be cordon off with semicircular coffer dam. The earthen coffer dam is planned, which will start from upstream of weir, covers half-length of weir and will be connected to right bank at downstream of weir.

In the second phase of construction the first stage coffer dam will be removed and approach channel to weir will be cleared. Second earthen cofferdam will be constructed on left abutment which will join the constructed part of weir. The weir will be used for river diversion and plugged area will be cleared for construction activities. Once the construction will be completed the dumped material will be removed from structure area.

CHAPTER – 4

OUTLINE DESIGN OF MECHANICAL COMPONENTS

4. OUTLINE DESIGN OF MECHANICAL COMPONENTS

4.1 GENERAL

This section presents a general description of the design criteria and the actual design/ selection of major mechanical equipment and systems forming part of Jabori Hydropower Plant. These include turbines, governors, inlet valves, gates, stop logs, trash racks, cranes and hoists etc.

4.2 CODES AND STANDARDS

The design will conform to the applicable portions of the following codes and standards.

1 DIN - Deutsche Industrial Normen.
2 EN - European Standard.
3 ISO - International Organization for Standardization.
4 FEM - Federation European de la Mauntention.
5 ASTM - American Society for Testing and Materials.
6 ACSE - Americans Society for Civil Engineers. Manuals and Reports on Engineering
7 AWWA - American Water Works Association.
8 CMAA - Crane Manufacturers Association of America. Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling cranes - No. 70.
9 ABMA - Americans Bearing Manufactures Association.
10 AGMA - Americans Gear Manufactures Association.
11 HMI - Hoist Manufacturers Institute.
12 NEC - National Electric Code.
13 NEI - National Elevator Industry, Inc.
14 NFPA - National Fire Protection Association.
15 NFP(A) - National Fluid Protection Association.
16 PPI - Plastic Pipe Institute.
17 SSPC - Steel Structures Painting Council.
18 UL - Underwriters Laboratories Inc.
19 FM - Factory Mutual Engineering and Research Corporation.
20 IAPMO - International Association of Plumbing and Mechanical Officials:

21 I EC - International Electro technical Commission.

4.3 TURBINE SELECTION

Considering operating net head of 148 m, rated flow of 8 m3/sec and the available power potential ; two turbines each of 4 m3/sec flow, have been selected. Both turbines will be operated up to 60% exceedance and further 40% of the time only one machine of 4 m^3/s will remain functional.

- Two units have been selected, so that maximum generation may be obtained and energy loss minimized when one unit is out of service due to non-availability of water.

- The number and size of units have been selected to ensure that the plant will operate at peak efficiency for as much of the time as is possible.

4.4 TURBINE TYPE

For the rated net head of 148 m and rated flow of 8 m3/s, the power will be 10.2 MW, considering turbine efficiency of 92%. This will result in turbine specific speed of (Ns) 106 . The foregoing parameters reaffirm that Francis Turbines are the most suitable units for Jabori Hydropower Plant.

Considering the above design head, specific speed and rotational speed, the average runner diameter of the turbine would be 792 mm. The net head and discharge is such that horizontal axis Francis Turbines would be more economical. Experience shows that compared with the vertical settings, the civil works cost of the powerhouse with horizontal setting, can be reduced by about 20% because of:

i) less excavation;
ii) Simple substructure;
iii) Smaller height of the powerhouse;
iv) Use of conical draft tube.

Additional advantages of horizontal settings are:

i) Easy inspection during operation and accessibility during maintenance;

ii) Ease of installing flywheels to improve speed regulation;

iii) Installation is somewhat easier.

iv) Less sensitive to minor misalignment of shafts.

4.5 PRINCIPAL DESIGN PARAMETERS

Principal design parameters have been tabulated hereunder for the recommended turbines for Jabori Hydropower Project. Turbine parameters need to be confirmed during the design stage on the basis of up-to-date hydrological and other features of the project combined with more specific information obtained from the turbine manufacturers.

Main Hydraulic Data of Turbine Layout

Characteristics	Unit	Intake / Powerhouse
Net Head (max)	masl	153
Net Head (min))	masl	148
Head Loss	M	8.7

Main Parameters of Turbines, (capacity given ex turbine unit)

Characteristic	Unit	Data
Type of Turbine	--	Horizontal Shaft Francis
Number of Units	--	Two
Q design/rated	m^3/s	4
H rated	m	148
P rated power	KW	5100 kw /one unit)
Runner diameter	mm	792
Setting of Turbine centerline with reference to minimum tail water level.	m	-1
Rated speed	rpm	750
Specific speed (Ns)	rpm	106 .6 m-KW)
Runaway speed at rated head (Nr)	rpm	1256
Spiral case inlet diameter	mm	910
Height of wicket gate	mm	147.00

4.6 TURBINE CENTERLINE SETTING

Francis Turbines must be set at level which avoids cavitation arising from insufficient submergence. For horizontal Francis Turbines, it is customary to choose the upper tip of the runner blade as the reference elevation. Determining of the turbine setting is based primarily on defining the plant sigma and choosing the vertical distance, the critical part of the runner is from the minimum full load tail water level. Final selection of turbine setting will be done by the turbine manufacturer in a manner similar to the selection of turbine size and shape, using results from model tests. However, it is often useful to make preliminary determination of the turbine setting elevation on the basis of the homologues nature of turbines. For Jabori turbines, on the basis of past experience, curves and formulae have been used for preliminary setting determination. The specific speed is used as a parameter to characterize the value of plant sigma and experience curves that are used in determining the setting elevation. Considering the existing operational data of the plant, at present the turbine setting of the centerline is defined as 1 m below the minimum tail water level.

4.7 TURBINE MAIN COMPONENTS

The spiral-case of welded construction serves as inlet to the radial-oriented stay and guide vanes, which are to convey the incoming water from axial to rotational flow.
A pressure relief valve on each spiral-case will be provided to limit the hydraulic transient and the water hammer in upstream waterways.

The guide-vanes should be made of stainless steel and may be optionally covered with hard ceramics. The guide-vane stems are supported by one lower and two upper self-lubricating bearings, which should be capable of adjustment, exchange and maintenance without dismantling the head cover or the bottom ring. The turbine is controlled by an electronic governor, which transforms each electronic signal into a hydraulic action to be executed by the hydraulic governor. For maintenance and commissioning purposes the governor can be operated from the local control panel of the electronic governor, but under normal operation it is remote controlled from the control room in the powerhouse or from any other place to be designated.

Particularly, the long lasting conditions of part-load operation have to be considered seriously and the runner designed to allow a continuous, fail safe operation without

increased vibration, noise and draft tube pressure pulsations as well as free of cavitational potential.

The runner is a welded fabrication of high alloy steel made-up of pre-fabricated cast or forged blades and rings. The runner material shall be Cr13Ni4Moi or 16.5CrNi.

4.8 GOVERNOR

In recent years, the advent of the microprocessor has changed the design of the electronic governors from analogue to digital systems with much more effective man-machine interfaces. The electronic governor control provides functions such as turbine start / stop, auto-frequency control and automatic load control, and provides interface connections to a main control and instrumentation system. Its monitoring functions include fault detection, alarm annunciation and unit shutdown. The governor also provides facilities for manual control of the turbine.

The electronic equipment has to be extremely reliable and the digital technology allows continuous self-checking of system operation. As the parameters for each turbine are stored within computer programs, there is no need for printed circuit boards to be pre-calibrated. With a digital system all the data is stored either within memory circuits (EPROMS) or is downloaded from a programming module or central computer. The governor is normally designed to allow circuit modules to be replaced whilst the unit remains connected to the grid. As the mean time between failures is usually in a number of years, a large stock of spares is not usually required.

4.9 HYDRAULIC SYSTEMS

The main development in hydraulic systems over recent years has been a steady increase in the operating pressure of the governor hydraulic systems. This change has been driven by two factors; cost and size. As the system pressure is increased the cost of the hydraulic system decreases due to reduction in its size. With increasing system pressure, the size of guide vane servo-motors, oil pumps, oil piping and tanks decreases. The overall effect of an increase in system pressure is a reduction in the turbine cost although there is some increase in the governor cost. For very large turbines, the oil storage requirements at low system pressures are very large and this has also encouraged the adoption of higher pressures.

One further advantage of reducing the size of the hydraulic system is that more of the equipment can be assembled and tested within the manufacturer's works. This means that site work can be limited to simply connecting a skid-mounted package containing low and high pressure tanks, oil pumps, control valves, etc., to the turbine servomotors. The reduction of site work shortens the installation time and also increases the reliability as there is less opportunity for contamination of the system.

4.10 MAIN INLET VALVES

The Butterfly Type Inlet valve will be used to shut off water in case of turbine failure, to relieve pressure on the turbine during shutdown and to permit dewatering the turbines. The valves shall be opened by means of pumped hydraulic oil and held in the full open position by means of a mechanical latching device. The valves are to be closed assisted by counterweight. Diameter of the valve for each unit will be 910 mm. The turbine hydraulic governor system may also be used for the operation of valves hydraulic operation.

The valves are normally to be opened and closed under nearly balanced pressure with by-pass valve open and wicket gates closed. However, the operating mechanism would have sufficient capacity to close the valve under maximum discharge and pressure in an emergency.

The inlet valve is of Butterfly type to economically accommodate the higher pressure and to avoid obstruction in the waterway. The sizes and appurtenances including hydraulic operators, extension pieces for connecting the valves with the penstock and turbine inlet by-pass valve assemblies, and counterweights will be determined during final design stage.

4.11 GATE EQUIPMENT

The Gate Equipment of Jabori HPP is described as below.

Intake

There will be one gate of the size 2.2m x2.3m

Gravel Trap

It will be provided with a gate of 0.8m x 0.5m

Sand Trap Inlet Gates

It will be equipped with two gates of 2.1m x 1.8m

Sandtrap Outlet Gates

Two gates of 2m x 1.3m

Flushing Gates

Two gates of 0.8 x 0.5m

Draft Tube Gates

Two draft tube gates are provided with hydraulic hoisting system.

The structural parts of the gates and stop logs will be designed and fabricated in accordance with criteria specified in ASTM, AISC, AWSD 1.1 and SSPC standards.

The Contractor shall pay particular attention to seal joints, especially in corners, so that a continuous line of contact is maintained. The seal corner joints shall be cut in one place and vulcanized or glued to the lateral and frontal seals.

Stop log and valve seals shall be free of any defect. The seals must be made of synthetic rubber, non-reactive with grease or hydrocarbons.

The vertical lift gates will be provided with screw winch machines operate-able manually for lifting and lowering the gates as required. The structural parts of the gates and stop logs will be designed and fabricated in accordance with criteria specified in ASTM, AISC, AWSD 1.1, FEM and SSPC standards.

4.12 CRANES AND HOISTS FOR POWER PLANT

Cranes and hoists form a basic necessity of any power plant not only during the erection period but also during the operational life of the plant. The cranes are extensively used during the plant erection period and the construction schedule of the Power station largely depends upon the availability of the cranes to various contractors involved in the Project. Keeping in view the importance of the cranes, the powerhouse is provided with an electric overhead traveling crane 25/5 ton capacity that will cover all the needs of the station i.e.

unloading and installation of plant during the erection period as well as during its operational life. Another 10 ton mobile crane is proposed for general use.

In accordance with the latest practice, all the station cranes and hoists are to be designed for standard industrial service as per the latest version of Crane Manufacturers Association of America (CMMA) Specification No. 70, FEM, ISO, IEC and AGMA standards.

4.13 MISCELLANEOUS AUXILIARY MECHANICAL SYSTEM

The Jabori power station is to be provided with all mechanical auxiliary systems required for reliable operation of a modern hydropower station.
The mechanical auxiliaries envisaged for the feasibility-level design of the power station comprise:

- Unit cooling water system
- Drainage and dewatering system
- Heating, ventilating and air-conditioning system
- Station water services
- Fire protection system
- Compressed air system
- Oil handling system
- Workshop Equipment

4.13.1 Unit Cooling Water System

Cooling water system is required to dissipate the heat energy produced during the operation of the Turbine shaft as well as the Generators. The cooling water temperature is to be about 20°C.

A simple cooling system is proposed for Jabori HPP wherein the cooling water is directly taken from draft tube or from upstream of inlet valve i.e. from penstock. This cooling water will be discharged into the tailrace after completion of the cooling process. This system does not require any additional equipment except the circulating pumps, filters and interconnecting piping.

4.13.2 Drainage System

All power station drain water is to be collected in a drainage sump from where it will be pumped out to the tailrace. Two submersible pumps with a capacity of 15 L/s each are provided for this purpose. Each pump will serve as standby of the other in such a way that the average running hours of both pumps will remain the same throughout the operational life.

4.13.3 Dewatering System

Dewatering of the units is required on the following occasions:

- Whenever any of the unit is stopped due to low discharge.
- During scheduled maintenance.
- Force Majeure/ Break down of one or both units.

For this purpose, a separate pumping system is proposed in the drainage and dewatering pit along with necessary equipment i.e. valves, interconnecting pipes etc. to ensure efficient dewatering of the units.

4.13.4 Heating, ventilating and Air-conditioning System

The functions of the heating, ventilating and air conditioning system for the power house are to:

- Protect equipment and personnel from the extremes of ambient temperature.
- Provide the required quantity of fresh outside air for ventilation.
- Maintain adequate ventilation in the battery room to prevent explosive concentration of hydrogen.
- Maintain the battery room within a temperature range that will maximize the output and life of the batteries.
- Maintain low vacuum in the Battery Room at all times to prevent leakage of hydrogen to the plant ambient.
- Provide smoke control in conjunction with the powerhouse fire protection system.

The heating and ventilation systems will provide fresh outside air to the powerhouse at various levels. These areas and the battery room will be ventilated by a forced air supply system. Only the control room and offices will have an air conditioning system.

The powerhouse is provided with a forced recirculation /exhaust ventilation system to meet the various temperatures and ventilation requirements. The system will bring in fresh air and exhaust warm air continuously during summer. During winter the ventilation system will re-circulate the powerhouse with supplemental makeup air to account for a small portion of air that will be continuously exhausted from contaminated spaces. The ventilation system will be modulated to regulate indoor temperatures. The powerhouse ventilation system consists of fans providing at least four (4) air changes per hour of the total volume of the powerhouse. Duct heaters are provided for cold weather operation.

The Battery Room is provided with a fan continuously exhausting room air directly to the outside. Air conditioning of the control room and offices has been provided for operating personnel's comfort and for protection of the control equipment.

4.13.5 Station Water Services

Station water services include the supply of water to the staff offices, toilets, ablution area and drinking water. Plumbing work along with a central storage overhead water tank and two reciprocating water pumps are required for the fulfilment of this basic necessity.

Provision for the drinking water is subject to the quality of the groundwater.

Capacities of the pumps and Storage tanks are calculated depending upon the number of staff required for the operation of the Jabori Power Plant.

4.13.6 Fire Protection System

Fire fighting water supply is to be drawn either from each penstock with back up from a pumped system, from the tailrace or a gravity system with a fire fighting tank. The location of the tank will be established during design stage.

4.13.7 Compressed Air System

Dual Air cooled service air compressor with a receiver is to provide service air for the power station. Following equipment will draw air from the service air receiver tank:

- Generator breaks
- Turbine maintenance seals
- Workshop hand tools.

4.13.8 Oil Handling System

A centralized oil handling and purification system has been provided in the power station. The system will include two oil storage tanks; one for the storage of clean oil and the other for dirty oil along with the piping system for supply of clean oil to the designated unit.

4.13.9 Workshop Equipment

A standard workshop with the facilities of the basic machine tools and machining operations is provided to enable the staff for in-house maintenance of the power station. This workshop includes the following equipments:

- Vertical Drilling machine
- Horizontal turntable with equipment for welding and thermal coating.
- Horizontal precision lathe.
- Hand Tools, i.e. air blower, hand drill machine and electric hammer.
- Different tool kits
- Steel work benches
- Steel storage cabinets and racks
- Manually operated trolley

CHAPTER – 5

OUTLINE DESIGN OF ELECTRICAL COMPONENTS

5. OUTLINE DESIGN OF ELECTRICAL COMPONENTS

5.1 GENERAL

This chapter presents electrical design criteria in order to establish the basis for electrical system for Jabori hydropower station. In addition, the codes and standards and other general technical requirements for the design of the electrical equipments are included herein.

Power generation studies indicate installed capacity of 10.2 MW for the power plant. The equipment discussed in this section has been selected based on this installed capacity for turbine units.

5.2 EQUIPMENT

Synchronous generators, 5.1 MW each, 3 phase 11 KV that matches with the capacity of the turbines output, connected to 11 KV Switchgear through generator circuit breakers. The output of both generators is than connected to 13/15 MVA step up transformer. The secondary of step up transformer is 132 KV connected to an outdoor 132 KV switchyard for connection to outgoing 132 KV transmission line. Power evacuation ids done to Battal Grid station through the 132 KV transmission line.

The following electrical equipment and systems are proposed for electrical design:

- Generators
- Excitation System
- Medium Voltage Switchgear
- Station auxiliary Transformer
- Lighting
- Protective Relaying
- Main Power Transformer
- 132 KV switchyard equipment
- Unit Automation and Control
- Cables and Raceway System
- DC and UPS System
- Grounding System etc
- 132 KV Transmission Line.

5.3 REFERENCE

All electrical equipments and systems are proposed to be designed in accordance with the NTDC Specifications and latest editions and amendments of codes and standards of the following institutions.

- IEC International Electro-technical Commission
- DIN Deutsche Industries Norman
- IEEE Institute of Electrical and Electronics Engineers
- NEMA National Electrical Manufacturers Association
- ICEA Insulated Cable Engineers Association
- ANSI American National Standards Institute
- ASTM American Society for Testing Materials
- NFPA

5.4 CODES AND STANDARDS

As a general rule, all electrical equipment is to comply with the applicable International codes and NTDC specifications.

5.5 GENERAL ELECTRICAL DESIGN CRITERIA

The general electrical design criteria, which has been used to establish for electrical design of the electrical equipment and systems is described below:

5.5.1 Voltage Consideration

The IEC standard defines three voltage classes:

- Low voltages are used to supply utilization equipment and are 1 KV or less.
- Medium voltages are used as the primary distribution voltages to be used to feed the primary winding of the step-down transformers to provide low-voltage systems. These voltages are greater than 1 KV but less than 36 KV.
- High voltages are used to transmit large amount of electrical power between transmission substations, and are all voltages higher than 36 KV.

5.5.2 DC Source Requirements for Controls

The following DC systems are proposed:

- For protection and Switchgear control, DC operating mechanism 220 V DC.
- For essential services, 230 V AC from UPS.
- For communication system, 48 V DC
- For Instrumentation, 24 V DC locally derived as required.

5.5.3 AC Source Requirements for Unit and Station Services

- Load requiring 3 phase power 415/230 V, 3-Phase, 4-wire, 50 HZ, earthed neutral
- Load requiring 1 phase power 230 V, 2-wire (one wire earthed), 50 HZ.

5.5.4 Protection and Coordination Philosophy

Electrical protection and coordination is required to prevent injury to personnel and to minimize damage to the system components. The protection level is proposed to be achieved with the help of detection devices like relays and instruments and interruption devices like fuses and circuit breakers.

Coordinating philosophy will select and set each protective device so as to minimize the portion of the electrical system affected by a fault. Full selectivity is to be designed to fulfil the following requirements:

Routine currents spikes must not cause disconnection:

- When operating properly, only the primary protective device nearest to the fault in the supply direction must respond.
- If the device fails, the backup device next to it in the direction of power flow must respond.

5.6 ELECTRICAL GENERATORS

5.6.1 General Considerations

Based on the hydraulic data relating to Jabori Hydropower Project; the total worked out rated output of the Jabori hydropower plant will be 10.2 MW. There will be a total of two (2) generators having capacity 5.1 MW each at 11 KV, 50 Hz with 0.85 power factor.

5.6.2 Generator Design Particulars

The proposed generators are to be designed, constructed and tested in accordance with IEC Publications No. 60034 and other relevant standards.

The rotating parts of the proposed generators will be able to withstand the stresses at runaway speed for five minutes.

5.6.3 Types and Rating

The proposed generators are horizontal-shaft, hydraulic driven, alternating current, synchronous type. The selection of generators is in accordance with the turbines proposed by the Mechanical Section. The rating of the generators will be as follows:

- Operating duty — Continuous
- Rated Capacity — 5.1 MW
- Efficiency — 97 %
- Power factor — 0.85
- Frequency — 50 Hz
- Number of Phases — 3
- Rated voltage — 11 kV

5.7 EXCITATION AND VOLTAGE REGULATION SYSTEM

5.7.1 Excitation System

The proposed excitation system is static type. The excitation current is controlled by a static automatic voltage regulator (AVR), which will be equipped with the normal feedback and control facilities including follow up manual control.

The generator field would be fed through Thyristor bridges controlled by an automatic voltage regulator. The input to the Thyristor Bridge will be AC fed from terminal mounted excitation transformers. The voltage regulator will hold the voltage within a bond of ± 0.5 % and will incorporate reactance compensation, under excited reactive ampere limit circuits and power system stabilizers.

5.7.2 Voltage Regulation

The generator is envisaged to have a state-of-the-art static excitation system with a digital Automatic Voltage Regulator (AVR).

The voltage regulator forms part of the excitation system. Its primary task is to maintain the voltage of the power system and the transient stability in the network. An additional task is to protect the generator against thermal strain in its windings and iron. The regulator shall have the following functions:

- Voltage regulation
- Field current regulation
- Field current limiter
- Reaction compensation
- Supervision and Logic Circuits
- Following line voltage during synchronizing
- Under excitation limiter
- Stator current limiter
- Power system stabilizer
- Power factor regulator
- Active compensation

The equipment will be powered from 110 V DC station batteries via a DC/AC converter if needed.

5.7.3 Main Step-up Transformer

For changing the generator voltage to transmission voltage, step up power transformer with capacity rating 13 / 15 MVA is proposed. The transformer voltage ratio has been chosen to match the generator voltage finally adapted as 11 KV.

5.7.4 Main Data for Transformers

One three-phase, step up transformer and two Auxiliary transformers of following ratings are proposed:

Item	Unit	Main
Function		Step-up
Rated output	MVA	13 / 15
Rated voltage		
1. Primary	KV	11
2. Secondary	KV	132
Frequency	Hz	50
Temperature rise	C°	55
Tap changer		Off-load
Vector group		YN d11

5.7.5 Overload Requirements

The overload rating and protection will be in accordance with IEC 600345. The overload capability of any ancillary equipment such as bushings, CT's, oil expansion tanks, leads etc. will not be less than the transformer overloads rating.

5.7.6 Short Circuit Capability

The proposed transformers and its accessories will be capable of withstanding mechanical and thermal stresses caused by short circuit fault currents without mechanical deformation or impairing electrical capabilities. The sudden pressure relay and other alarm initiating devices will not respond to the effect of the through fault short circuit current.

5.7.7 Buchholz Relay

Each transformer will be equipped with a Buchholz Relay of earthquake proof design. These relays will be mounted in the pipe connecting the conservator tank to the main transformer tank. The relay is to provide two contacts, one for alarm circuit and other for shutdown

circuit.

5.7.8 Cooling System and Requirement

The cooling system is ONAF. The cooling equipment of each transformer will be furnished complete in every respect and will include radiator, fans, piping, valves, motor contactors, relays, control equipment and all supplementary equipment required for the function of the cooling system. Coolers, fans etc. will be mounted on the tank walls.

5.7.9 Auxiliary Station Transformer

One No. of auxiliary transformer 300 KVA has been proposed for providing the continuous electric power for the operation of the auxiliary equipment in the powerhouse.

5.7.10 Station Colony Transformer

Three transformers, with a total capacity of 300 KVA, having voltage ratio 11 / 0.400 / 0.230 KV has been proposed for the colony supply and outdoor / external lighting. The transformer rating has been calculated on the assessment of residential and commercial load of the colony.

5.7.11 11 KV (Medium Voltage) Supply System

The 11 KV switchgear is to take generator power supply and feed to main power transformer as well as to supply auxiliary power for the power plant.

The 11 KV switchgear to be equipped with circuit breakers of Vacuum type enclosed in cubicles, thus providing high personnel safety.

5.7.12 Low Voltage AC Supply

The low voltage AC distribution is proposed to design as 400 V, 3 phase four wire plus earth system. Normally, the power station will have the auxiliary supply transformer The standby diesel generating sets provided for emergency requirement will automatically start and supply

to essential equipment during the failure of station power supply.

5.7.13 Emergency Diesel Generator Set

In case of a breakdown of the normal hydro generators, a diesel generator of 250 KW is proposed to be installed at the powerhouse to take over the supply to a certain group of equipment to ensure and facilitate a safe shutdown or black start up. This Diesel Generator will be synchronous, rotating field type with rotating brushless exciter controlled by a solid state voltage regulator.

5.7.14 DC Supply and UPS System

DC system has been provided to supply uninterruptible power for control of protective and instrumentation equipment, other equipment specific controls and to power critical DC operated equipment. An uninterruptible AC system has been provided to supply uninterrupted, transient free regulated AC power during all normal and abnormal plant operating conditions to specific critical AC loads.

For control and protecting equipment and for providing emergency lighting, in case of AC power failure, a bank of sealed lead acid battery will be used for DC power supply system in the power plant. Voltage level of this system will be 220 VDC.

A 48 VDC will be used for communication system derived from another set of batteries.

5.7.15 Lighting and Small Power

Adequate indoor and outdoor lighting with illumination levels in accordance with recognized standards has been foreseen. Inside the powerhouse, an emergency lighting system powered from the station battery should be installed; the system shall operate through automatic AC / DC change over switch in case of normal supply failure.

AC lighting and small power socket outlets, for 230V, shall be single-phase, connected between phase and neutral of the 400V system. Under normal conditions, both the emergency and normal lighting will be in operation. These two systems are proposed to have totally separate circuits with power supply as follows:

- Normal lighting: Powered from Unit Auxiliary Boards
- Emergency lighting: Powered from 400 V essential supply switchgear

It is recommended that the normal lighting system shall be designed according to the following design criteria:

Type of Area	Illumination level
Outdoor:	
• Areas with common staff traffic & streetlights	50 Lux
• Switchyard perimeter light	50 Lux
• Switchyard inside area	50 Lux
Indoor:	
• Offices, control rooms, switchgear rooms	400 Lux
• Storage rooms, corridors, etc.	100 Lux
• Equipment rooms	200 Lux
• Machine hall, etc.	300 Lux
• Workshop	300 Lux

The illumination requirement for the emergency lighting is at least 50 Lux all over the related areas. Exit lights shall be installed above doors, staircases, etc. During blackouts these shall be powered from their internal batteries for minimum 15 minutes.

5.8 CONTROL AND PROTECTION SYSTEMS

5.8.1 SCADA Control System

SCADA system is proposed for overall control and monitoring of the power plant. Local control units (LCU's) have also been proposed for unit controls and auxiliaries.

5.8.2 Protection System

Protection Relays

Protection relays and circuit breaker shall be provided to prevent or limit damage during faults or overloads and to minimize their effect on the remainder of the system. The system shall be divided into protective zones separated by circuit breakers. These zones may be divided into four classes:

- Generator
- Bus
- Transformer
- Line

During a fault the zone, which includes the faulted apparatus, shall be de-energized and disconnected from the system.

The functioning of the protection relays shall not depend on the control system. The relays are to be organized in two groups so that one group provides back-up protection for the other group.

Cables

Design for Cables

All cables and tests are recommended to be in accordance with the applicable IEC standards and where applicable with the Pakistani standards. Cables will be selected considering the following:

- Cables will be specified as being suitable for underground and surface installation in wet or dry locations as the application dictates.
- Cable construction will be non-flame propagating.
- Cable conductors will be copper.
- Required power cables capacities will be determined on the basis of equipment loads, conductor material, insulation thermal rating, type of installation, ambient

temperature, etc. Insulation levels will be selected on the basis of system voltage and type of grounding.

- Minimum allowable power conductor size will be selected so that the fault current capability of the cable will not exceed.
- Voltages drop in the circuit for power and control cables.

Medium Voltage Power Cables

15 KV rated (for application of 13.8KV) with 133% insulation level single conductor, Jacketed and tray rated.

- Conductor: Stranded bare annealed copper and extruded semi-conducting insulation shield.
- Insulation: Cross-linked polyethylene (XLPE) with a semi-conducting layer.
- Shield: 0.125 mm uncoated copper tape with 12.5% overlap.
- Jacket: PVC or chlorinated polyethylene

Low Voltage Power Cables (600 V and below)

600V class insulation has been provided for 400V and 230V circuits.

- Conductor: Stranded bare annealed copper
- Insulation: Frame retardant Cross-linked polyethylene (XLPE)
- Jacket: Flame resistant PVC or chlorinated polyethylene

Control Cables

600V single or multiple conductors will be jacketed, flame retardant and tray rated.

- Conductor: Stranded bare annealed copper

- Insulation: Frame retardant Cross-linked polyethylene (XLPE)
- Jacket: Flame resistant PVC or chlorinated polyethylene

Instrumentation Cables

Type PLTC 300V.

- Conductor: Stranded bare annealed copper single or multiple pairs or triads.
- Insulation: Flame resistant PVC or equal.
- Shield: Aluminum foil screen aluminum coated Mylar tape with tinned copper drain wire over each pair or triad. Overall shields with drain wire will be provided for multi-pair or multi-triad cables. All shields will be grounded at one end only.
- Jacket: Flame resistant PVC with ripcord or equal.
- Color Code: Black and white in pairs, black, white and red in triads. White printed numerically for group identification

Lighting Cables

600 V single conductors:

- Conductor: Stranded bare annealed copper
- Insulation: Cross-linked polyethylene
- Jacket: Nylon

Earthing / Grounding System

The design of the earthing system generally follows the main requirements outlined in the IEEE publication No 80, "Guide for Safety in Substation Grounding". The main criteria for the design of grounding system for the powerhouse and the switchyard is as outlined below:

- Protect the personnel and public from dangerous potentials such as transferred potentials, touch and step potentials and mesh potentials during both normal and operating and maximum ground fault conditions.
- Provide connection to ground for non-current carrying parts of the electrical equipment and power equipment neutrals.
- Facilitate clearing of ground faults through protective system.
- Dissipate static charges and/or induced current from current carrying lines or parts thereof that need to be worked on.
- Dissipate lightning discharges.

The proposed grounding system is comprised of the following:

(i) Conductors

The conductors used for the station grounding mat and bonding system will be bare stranded copper. All buried copper cable will be, if required, alloy coated (lead-tin or tin coated to reduce the galvanic corrosion of the buried steel and cast iron piping). Above ground and inside concrete, stranded copper cable will be used with or without the alloy coatings. Low voltage grounding conductors will use green/yellow insulated or marked equipment grounding or other approved methods for bonding.

(ii) Ground Rods

Ground rods will be made of copper-clad steel (Copper weld). For usual grounding applications, 20 mm nominal rod diameter sizes will be used. The length will be usually 2.5 m or 3 m but if longer rods are required, sectional ground rods that can be joined together to provide the required length will be used. Special soil conditioning and/or special electrodes may be used in rocky areas.

(iii) Grounding Conductor Connection Materials and Techniques

The types of connections to be used in the installation of the grounding system will be based on the following:

5.9 132 KV SWITCHGEAR

5.9.1 Selection of Switchgear Arrangement

For an above ground hydropower plant, the most cost effective design for switchyard is an outdoor installation. Normally following four alternatives are possible.

- Single Circuit Breaker System
- Single Circuit Breaker System with bypass
- One & a Half Circuit Breaker System
- Double Circuit Breaker System

The third and fourth system, stated above offer great flexibility in operation but involve higher cost than first and second system.

Different circuit breaker systems include higher flexibility and availability in operation. In particular, such benefits will occur, where in case of circuit breaker failure risk of a subsequent complete shutdown of one of the units.

The risk of a circuit breaker failure is, however, difficult to predict. It depends not only on the statistical failure rate of the breaker itself, but also on the mode of operation of the plant and quality and intervals of maintenance. Life expectancy for the equipment is in any case very high under rated condition.

Based on the above considerations, the best alternative, the standard configuration i.e. single bus with single circuit breaker arrangement is proposed. In case of fault, the faulty section can be isolated in minimum time with the operation of respective circuit breaker and isolators etc.

5.9.2 Switchyard Layout Arrangement

The power generated at 11 KV is stepped up to high voltage for transmission onward. Gantry structure would be installed to accommodate the incoming conductor from the step up transformers and the outgoing 132 KV Transmission Line. A single bus of appropriate size aluminum conductor tube would be installed to provide convenient connection between the step up transformer and the outgoing transmission line. Three phase circuit breakers and isolators have been employed for the safe connections and the isolation protection etc. High mast structures with overhead conductors are proposed to avoid lightning strokes etc. to the switch yard equipment.

5.9.3 Design Criteria

The switchgear is assumed to be the conventional outdoor type with modern SF6 circuit breakers. The design consists of three bays: one for the main step-up transformer, one for the outgoing line and one for bus-bar voltage transformers.

The following design criteria would apply:

• Installation of equipment	outdoor
• Highest Voltage for Equipment	145 KV
• Rated Lightning impulse withstand Voltage 1.2/50 μs (peak value)	650 KV (to earth)
• One minute power frequency With stand voltage	275 KV

The circuit breakers and auxiliary equipment would conform to IEC standards. The proposed Circuit breakers are the outdoors type SF6 circuit breakers.

The 132 kV SF6 breakers are designed for the following ratings:

• Nominal voltage	132 KV
• Highest voltage	145 KV
• Frequency	50 Hz

•	No. of Phases	3
•	B.I.L rating	650 kV
•	Busbar arrangement	Single
•	Nominal current	2000A
•	Short circuit current	40 kA
•	Rated supply voltage for control & auxiliary Circuits, DC volts	220

5.10 TELECOMMUNICATION

5.10.1 Internal Communication

A digital telephone network shall be installed in the powerhouse to cover the entire plant, powerhouse, intake and the residential colony. Each generating unit shall include at least one telephone per floor. All cranes shall be connected to this communication system, as well as the working and lay down areas. The central exchange shall be connected to the station battery to ensure no outage in the case of a complete shutdown of the plant.

5.10.2 External Communication

A Power Line Carrier system (PLC) shall be installed for communication between powerhouse and load dispatch centre NPCC/RCC Islamabad. The coupling shall be done between one phase and earth which necessitate installation of one line trap for each communication line and one coupling capacitor at each terminal. Line traps and capacitive voltage transformers shall be installed in the switchyard and/or in the control room. The 48 V supply shall be provided by DC/DC Converters fed by the 220 V main battery.

5.11 TRANSMISSION LINE

5.11.1 General Design Criteria

The design work include final load flow studies, tower spotting, tower selection and application, preparation of plan and profile drawings showing towers and conductors

clearances, conductor and shields wire sag and tension calculations, foundation design, clipping offset calculations, structures lists and leg extension information, site preparation requirements, design of access roads and trails, design of road crossings, railroad crossings, river crossings, preparation of clearance and permit diagrams, and all other engineering design services normally associated with the engineering design of a high voltage transmission line.

5.11.2 Vertical Clearances

The minimum clearances that shall be maintained at the maximum final conductor sag are shown below.

Closing Clearance Description	Crossing Clearance (Meters)
Over lands and areas transverse by vehicles	7.5
Over highways	8.0
Over ground wires of other power lines	3.5
Over distribution conductors	3.5
Over communication lines	3.5
Over roofs of buildings and accessible to pedestrians	5.9

5.11.3 Lattice Steel Structures

Galvanized steel structures shall be of single/double circuit type for safely supporting and carrying all dead wind, pull off and any other applied loads. Dimensions and all arrangements shall be such that specific electrical clearances are not infringed. Steel structures shall be rigid and self-supporting once erected. The design shall be such as to keep the number of different parts as small as possible and to facilitate transport, erection and inspection.

5.11.4 Conductors

Conductors for transmission line are aluminum conductor steel reinforced (ACSR) Lynx type or other with suitable cross sectional area, keeping in view the nominal plant capacity and consequences of line loss. Conductors should be capable of economically transmitting all electrical loads.

All materials and fabrication of the conductors shall be governed by the applicable ASTM and ANSI standards or equivalent standards.

5.11.5 Dampers

Steel dampers for transmission line conductors shall be capable of providing safety against conductor galloping caused by nay wind pressure and of standard size meeting IEC requirements.

5.11.6 Insulators

All insulators for the transmission line conductors shall satisfactorily withstand prevailing climatic and service conditions. Insulators and accessories shall be in accordance with the applicable ANSI, IEC and ASTM standards or equivalent standards.

5.11.7 Shield Wire

A shield wire shall run on the top of the steel towers supporting the conductors to protect the line conductors against direct lightning strokes. The shields wire shall be stranded glazed steel wire, and connected to the structure with appropriate hardwire. The design shall provide for adequate clearance between the shield wire and energized conductors.
The shield wire should provide the low impedance path to earth for all incidental current it may have to carry.

Shield wire shall be in accordance with ASTM A 363, Class A galvanizing, and/or other equivalent/ applicable standards (e.g. IEC). Appropriate steel dampers shall be provided.

5.11.8 Structure Grounding Arrangement

Steel structure for the transmission line shall be grounded through ground rods. The ground rods shall be copper covered steel (copper weld) of 19 mm (3/4 inch) diameter and minimum 3 meters in length. The ground rods shall be driven in ground and bolted to the legs of steel structure through hard drawn electrolytic bare copper conductor.

5.12 INTERCONNECTION WITH NATIONAL GRID SYSTEM

The existing transmission system in the area has been extensively studied. The existing system feeding Swat / Mansehra Districts is connected to NTDC/ WAPDA grid system by means of 132 kV Battal, 132 kV Mansehra grid station and by existing 66 kV Chaksar - Daggar - Chakdara grid station in Mansehra west region.

Information gathered from the local office of NTDC/ WAPDA revealed that 132 / 11 kV Batal grid station is the existing last point of NTDC System. It has therefore been considered feasible that the output of Jabori Hydropower Project would be injected to 132 kV Batal grid station for further interconnection with the existing NTDC / WAPDA system. The proposed 132 KV transmission line is approximately 20 Km. A separate line bay is proposed in 132 KV Battal Grid Station.

JABORI HYDROPOWER PROJECT

FINAL FEASIBILITY REPORT

VOLUME – II

ENVIRONMENTAL AND SOCIAL ASSESSMENT

A- INITIAL ENVIRONMENTAL EXAMINATION (IEE)

B- SOCIAL IMPACT ASSESSMENT (SIA)

August 2011

JABORI HYDROPOWER PROJECT

FINAL FEASIBILITY REPORT

INDEX OF VOLUMES

JABORI HYDROPOWER PROJECT

VOLUME – II

A- INITIAL ENVIRONMENTAL EXAMINATION (IEE)

TABLE OF CONTENTS

JABORI HYDROPOWER PROJECT

VOLUME – II

A- INITIAL ENVIRONMENTAL EXAMINATION (IEE)

LIST OF TABLES

JABORI HYDROPOWER PROJECT

VOLUME – II

A- INITIAL ENVIRONMENTAL EXAMINATION (IEE)

LIST OF FIGURES / PHOTOGRPAHS

EXECU

ARY

Executive Summary

The proposed Jabori HPP is a run-of-river scheme, about 1 Km upstream of Jabori Town on Siran River. The proposed weir site is located at latitude 34° 36" 02' and longitude 73°14' 59" near Giyar Sacha Village on the Siran river. The powerhouse is located at latitude 34°35"13' and longitude 73° 15" 24' near Granthali Village.

Jabori Hydropower Project is located in tectonically and seismically critical zones of convergence between Indo-Pakistani and Eurasian continental plates. More than ninety percent of severe earthquakes of Pakistan and adjoining countries are located within this Orogenic belt. The lands in the project areas are mainly proprietary and are used for cultivation, forest and settlements. The project will consume 459 kanals of private land, out of which 232 kanals are used for cultivation. The rest includes forest land, residential land and waste land. Only 1 house is falling in project area and needs resettlement.

About 200 shade trees and 150 fruit trees lie in project area and have to be cut. General Flora of the project area includes Drawa, Deodar, Shisham, Pine, Poplar, Chir, Draic, Bakain, Apricot, Pear, Peaches, and Apple.

Maize and rice are staple food of locals. Wheat, maize and paddy production is about 200kg, 360kg, and 280 kg/kanal respectively as derived from census survey analysis.

No air quality monitoring data is available for the project area. However, no major sources of air pollution, viz., industries, exist in the project area except for road traffic in the valleys of Siran River and other nullahs. Due to presence of ample plantation, the quality of air is good. Quality of air along roads is impaired to some extent.

The main surface water resource of the project area is the Siran River besides spring water. Water quality of the project area is safe for non domestic consumption because there is no industry exist which discharge their effluent in the river. Anyhow, the waters would require appropriate treatment, before these are used for drinking by non – local construction crew.

Most of the people between weir to powerhouse use spring or rain water for daily use agricultural requirements. There is no water channel or any other structure exists between this reach which divert Siran river water. Further no water requirements has been discussed by the community during scoping sessions and it was confirmed during the transect walk by the field staff.

Aquatic ecology and fisheries was discussed with the official of wild life department and it was declared that the project area has no natural habitat which impacted with the project implementation.

The socio-economic environment of the project area is a mixture of rich and poor with a low percentage of middle income groups. People are relying for their earning from small agricultural land holdings and/or providing services on daily wages. Among the literate class, mostly doctors, engineers, teachers and college lecturers represent the district population at the country level.

INTRODUCTION

CHAPTER - 1

INTRODUCTION

1.1 General

Pakistan is rich in hydropower potential but, unfortunately, Pakistan's investment in hydelpower generation has remained caught up in confusion and paradoxes for more than a decade, while no significant progress has been achieved. On the other hand, the Government is trying to facilitate private investors to promote hydel generation. Pakistan is endowed with a hydel potential of approximately 40,000 MW, most of which lies in the Khyber Pakhtunkhwa, Gilgit-Baltistan, Azad Jammu & Kashmir and some parts of Punjab. Electric power is a stimulator for the socio-economic uplift of the country, yet only half of the country's population has access to it. After the creation of Pakistan, the country faced numerous problems including dearth of electrical power. Abundant hydel potential remains untapped, which needs to be harnessed.

In this respect, Sarhad Hydel Development Organization (SHYDO) and Deutsche Gesellschaft fur Technique Zusammenarbeit (GTZ), A German Government Agency for Technical Co-operation, in 1992 carried out extensive studies in Pakistan for the identification of potential sites for the generation of hydropower. During this exercise, SHYDO-GTZ, inter alia identified 18 MW Koto hydropower project on Panjkora River near Temergara, District Lower Dir, 8 MW Jabori hydropower project on Siran River near Jabori Town, District Mansehra and 7.5 MW Karora hydropower project on Khan Khwar near village Karora, District Shangla.

The Asian Development Bank (ADB) recently provided a loan for financing the consultancy services to carry out Feasibility Studies of above-mentioned three hydropower projects. M/S Associated Consulting Engineers - ACE (Pvt.) Ltd has been appointed as Consultants by SHYDO to prepare Feasibility Studies for Koto, Jabori and Karora. The Contract Agreement for the study was signed between SHYDO and M/S Associated Consulting Engineers (ACE) in July 2008, with a time period of 18 months to complete the proposed Feasibility Studies.

1.2 The Project

1.2.1 Brief Description of The Project

Jabori Hydropower Project will exploit the water resources of the Siran River for power generation. Its main components, viz., Weir, Intake Structure, Power Tunnel, Power Channel and Power house. The Weir will be located on the Siran River at about 1 km upstream of Jabori Town. The Powerhouse and outlet portal of the Power Tunnel will be located on Siran River near Granthali village about 7 km downstream of the Weir structure.

The Siran River has an average slope of 9% up to the proposed weir site and about 8% up to the proposed powerhouse. Salient features of the project are given in the following paragraph.

1.3.2 Environmental Categorization of ADB on Projects

All ADB projects are assigned one of the four categories (A, B, C, or FI) for environmental assessment. The category is assigned based on the project's potential for environmental impact as follows:

Category A (OM 20): Projects with potential for significant adverse environmental impacts. An environmental impact assessment (EIA) is required to address significant impacts.

Category B (OM 20): Projects judged to have some adverse environmental impacts, but of lesser degree and/or significance than those for category A projects. An initial environmental examination (IEE) is required to determine whether or not significant environmental impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report.

Category C (OM 20): Projects unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are still reviewed.

Category FI (OM 20): Projects are classified as category FI if they involve a credit line through a financial intermediary or an equity investment in a financial intermediary. The financial intermediary must apply an environmental management system, unless all subprojects will result in insignificant impacts.

1.3.3 Justification for IEE

According to Pak EPA:

For Jabori Hydropower Project an IEE will suffice as the power generation is less than 50 MW or reservoir having storage volume less than 50 million m^3 or surface areas less than 8 Km^2. Accordingly, the project falls under Schedule I of Pak-EPA regulations.

According to ADB:

The project is relatively small size (6.5 MW) and it will have some adverse environmental impact, but a lesser degree and / or insignificant than those of category-A project so, it is classified as a Category "B" project in accordance with ADB's Environmental Assessment Guidelines 2003.

1.4 Environmental Regulation and Legal Framework

1.4.1 Government of Pakistan

Environmental – related statutes of government of Pakistan includes:

- Pakistan Environmental Protection Act, 1997
- Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000

2. The need to mainstream environmental considerations into economic growth and development planning.

3. The need to maintain regional and global life support systems.

4. The need to work in partnership with others.

5. The need to further strengthen the processes and procedures for addressing environmental concerns in ADB's own operations.

The Policy highlights a number of areas that require attention in pursuit of ADB's environmental assessment process. It addresses the need for more upstream environmental assessment at the level of country programming, the need for more structured consultation in the conduct of environmental assessments, the need for greater emphasis on monitoring and compliance with environmental requirements during project implementation, and finally the need to view environmental assessment as an ongoing process rather than a one-time event.

1.5 Approach Adopted for the Study

The Initial Environmental Examination study is should cover several parameters relating to physical, biological and human setting of the Project area. Both primary and secondary sources were explored to gather information regarding various environmental and social parameters of the project. As a first step a reconnaissance visit to the project area was made to familiarize with the environmental and social setting and to carry out a screening process to identify the probable areas of impacts. On the basis of this a plan was prepared to carry out environmental and social survey and to conduct scoping sessions for public consultation. Consultation was also carried out with officials of various department, knowledgeable people, public representatives and local NGOs. In addition to these primary sources, information was also extracted from the published literature and data (secondary source).

1.6 Scope of the IEE Study

The brief scope of IEE study includes:

- Assessment of the existing status of environment and socioeconomic aspects.
- Identification of potential impacts on various environmental components due to activities envisaged during construction and operational phases of the proposed Hydro-electric project.
- Prediction of significant impacts on major environmental components.
- Preparation of Environmental Management & Monitoring Plan (EMM_tP) outlining measures to minimize adverse impacts of the proposed project.
- Preparation of abbreviated resettlement plan for compensating the affected persons (AP's)

Chapter 8 Abbreviated Resettlement Plan, for compensating the affected people resettlement plan is prepared.

Chapter 9 Environmental cost comprises the Compensation for trees plus Afforestation, Monitoring and Resettlement cost was estimated in this chapter.

Chapter 10 Conclusions are sums up the report and the recommendations are described in this chapter.

DESCRI THE

CHAPTER - 2

DESCRIPTION OF THE PROJECT

2.1 General

The proposed Jabori HPP is a run-of-river scheme, about 1 Km upstream of Jabori Town on Siran River. The proposed Weir site is located at latitude 34° 36" 02' and longitude 73°14' 59" near Giyar Sacha Village on the Siran river. The powerhouse is located at latitude 34°35"13' and longitude 73° 15" 24' near Granthali Village. (Site location map is shown in Figure 2.1 while in Figure 2.2 shows Project Foot Print/Project Area)

The proposed Weir site and powerhouse are accessible through asphalt mountainous road. The catchment area of proposed Site lies between latitude 34° 35' 10" to 34° 47' 40" and longitude 73° 11' 15" to 73° 21' 58".

Siran River is one of the major tributary contributing Tarbela reservoirs which originates from mountains at an elevation of about 4745 masl (above sea level) at north east of the catchment and drains in Indus River few Kms upstream of Tarbela reservoir. Most part of the catchment is covered by rugged mountains and hills. The catchment forms dandretic channel network which is favorable for source of flow in river. The catchment area up to the proposed Weir site has been estimated by the Consultants using 1:250,000 Survey of Pakistan (SOP) sheet and then verified by 1:50,000 SOP sheet and worked out as 236 km^2. Siran river has a total of 1057 Km^2 catchment area.

The length of the Siran River is about 84 km up-to SWHP (Surface Water Hydrology of Project) Gauging Station at Phulra. The river originates in the mountains of Musa ka Masala and traveling through the meandering reaches, joining the Indus River. The Siran River has an average slope of 9 percent up-to proposed Weir site and about 8 percent up-to proposed power house. Salient features of the project are given below:

- Basin (at Elev. 1383)	55363 m^2
- Average long-term discharge	178 m^3/s
- Weir crest elevation	1387 masl
- Height	15 m
- River bed elevation	1374 masl
- Minimum normal reservoir elevation	1381 masl
- Maximum normal reservoir elevation	1383 masl
- Spillway design discharge	126 m^3/s
- Maximum discharge at MFL	482 m^3/s
- Tunnel length	1.060 km

The two Routes with mountainous metalled road from Hassan Abdal take about three to four hours to reach at proposed weir site. The road is in good condition for traveling, however for the transportation of heavy machinery, it is suggested to review the road conditions before mobilization of the machinery for the construction of the Project. Road distances of various routes are shown in site location map in Figure 2.1.

2.6 Construction Material

The materials used for the construction of the Jabori HPP include coarse aggregates, fine aggregates (sand), rock for stone pitching and riprap, earth, water, cement and steel. Most of the construction material would need to import from other part of the country, however limited quantity of course aggregate are stones for pitching and rip rap, will locally be available for the excavation material and existing quarries.

2.7 Construction Machinery

The Project will deploy various types of machinery for construction purposes. These will include bulldozers, excavators, shovels, tunneling machine, dumpers, batching plant, tankers, trucks, etc.

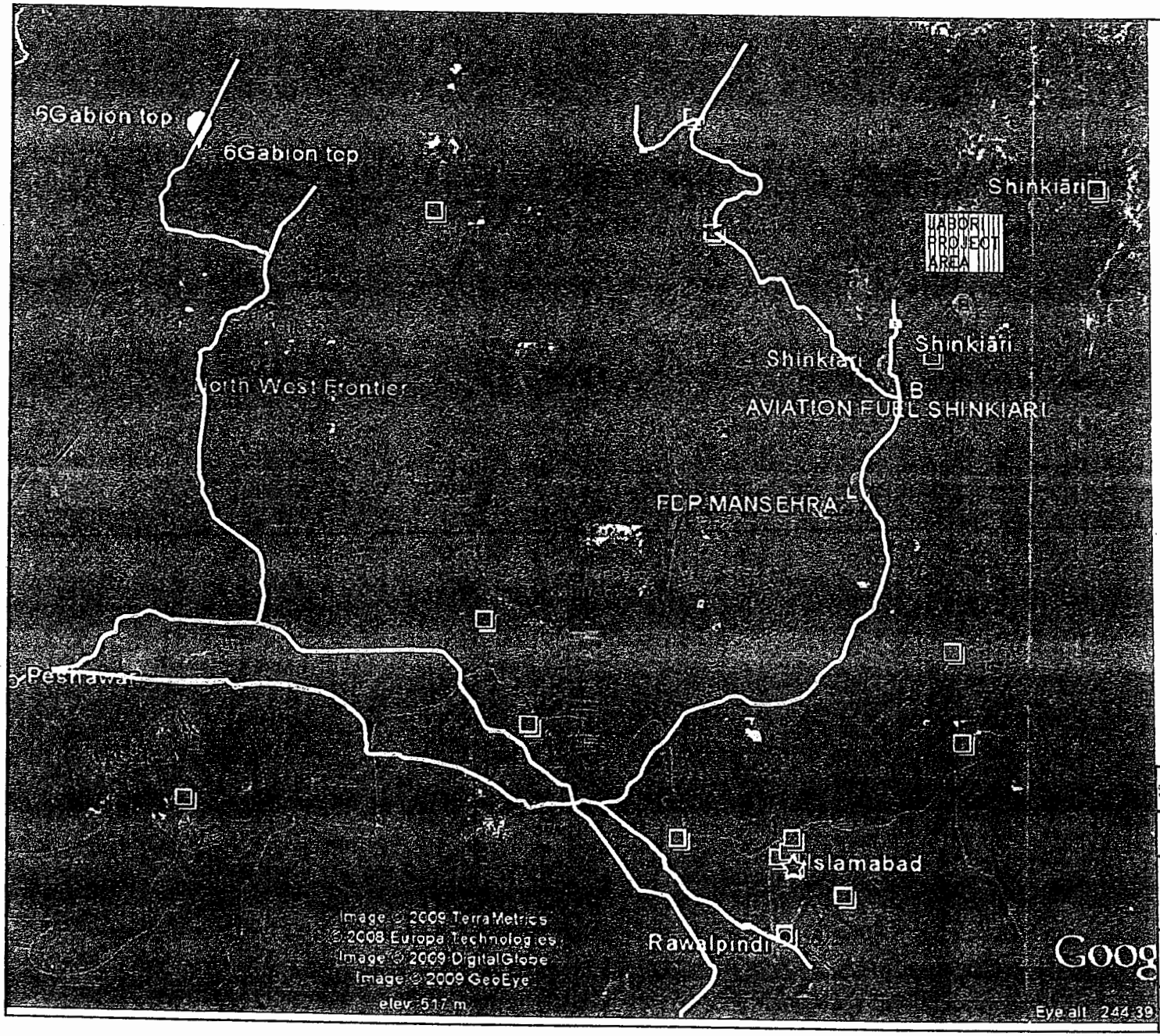
2.8 Excavated Material

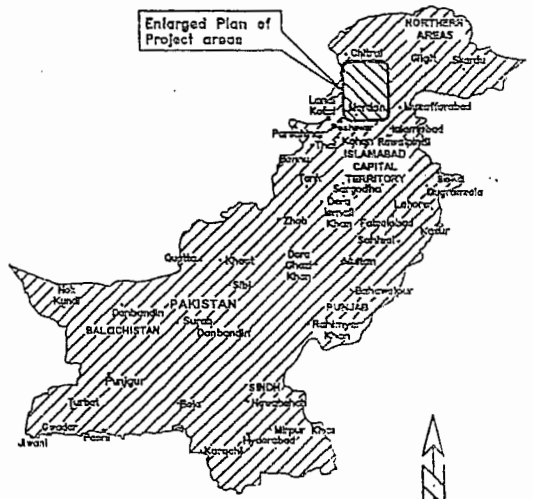
The Project will generate about 25,880 cu m of rock material from excavation for the Project components. Excavation for Weir and allied structure will generate a quantity of about 14,695 cu m, at Power Tunnel 8,476 cu m and Powerhouse 2,709 cu m. Depending upon the quality of the excavated stone material, some quantity will be used to meet the requirement of aggregate, rock fill at cofferdams, stone pitching, etc. This will be carried out at the designated area that will comprise waste land on the hilly area or along the river banks.

2.9 Project Capital Cost

The estimated capital cost of the project is Rs. 1,977.377 Million Rupees.

FIGURES





INDEX MAP

Sr. no.	Route	Distance
1	Lahore to Abbottabad	430
2	Abbottabad to Mansehra	35
3	Mansehra to Shinkiari	12
4	Shinkiari to Project Site	20

SARHAD HYDEL DEVELOPMENT ORGANIZATION (SHYDO)
GOVERNMENT OF NWFP

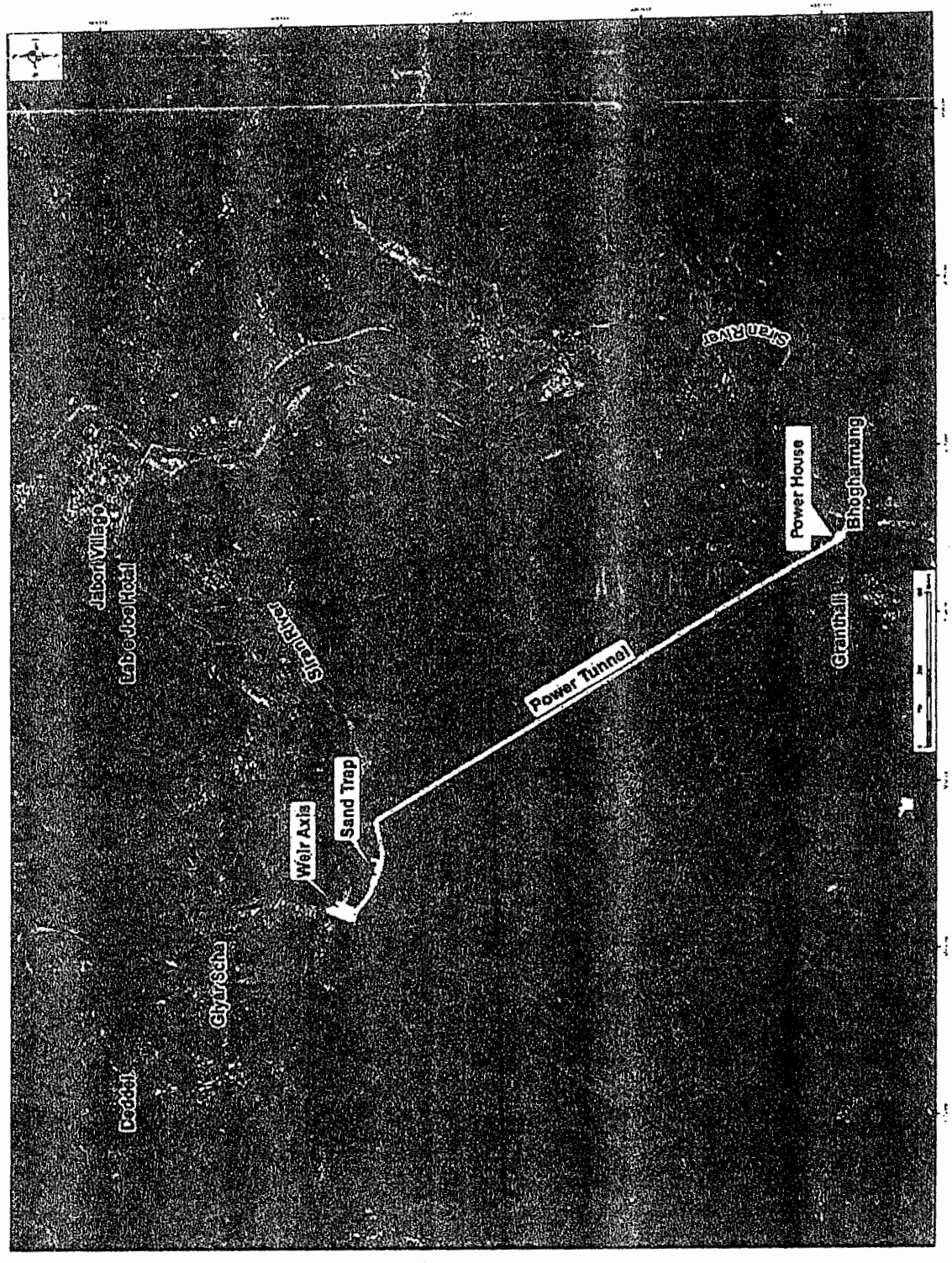
FEASIBILITY STUDIES OF THREE HYDROPOWER PLANTS
(KOTO, JABORI AND KARORA)

JABORI HYDROPOWER PROJECT
SITE LOCATION MAP

ASSOCIATED CONSULTING ENGINEERS ACE (Pvt) Ltd
36-CIVIC CENTRE, M BLOCK MODEL TOWN EXTENSION
LAHORE

DESIGNED		CHECKED		APPROVED	
DRAWN	IMTIAZ	DATE	MAY 05, 2010	FIGURE	2.1

Figure 2.2
Foot Print of Jabori HPP/ Project Area



CHAPTER 3

ENVIRONMENTAL BASELINE CONDITIONS

CHAPTER – 3

ENVIRONMENTAL BASELINE CONDITIONS

3.1 General

The environmental baseline conditions have been established on the basis of information gathered through structured interviews, formal and informal scoping sessions and group discussions with the communities of various settlements located along the river and in the vicinity of sites selected for construction of project components. In addition, information was also gathered from officials of various departments including departments of Forestry, Wildlife, Agriculture and Revenue. The information available from the limited secondary source has also been used for drawing inferences.

3.2 Delineation of the Project Area

From environmental view point the project area is defined as the areas of project influence. Some of these areas are directly impacted while others may be influenced indirectly. For this Project the areas of most concerns are as follows:

- Areas falling in the vicinity of the structures viz. Weir, Powerhouse and upstream and downstream portals of the Power Tunnel.
- Areas to be used for establishing construction camps and colony.
- Areas likely to be submerged by water impoundment.
- Areas likely to be used for dumping of spoil material from excavation of tunnel and the sites where weir and powerhouse are going to be located.
- Areas to be used for developing haul tracks.
- Quarry areas.
- About 7 km stretch of the river reach from Weir up to the Powerhouse that is going to be deprived from the river flows during low-flow season for its practical diversion into the Power Tunnel for power generation.
- Areas located on high-benches through which the Power Tunnel is going to be excavated. These areas are not going to be directly affected, but it is likely that the settlements on these benches may be disrupted due to vibrations from blasting and drilling of the Power Tunnel.
- Majority of residential area is not going to be directly impacted by the Project; however, the area is likely to have indirect effects of mixed type. Primarily, the induction of heavy machinery and vehicles when transporting construction material from quarries falling on other side of the town will cause traffic congestions and hazards, while on the other hand the induction of outside workforce will be beneficial in boosting the local business.

- The population residing in the valley on both sides of the Siran River is dependent on agriculture, sand and gravel extraction is going to be impacted due to break in the communication by the creation of reservoir.

3.3 Land Resources

3.3.1 Geology, Morphology and Soils

The geology of the area may be described as a section of Earth's Crust coming well within the area of Himalayan disturbance. The project area is a part of land formations developed at the foothills of Himalayan Range through tectonic events subsequent to those that caused building of Himalaya. The rock formations include extremely folded beds of various types of sandstones, clay-stones and silt stones. Both the banks of Siran River at weir site are almost fully covered with thick alluvial material having terrace cultivation, cluster of trees at places and natural grass and plants etc. The tunnel will run across the mountain from right bank of Siran River to a place near village Granthali located on the right bank of Siran River. The hill slopes are generally covered with vegetation, comprising cultivated terraces, natural grass and plants and trees. There are number of major steep gradient nullahs joining Siran River. Geological conditions at forebay and powerhouse are almost similar and favourable.

The right bank of Siran River at powerhouse site near Granthali Village is covered with thick vegetation, however; seemingly sound rock is well exposed at the proposed site. The left bank at weir site is covered with thick alluvial terrace, however, bed rock out crop is well exposed at the bottom whereas the right abutment seems comparatively better, having less alluvial cover. The Penstock site consists of thick alluvial cover ranging between 20 to 30 m.

The soils of Mansehra District are derived from metamorphic rocks and silts of Mica Granite. Mostly the mountains are covered with primary soils, except along the river and nullahs where the beds are almost devoid of soil material because of steep slopes or the scouring action of the river and nullah flows. The texture of the primary soils varies from moderately fine to moderately coarse depending upon the rock type from which these have developed. The soils of the raised terraces in floodplains are generally devoid of the stony material whereas the soils of lower terraces generally contain varied quantities of pebbles, cobbles and boulders. However, within the flood plains where slopes are milder to nearly level, deposits of secondary soils are met with. Such areas include Sacha Khurd, Deedal, Giyar Sacha, Upper bela and Lower bela, Granthali and Kundi Sehri Villages.

3.3.2 Seismic Hazards

A number of active local and regional faults pass around the project site. It lies very close to the Main Boundary Thrust (MBT) which is at a distance of about 15 km towards east. Jabori Hydropower Project is located in tectonically and seismically critical zones of convergence between Indo-Pakistan and Eurasia continental plates as shown in Figure-3.1.

3.3.2.1 The Muzaffarabad Earthquake of 8th October 2005

The Epicenter of the earthquake was at a place called Gori which was 20 km from Muzaffarabad. The epicenter of the earthquake was 10-20 Km below the ground surface

(thus it is classified as shallow earthquake and the principal cause of wide spread damage to public and private property). The earthquake measured 7.6 on Richter scale at the Epicenter. The shock wave traveled out as shown in the Figure-3.2. The strength of the shock wave reduced as the diameter of circle of influence increased. The affected areas are shown in pink color. The strength of earthquake felt at various locations as analyzed by US Geological Survey is shown in the following section;

		Earthquake Strength
Location		**Modified Marcalli Intensity Scale (MMI scale)**
1.	Gori (epicenter: 20 Km from Muzaffarabad)	XII
2.	Mansehra, Bag and Rawalakot	X
3.	Battagram	IX
4.	Abbottabad	VIII
5.	Islamabad	VI
6.	Lahore	V

Significant loss was limited to areas 1 to 5 listed above. The earthquake of 8th October 2005 has been followed by more than 5 aftershocks above magnitude (Mw=5) and about 2000 of lower magnitudes.

A detailed seismic hazard study has been carried out during the feasibility stage and the project components have been designed accordingly.

3.4 Land Ownerships

The lands in the project area are mainly proprietary and used for cultivation and settlements. The river and nullah beds along – with the adjacent slopes are also proprietary land .As such, the Project components, will be located on the proprietary land. However, the Power Tunnel will pass underneath the lands belonging either to the Forestry Department or to the individual owners of the Granthali Village. These lands would not be affected by the Project as the tunnel will be below the natural ground. The land required for construction camps and colony has been proposed to be acquired from the land available on the raised benches near, village Kundi Sehri. Table-3.1 provides detail of land ownerships in the project area. On the other hand, the reservoir will cover only proprietary lands. Of these, the major chunk is the agricultural land. It is also observed that the landholdings are small.

3.5 Water Resources

3.5.1 Surface Water

The main surface water resource of the Project area is the Siran River, which flows along Jabori town and joins the Tarbela Reservoir built on Indus River. There are numerous

smaller nullahs that discharge into the Siran River from left and right side. Figure-3.3 shows Siran River passing through project site

There is a gauge station maintained by SHYDO to measure river flow at the dam site. River discharge data is available from March, 2005. The mean monthly flows of Siran River during 2005 to 2008 are as shown in Figure-3.4. This figure shows that in the months of monsoon (July to September) average discharge is above 6.0 cumec and in the low flow seasons, (winter months) average discharge is 4.0 cumec.

3.5.2 Groundwater

Basically, the Project area and even the whole Mansehra District is devoid of any true ground water aquifer. This is because of the rocky formation of the area and steep slopes of the mountains.

The snow melt and rain water seeps into the ground to recharge the local aquifer of the mountains but reappears at places in the form of springs. The domestic water requirement of the communities is generally met from the spring water. It has been observed that the settlements are located where spring water is available in addition to the availability of level ground for housing and cultivation. The quality of spring water is reported by locals to be good. The water is free from contamination because of filtrating action of the strata through which it is passing.

3.5.3 Water Quality

Water quality of the project area is safe for non domestic consumption because there is no industry exist which discharge their effluent in the river. Even household sewage waste is discharged into nearby nullah and did not reach to the river which causing degradation of river quality. Anyhow, the waters would require appropriate treatment, before these are used for drinking by non – local construction crew.

3.5.4 Water Use in Project Area

Most of the people between weir to powerhouse use spring or rain water for daily use agricultural requirements. There is no water channel or any other structure exists between this reach which divert Siran river water. Further no water requirements has been discussed by the community during scoping sessions and it was confirmed during the transect walk by the field staff.

3.6 Biological Resources

3.6.1 Flora in District

Mansehra District is rich in natural vegetation. Besides the scattered vegetation in almost entire area, the hills are covered with forests of broad leaf and pine trees in accordance with the altitude. Fruit trees are rare; these are generally found in the courtyards of the farming communities. Most common trees are Drawa, Deodar, Shisham, Pine, Poplar, Chir, Draic and Bakain. Trees of Apricot, Pear, Peaches, and Apple exist. Main flora in the District is shown in Table-3.2 and in Figures-3.5 to 3.15 as well.

3.6.2 Major Flora in Project Area

Number of trees is spread over the project area. In so called plain areas shade trees, Shrubs are present. Among shade trees Shisham, Deodar and Drawa are common. While in fruit trees Peach, Pear and Apricot trees are to be found. Detail of flora in project area is given in Table-3.3.

3.6.3 Fauna

Most of the fauna in the Project area are local or domestic. During winter, however, a few migratory bird species visit the Project area on route to further south. The Project area is devoid of any habitat for the migratory species. Some species however, use local water resources as resting and feeding ground. Table-3.4(a) enlists the commonly occurring wildlife in the mountains of the District and 3.4(b) shown fauna in the project area and depicted in Figures-3.16 and 3.17.

3.6.3.1 Aquatic Life

Aquatic ecology and fisheries was discussed with the official of wild life department and it was declared that the project area has no natural habitat which impacted with the project implementation. However, no definite record is available, as there is no official from the Fishery Department posted at Jabori. The Siran River reach between weir to powerhouse site has negligible biological productivity. Fishery is not being practiced in the reach.

The available fish in Siran River are Barbus tor putitora. This fish is an undisputed king of the Himalayan Rivers. There is no commercial fishery in the area. Even traditional fishermen do not exist. However, some fishing is carried out for household use and recreational purpose.

3.6.3.2 Birds

Bird life is scanty. The birds such as crow, kite and common sparrow, King Fisher, Monal, Little brown dove can be seen. The bird population is thin in project area. Some common birds are shown in Figure-3.18 – 3.20.

3.6.4 Rare or Endangered Species

There are no endangered species in the project area.

3.7 Climate

3.7.1 General

The climate of the district is warm in summer and cold in winter. Since the altitude of the district ranges from 2000 to 4500 meters, the winter season remains extremely cold in the upper half of the district while in the lower half it remains moderate. Snow fall generally starts by the end of November on the high peaks of the mountains and descends downwards as the temperature falls further. Snow fall also occurs in the late February and continues sometimes up to the middle of March after which the weather becomes pleasant and usually remains mild during the remaining period of the year. May to August is the

summer months. January is the coldest month. Rainfall is less in the Northern portion of the district.

3.7.2 Temperature

The data shows that the average monthly mean maximum temperature varies from 14.0° C in January to 35 ° C in June, whereas monthly mean minimum temperature ranges between 2° C in January and 21 ° C in June.

3.7.3 Precipitation

Table-3.5 shows that the average annual precipitation of the project area is 1680 mm, most part of which is received during monsoon moths .winter rains are received during February to April.

Table-3.6 and Figure-3.21 depict maximum one day rainfall for 36 years (1961 through 2004). The table shows that minimum one day rainfall was experienced in the year 1973 with the figure of 21.60mm. The maximum one day rainfall occurred during the year of 1976 when the precipitation was 193.80 mm.

3.7.4 Evaporation

Terbela Reservoir is the nearest station where the evaporation data was available. Climatic condition of this reservoir is similar as that of the project area and as such this data has been utilized for the project area. Mean monthly maximum and minimum evaporation at Terbela Reservoir is 250 mm and 65 mm, respectively. The mean monthly maximum and minimum evaporation in the year 2000 is 270 mm and 70mm respectively.

3.7.5 Ambient Air Quality

No air quality monitoring data is available for the Project area. However, no major sources of air pollution, viz., industries, exist in the Project area except road traffic in the valleys of Siran River and other nullahs. This may be deteriorating the quality of air to some extent. However, due to presence of ample plantation and green areas on the mountains off side the roads the air quality is expected to be generally good.

3.7.6 Ambient Noise Levels

The project area is located in the valleys surrounded by steep slopes having vegetation. There are very few houses located near the sites of project component. Though the roads are available in the project area but the intensity of traffic is very low and the level of noise is assumed to be low.

3.8 Human Resources/ Socio-Economic Set-up

The findings of the Social Impact Assessment study has been made part of this subsequent section, however detailed and separate Social Impact Assessment (SIA) and their bearing on the population living in and around the vicinity of the project areas has been described in Volume II-B of this report.

3.8.1 Political and Administrative Set-up of the District

The Mansehra District covered an area of 4,579 square kilometers and is administratively divided into three sub-divisions namely Mansehra, Balakot and Oghi. In addition a belt of tribal area known as Kala Dhaka is also under the administrative control of the District. Politically the district is governed by District Coordination Officer/DCO. The DCO stationed at district headquarter Mansehra is responsible for law & order and is the custodian of state property.

On the revenue side, each sub-division has a separate revenue set-up consisting of an Deputy District Officer (Revenue), revenue officers, kanungos and patwaris. The district is further divided into kanungo halqas and patwar circles. The kanungos supervise the work of patwaries of their respective patwar circle.

3.8.2 Demography of the District

The total population of Mansehra district is 1,152,000 according to the census of 1998. Its population was 770,235 in 1981 meaning an increase of 49.7 percent was recorded during the seventeen (17) years. The average annual growth rate of population was 2.4 percent in the district during inter-censual period 1981-1998. The average household size of Mansehra District is 6.7 persons per family with average population density of 251 persons per sq. km.

Majority, 94.7% of the Mansehra District resides in rural areas while only 5.7% constitutes urban population living in Mansehra and Baffa municipal and town committees.

The majority of population of the district is Muslim, constituting 99.70 percent of the total population. Other population includes Christians, Hindus and Schedule Castes, etc.

3.8.3 Educational Status in the District

The District Education Officer assisted by male and female SDO's is responsible for education institutions in the district. Mostly the educational institutions belong to government however, some schools have also been established in the private sector. The district has seven colleges and two thousand two hundred and sixty schools including three Degree Colleges, one Commerce, Post Graduate, Polytechnic and Elementary College each, thirteen Higher Secondary Schools, ninety six High Schools, one hundred and fifty Middle Schools and one thousand three hundred and seventy Primary Schools for boys and girls. Model Schools, Maktab Schools and Mosque Schools are also established in the district for providing educational facilities to the people.

However, the Project Area settlements of Jabori and Granthali are deprived off education and health facilities. The people have to go to far places for schooling and health facilities. Literacy ratio in both the villages is 25.4% and 40.9%, respectively.

3.8.4 Major Infrastructure of the District

District Mansehra is devoid of any large scale industry and is backward in terms of industrialization due to non availability of basic infrastructure. There are, however, 25 units for manufacturing soap, furniture, ice, floor, plastic and shoes etc in the district. Woolen

clothing, wool handicrafts and woolen blankets are produced/ manufactured on small scale as a cottage industry. There are some water mills for Flour and Paddy.

District Mansehra is linked with the neighboring districts through metalled and non-metalled roads and foot-tracks whereas inside the district the roads are some-where metalled and some-where non-metalled. About 473 kilometers metalled and 277 kilometers non-metalled roads are spread throughout the district. Karakoram Highway is also passing through the district and serves as link between the district and rest of the country. There is no railway due to mountainous terrain of the district. But Jabori town is connected with Shinkiari and Mansehra through metalled roads.

District Mansehra has been provided with telephone facilities, digital telephone exchanges having various capacities of serving telephone lines have been established in Mansehra, Baffa, Batal, Balakot, Ghari Habibullah, Kaghan, Khawari, Shoill Najaf Khan, Madan Khwajgan, Naran, Oghi, Phulara, Pharna and Shinkiari. In addition analog, telephone exchanges of 1000 Nos. each are also working at Mansehra and Shinkiari.

About 100 units of health facilities are available in the district. There are thirteen Civil Hospitals, fifty eight Basic Health Units, eighteen Dispensaries and eight Rural Health Centers.

The villages are invariably supplied with electricity and telephone facilities except to those which are located at difficult terrains, access point of view.

3.8.5 Socio-Economic Set-up of the District

The socio-economic environment of the district is a mixture of rich and poor with a low percentage of mediocre. Due to lack of economic activities in the area, the people of the area started migrating abroad for search of opportunities. However, the people did not break their link with their homeland. The earning from abroad is being invested in different kinds of activities such as purchase of land and constructing houses. In general, the people are well to do except a few families. The annual income of most of the families ranges between Rs. 30,000 and Rs. 50,000. However, in some cases the annual incomes ranges between Rs. 60,000 and Rs. 80,000, generally, the income quoted by the people did not include return from the agricultural land. The people consider that the agricultural landholdings of the families are just sufficient to meet the household requirements only. Having no monetary return, the people do not consider it as an income.

The trend of investment in industrial sector is generally non-existent for many reasons, mainly because of non-availability of know-how, incentives and difficult terrain of the area. However, investment in commercial sector is plentiful.

People are relying for their earning from small agricultural land holdings and/or providing services on daily wages. Among the literate class doctors, engineers, teachers and college lecturers represent the district at country level.

The main economic activity in the area remains in agriculture, livestock and service sectors. Of the total land area about 439,423 Hectares of the District, 18% is available of cultivation while 82% of the land bears forest, settlements, infrastructures or lie in the form of

uncultivable waste land. Wheat, maize and rice are cultivated on about 39,340 Hectares, 57,247 Hectares and 2,702 Hectares of land, respectively. Barley, Sugarcane and Potatoes are also grown rarely. Vegetables and fruit trees are spread over the area of entire district. Total area covered by the fruit trees is about 987 Hectares or 0.22 %. Citrus, Loquat, Banana, Apricot, Apple, Pear, Peaches, Plum, and Walnut are the main fruits while vegetables like Cabbage, Carrot, Reddish, potatoes, turnip and Onion are grown for domestic needs.

The picture of the Project Area is, however, somewhat different from the district statistics. The area to be consumed by the Project structures i.e. reservoir, channel, sand trap, power house, and camps & colony and approach roads is given in Table-3.7 below and also shown in Figures-3.23 and 3.24.

3.9 Socio-Economic Set-up of the Project Area

3.9.1 Demography

Jabori Town is located in Jabori Patwar Circle in Mansehra Tehsil of Mansehra District. The population of Jabori PC is 13,521 Jabori with a population of 6,203 is the biggest village amongst the five villages falling in the PC Jabori.

Granthali village located in Bhogarmang Patwar Circle and its population was 1,521 as per 1998 census. In Jabori 99.76% and in Granthali 100% population is Muslim. Household size is 6.7 and 6.8 in respective area.

3.9.1.1 Age Composition

The analysis of the socio-economic data collected from project villages reveals that the 62% population falls between 10-50 years of age group. The Highest 20.88% belongs to 10-20 years age group followed by 17.40% who are in 20-30 years, 12.76% in 30-40 years and 10.90 % in 40-50 years. Children (< 10 years) are 27.37 % and remaining 4.41% and 6.25 % falls in 50-60 and 60 & above category respectively. The same results are shown in the Table-3.8.

3.9.1.2 Gender Composition

Socio-economic household data collected through field surveys reflects that with a household size of 6.06, the gender composition of surveyed villages is 53.36 males to 48.04 females. The same is depicted in the Table-3.9

3.9.1.3 Ethnic Groups in Project Area

Project area is home to a diverse group of people including different tribes and clans, amongst whom Swati are dominant with a percentage of 73.2. Remaining population belongs to Yousaf Zia (15%), Tanoli (8.2%), Gujjar (3.1%), Awan (2.4%) and Quraishi (2.1%) tribes. Community, on the whole, is socially cohesive with minor conflicts which are resolved locally by the elders. Same is shown in Figure-3.22.

3.9.2 Housing Conditions in Project Area

Eighty five percent houses in project area are Pacca while 4.9 % and 10.26% are semi Pacca and Kacha, respectively. Ten percent houses have potable water supply while 47.76% houses are electrified.

A single housing unit, on the average, comprises 3-4 residential rooms, 1-2 animal sheds and one bath rooms. Average room size for the living room is 30 square meters (98.2 square feet) while animal shed's average size is 28 square meter. Average area of one house is 165 square meters. Most of the houses are build of wood and stone, however use of mud and stones is also observed in second class construction. The analysis reveals that the construction cost for a living room is Rs.1, 069 per square feet, while it is Rs. 653 for animal sheds and Rs. 508 for the bathroom.

3.9.3 Occupation and Income Resources

Half of the household members are not working as they are either very young to take up work or could not get an opportunity to work. Women play a vital role as housewives taking up most of the domestic works. Agriculture and livestock are the main as well as secondary occupations adopted by the residents. Average Income from main occupation is Rs 8,000 per month and from secondary occupation it is Rs 5,000 per month. Detail of occupation is given in Table-3.10.

3.9.3.1 Household Assets

Data was collected on the assets possessed by the households which reflect that more than half of the population posses Radio and TV. Most of them (83.53 %) have cell phones while only 12.37% have vehicle. Table-3.11 shows the number of assets per household and their per unit price.

3.9.3.2 Other Assets

Results of social survey show that there is only 3 % households own a shop/business.

3.9.3.3 Livestock

Socio-economic data reflects that livestock holding per household is not very high. On the average, each household possess 1.63 goats and 13.06 poultry. The remaining livestock possession by a household is less than one which is evident in the Table-3.12.

3.9.4 Land Status in Project Area

Lands in the project area are mainly proprietary and used for cultivation and settlements. River and nullah beds along with the adjacent slopes are also proprietary land. However, majority of the affected population of Jabori site (98 %) are non-settler. They own land in the Project Area but reside elsewhere. While in case of Granthali village the affected population is almost resident-owner.

As such, the Project components will be located on the proprietary land. Even the reservoir will occupy the proprietary lands. However, the Power Tunnel will pass underneath the

lands belonging either to the Forestry Department. These lands would not be affected by the project as the tunnel will be below the natural ground.

It is also observed that the landholdings are small. The landholdings of the affected families range from 5 Kanal to 18 kanals.

Land required for construction camps and colony has been proposed to be acquired from the land available on the raised benches near village Kundi Sehri.

3.9.4.1 Land and Land Use

Of the total landholdings in the project area 15.6% is available for cultivation, 25.1% is forest land, 16.2 is grazing land while the remaining land is under residential settlements or lie in the form of uncultivable waste land. Different land types in the project area are shown in Table-3.13.

3.9.4.2 Major Crops Cultivated in Project Area

Wheat, maize and rice are cultivated on about 284 kanal, 247 kanal and 137 kanal of land, respectively. Rice is not a common crop of Jabori village but it is cultivated in Bhogarmang. Detail is given in Table-3.14.

Average production of wheat, maize and Paddy is 200, 360 and 280 Kg/Kanal, respectively. Wheat is cultivated for the individual family needs.

3.9.5 Social Amenities in Project Area

The findings of the analysis on the provision of social amenities/infrastructure for the households reveals that drinking water and washing / bathing points, mosques, graveyards, electricity and primary schools for boys/girls, are those amenities which are available to most of the households (see Table-3.15). Comparative to these services, telephone connections, disposal of solid and liquid waste are available to lesser percentage of households.

Area is almost devoid of secondary school, dispensary and hospital. Availability of social amenities and the degree of efficiency according to resident is depicted in Table-3.15.

3.9.6 Food Sufficiency and Security in Project Area

Majority of respondents do not experience any shortage of food in any part of the year. However, according to less than one forth of respondent household's food deficiency does occur in winter months.

3.9.7 Gender Situation in Project Area

Within the prevailing social culture, preference of a son over a daughter is predominant mainly for reasons of securing lineage and right to property. Women are infrequently consulted; usually men have the deciding power and even make purchases for females. Rural women mostly remain inside the home. Young girls are born to be submissive and have to obey the rules laid down by the males.

The situation of women in the project area has been analyzed through Gender Survey conducted in the project area's villages. An overall situation of women in the project area based on the findings of this survey is summarized below.

Food Consumption: Women's share in the daily consumption of food was assessed in comparison with men. According to the opinion of 69 % of respondents women's share in daily food consumption is somewhat less as compared to men. Proteins in the form of meat, eggs, milk, and beans are frequently consumed by women, i.e. there is no gender difference in the quality of food.

Housing: On the average each household share 2.42 rooms in which 0.7 rooms are used exclusively by women. Bathroom and toilet facilities, within the house, are available for women in most of the houses.

Decision Making: Decisions of marriage of children, sale purchase of property and purchase of household consumption items largely rests with the men with a meager role of occasional consultation with women.

Responsibilities: Women's pressing responsibilities are maintenance of house followed by food arrangement for household, child rearing and treatment of ailing members both men and women.

Awareness of Project: The awareness of the project amongst women is quite low as only 18% women respondents had knowledge that a hydropower project is coming in their area. They however, expect that project will be beneficial for the area and shall resolve some of their economic and social problems. They are anticipating that project will bring schools and educational facilities and hospitals in the area and hoped that the problems of women shall also be addressed by the project.

3.9.8 Main Diseases in the Project Area

The major diseases in the project area are:

- Acute Respiratory Track Infection (ARI)
- Gastroenteritis
- Chronic Dieses such as TB.

There is no health facility in the Project area. The people have to go to Shinkiari, Mansehra and Dadar. Dadar is known for its Tuberculosis Sanitarium, where weather is very pleasant in summers due to thick vegetation.

TABLES

Table-3.1

Detail of Land Ownership

Categories	%	Legal Status of Ownership
Resident Owner	1.9	Formal
Resident tenant	0	Formal
Non settler	98.1	Formal
Squatter	0	Formal

Table-3.2

Detail of Flora in the District

Sr. No.	Scientific Name	Vernacular Name
1	Pinus roxberghii	Pine
2	Dalbergia sisso	Shisham
3	Cedrus deodara	Deodar
4	Melea azedarie	Bakain
5	Punica granatum	Daroon
6	Zyziphus jajuba	Beri
7	Melia azedarach	Bakain
8	Olea cuspidate	Kahu
9	Liriodendron tulipifera	Poplar
10	Diospyros digyna	Persimmon
11	Robinia pseudoacacia	Rubania
12	Malus domestica	Apple
13	Prunus persica	Peach
14	Pyrus boissieriana	Pear
15	Prunus armeniaca	Apricot
16	Sect. Juglans.	Walnut
17	Acacia nilotica	Kikar
18	Malus domestica	Apple

Table-3.3

Detail of Flora in Project Area

Shade Trees	%
Shisham	10
Deodar	17
Drawa	29
Pine	10
Beeri	5
Kikar	3
Poplar	10
Rubania	5
Bakain	12
Fruit Trees	
Apple	2
Walnut	11
Peach	28
Pear	24
Persimmon	1
Apricot	34

Table-3.4 (a)

List of Wild Fauna in the District

Sr. No.	Scientific Name	Local Name
1	Capre falconeri	Markhur
2	Porcus impejanus	Monal
3	Ovis Orientalis	Urial
4	Selenaretos, thibetanus	Himalyan bear
5	Panthera pardus	Leopard
6	S.senegalensis	Little brown dove
7	Canis lupus pallipes	Wolf
8	Rhesus Monkey	Maaca mulatta
9	Vulpes bengalensis	Fox
10	Streptopelia chinensis	Spotted dove
11	Coraciiformes	King fisher
12	Felis silvestris	Wild cat
13	Sylvilagus brasiliensis	Forest rabbit

Table 3.4 (b)

Detail of Domestic Fauna in Project Area

Sr. No.	Scientific Name	Local Name
1	Anoa spp	Buffalo
2	Caprahircus	Goat
3	Equus asinus	Donkey
4	Equus Cahallus	Horse
5	Equus spp	Mule
6	Canis spp	Dog
7	Gallus domesticus	Domestic Chicken
8	Columbia livia	Pigeon

Table- 3.5

Temperature and Rainfall Data for the period 1961-90

	Mean Temperature (°C)		Precipitation (millimeters)	Relative Humidity (%)
Month	Maximum	Minimum		
January	14.0	2.0	94.9	67.1
February	15.4	3.9	153.5	63.4
March	19.5	7.6	188.6	59.9
April	25.3	12.6	134.3	54.3
May	31.0	17.2	77.0	43.3
June	35.3	21.0	98.4	42.2
July	32.3	21.3	359.4	67.3
August	31.3	20.6	292.5	75.1
September	30.9	17.1	100.8	65.8
October	27.5	11.5	44.7	58.9
November	21.9	6.2	45.9	62.1
December	16.0	2.9	81.2	68.5
Annual	**25.1**	**12.0**	**1,680.0**	**60.7**

Source: Data Processing Centre, Pakistan Meteorological Department, Karachi.

Table-3.6

Maximum & Minimum Annual One day Rainfall at Jabbar

Sr. No.	Year	Annual One Day Rainfall (mm)
1	1969	44.96
2	1973	21.60
3	1974	74.70
4	1975	72.14
5	1976	193.80
6	1977	114.30
7	1978	68.80
8	1979	68.80
9	1980	69.90
10	1981	52.32
11	1982	56.00
12	1983	104.00
13	1984	73.00
14	1985	94.00
15	1986	89.00
16	1987	55.00
17	1988	48.00
18	1989	75.20
19	1990	86.90
20	1991	92.50
21	1992	102.40
22	1993	89.40
23	1994	79.00
24	1995	100.30
25	1996	93.20
26	1997	87.60
27	1998	101.10
28	2001	109.20
29	2002	114.60
30	2003	143.50
31	2004	147.30

Note: For the years 1999, 2000, 2005 and 2006 Data is not Available

Table-3.7

Land Required by the Project Structures

Project Structures	Cultivated land		Waste land		Forest /Grazing Land		Total	
	Land (kanal)	%	Land (kanal)	%	Land (kanal)	%	Land (kanal)	%
Reservoir and Channel	104	44.8	169.4	98.5	30	54.5	303.4	66.1
Sand Trap	0	0.0	0.6	0.3	0	0.0	0.6	0.1
Access Road	1	0.4	2.0	1.2	0	0.0	3.0	0.7
Camps and Colony	25	10.8	0.0	0.0	0	0.0	25.0	5.4
Power House etc.	102	44.0	0.0	0.0	25	45.5	127.0	27.7
TOTAL LAND REQUIRED	232		172		55		459	

Table- 3.8
Age Composition

Age Group (Years)	No.	%
< -5	47	10.90
5-10	71	16.47
10-20	90	20.88
20-30	75	17.40
30-40	55	12.76
40-50	47	10.90
50-60	19	4.41
60 & Above	27	6.26
Total	**431**	**100.00**

Table- 3.9
Gender Composition

Gender	No.	%
Male	230	53.36
Female	201	46.64
Total	**431**	**100.00**

Table- 3.10

Detail of Occupations in the Project Area

Sr. No.	Occupation	Main %
1	Agriculture	80
2	Livestock	11
3	Labour	4
4	Govt. Service	0
5	Logging	0
6	Fishing	0
7	Other	5

Table- 3.11
Household Assets

Type	# Per Household	Per unit Price(Rs.)
Radio	1	1,862
TV	1	8,750
Telephone / Cell	2	7,441
Vehicle :Type	0.1	568,824
Household Accessories	0.01	10,000

Table 3.12
Livestock in Households (HH)

Type	Avg. # Per HH	Avg. Per unit Price
Goat	1.63	6,310
Sheep	0.25	7,792
Cow	0.19	38,889
Buffalo	0.63	65,902
Horse	0.05	24,000
Mule	0.11	5,000
Donkey	0.02	15,000
Poultry	13.06	267

Table-3.13

Land and Land Use

Land Type	Avg. per Household (Kanals)	%Land type
Cultivable Area	18.1	15.6
Area Cropped	10.4	8.9
Grazing Land	18.9	16.2
Waste Land	5.2	4.4
Forested Area	29.3	25.1
Meadows	28.3	24.3
Mountains	6.3	5.4

Table-3.14

Crops Cultivated in Project Area

Crop	Areas Sown (Kanals)	Avg. Production(Kgs)	Price (Rs./Kg)
Wheat	284	200	25
Maize	247	360	15
Rice	137	280	100

Table- 3.15

Detail of Social Amenities in Project Area

Amenities	% of Household	Response about Amenity's Efficiency		
		Excellent	Good	Poor
Water Supply	87.6	41.2	58.8	0.0
Drinking Water Points	75.2	29.3	70.7	0.0
Washing / Bathing Points	80.0	22.4	53.9	23.7
Primary School (Boys / Girls)	87.6	15.2	84.8	0.0
Secondary /Higher School (Boys / Girls)	1.0	0.0	0.0	100.0
Dispensary / BHU	1.0	0.0	0.0	100.0
Hospital	0.0	0.0	0.0	0.0
Mosque	89.5	70.1	24.7	5.2
Market	1.9	0.0	16.7	83.3
Graveyard	90.5	33.3	57.1	9.5
Telephone Connection	33.3	13.8	79.3	6.9
Electricity Connection	89.5	12.2	53.7	34.1
Disposal of Solid Waste	53.3	12.2	49.0	38.8
Disposal of Waste Water	46.7	13.0	37.0	50.0
Bridge Crossing	59.0	0.0	40.0	60.0
Water Mill	1.0	16.7	0.0	83.3
Irrigation Scheme	1.9	0.0	12.5	87.5
Hydel Power Generators	0.0	0.0	0.0	0.0
Access Road	5.7	0.0	25.0	75.0

FIGURES

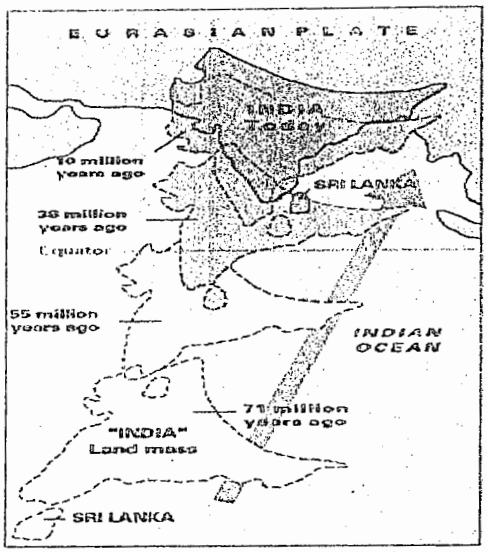


Figure: 3.1 Convergences between Indo-Pakistani and Eurasia continental plates.

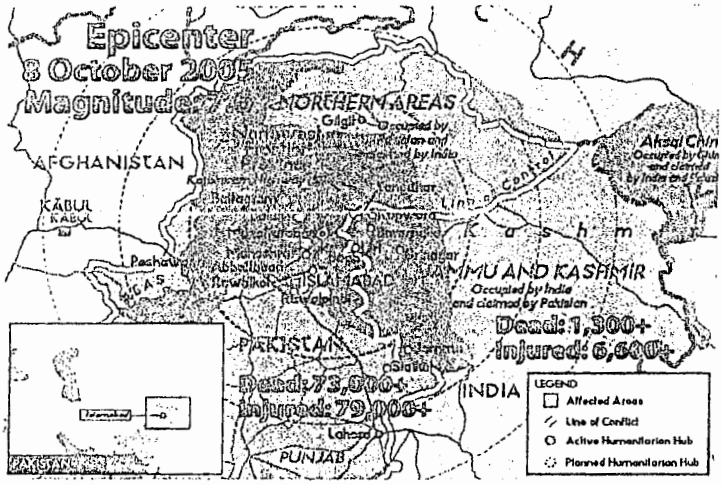


Figure: 3.2 Shock waves of Muzaffarabad Earthquake, 2005.

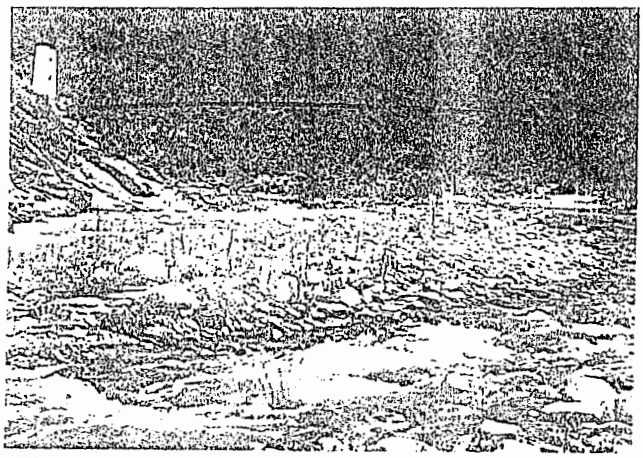


Figure: 3.3. Siran River passing through project area

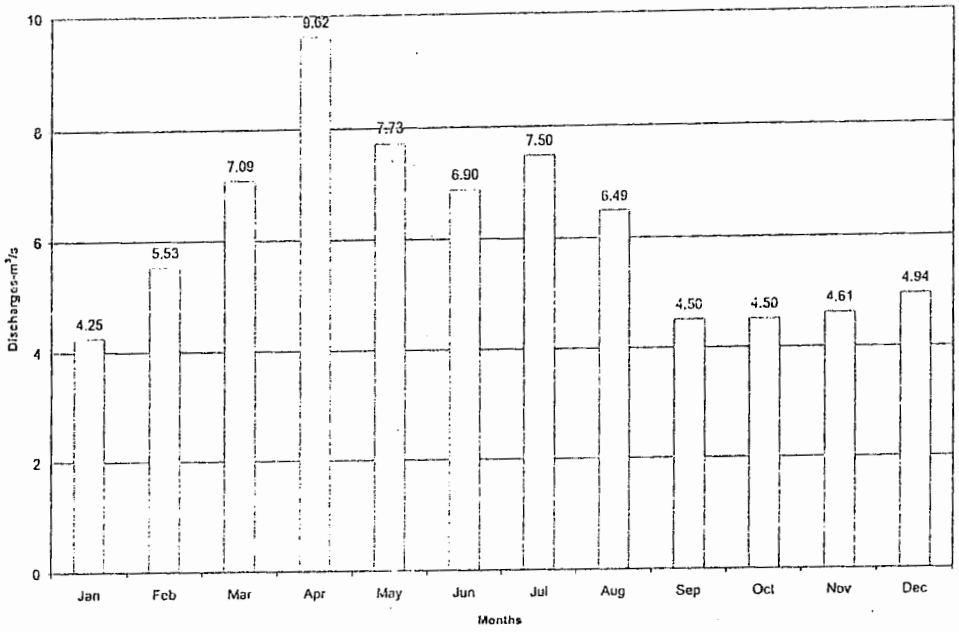


Figure 3.4 Observed Mean Monthly Flows for Siran River at Jabori (2005-2008)

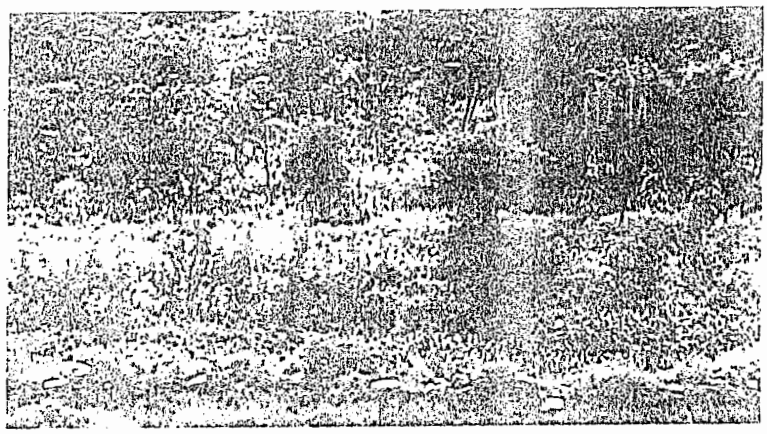


Figure: 3.5 A view of thick vegetation at Reservoir site

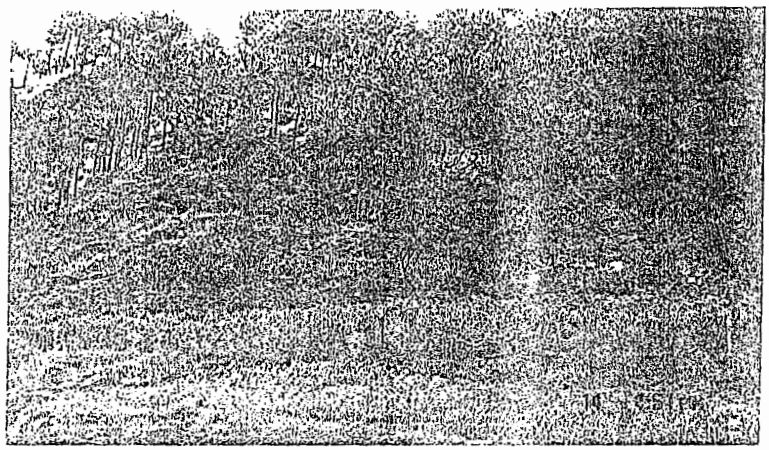


Figure: 3.6 A view of thick vegetation at Powerhouse Site

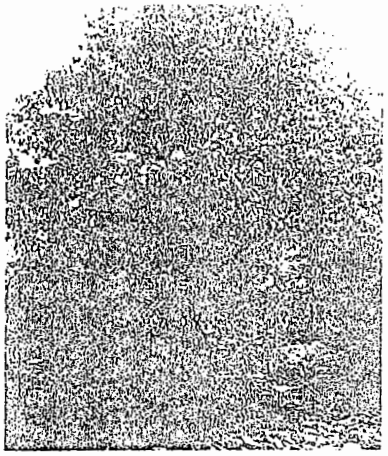


Figure: 3.7 Drawa

Figure: 3.8 Pinus roxberghii

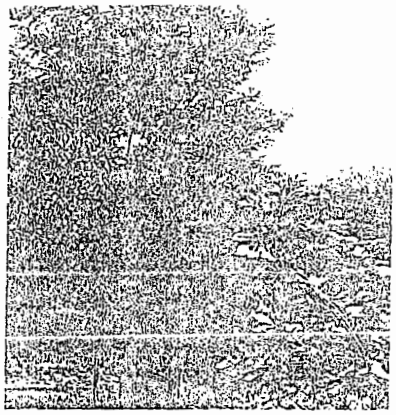


Figure: 3.9 Acacia nilotica

Figure: 3.10 Dalbergia sisso

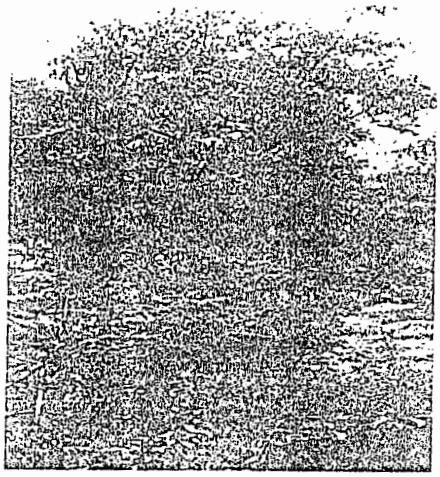


Figure: 3.11 Zyziphus jajuba

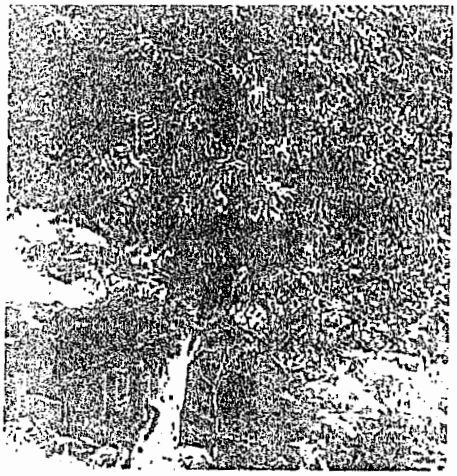


Figure: 3.12 Olea cuspidate

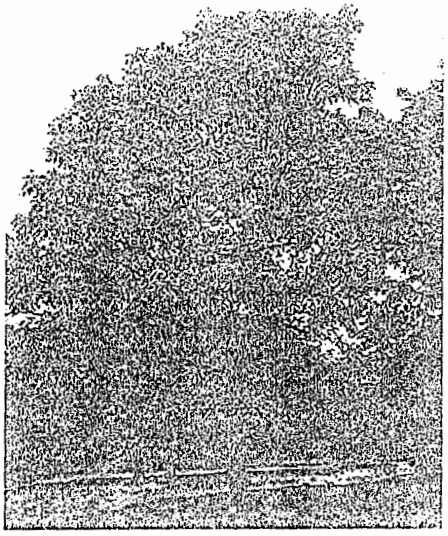


Figure: 3.13 Sect. Juglans

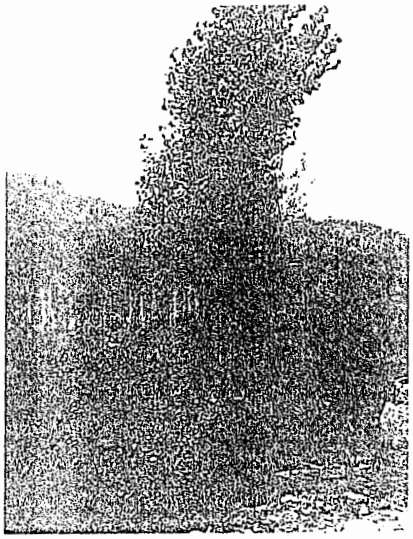


Figure: 3.14 Punica granatum

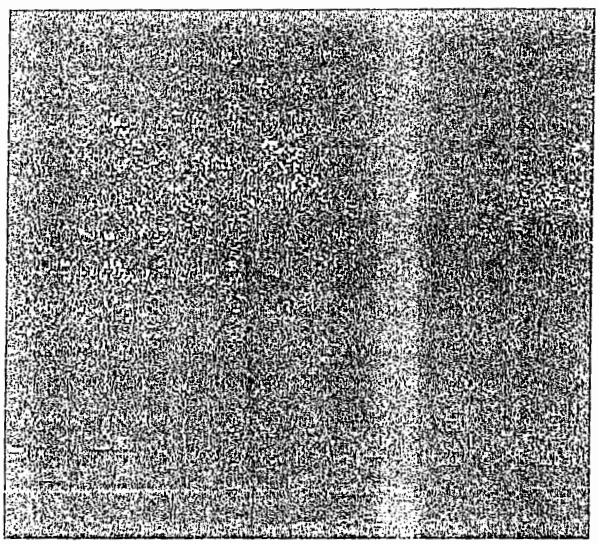


Figure: 3.15 Prunus persica

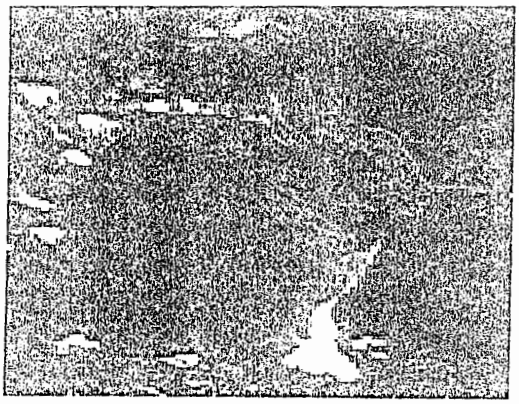


Figure: 3.16 Forest Rabbit

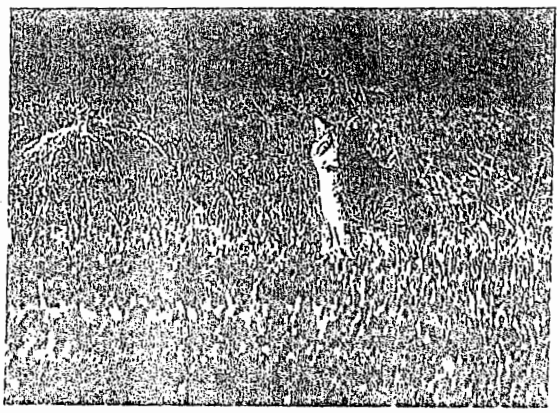


Figure: 3.17 Wild Cat

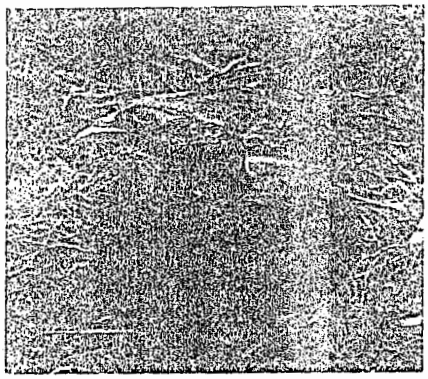


Figure: 3.18 Monal

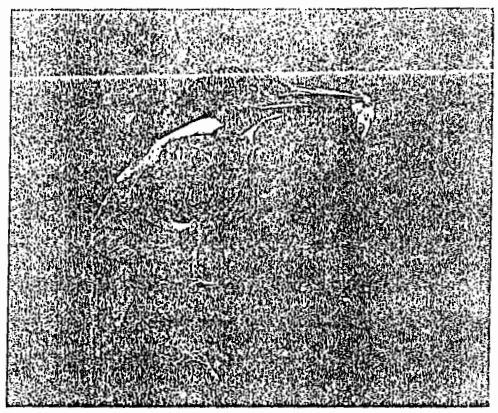


Figure: 3.19 King fisher

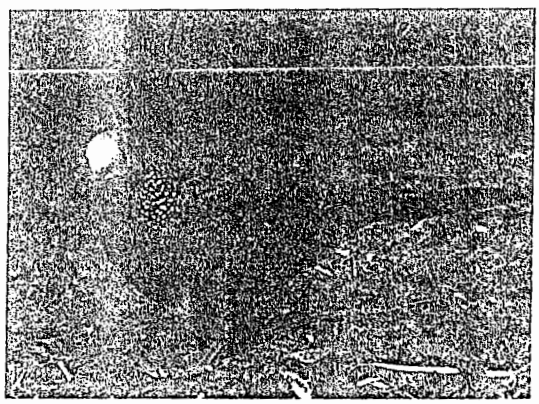


Figure: 3.20 Little brown dove

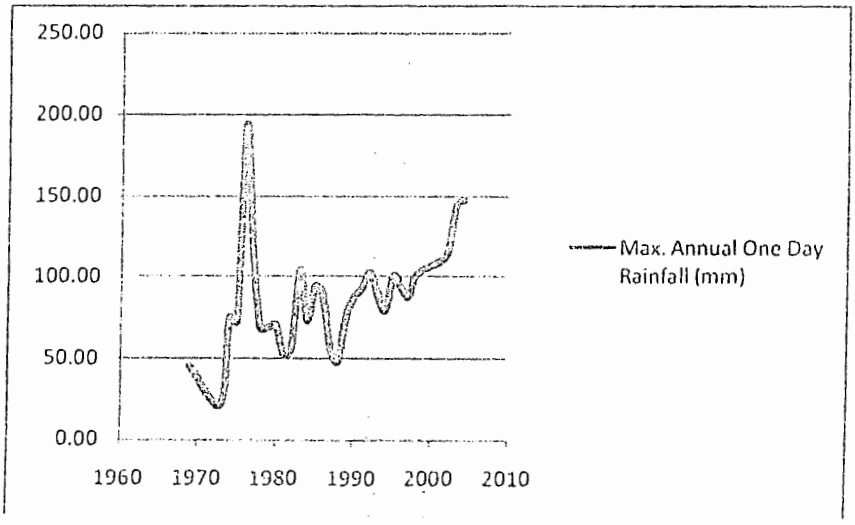


Figure: 3.21 Maximum Annual One day Rainfall at Jabbar (1960-2010)

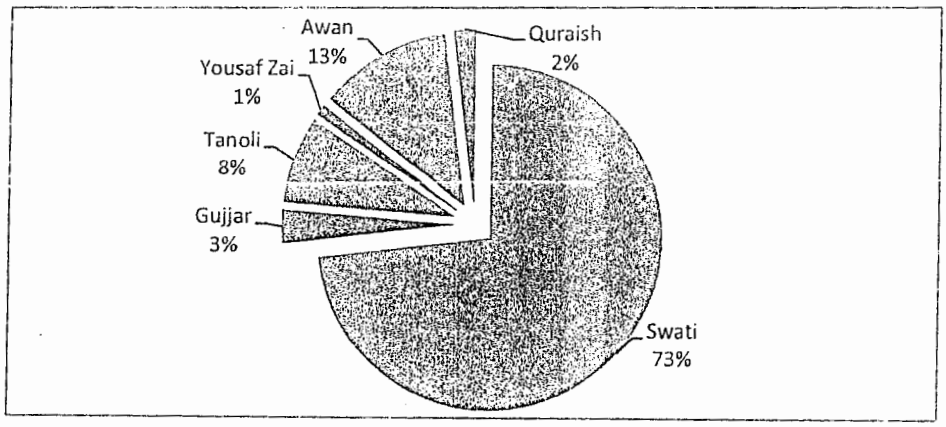


Figure: 3.22 Details of Tribes/Clans

CHAPTER 4

POTENTIAL IMPACTS AND MITIGATIONS OF THE PROJECT

CHAPTER - 4

POTENTIAL IMPACTS AND MITIGATIONS OF THE PROJECT

4.1 General

This chapter describes the potential impacts of the Project on the environmental and social setting of the Project area. The chapter also deals with the proposed actions for mitigation of environmental hazards and resettlement/compensation requirements of the Project.

Initial Environmental Examination has been carried out in line with guidelines issued by the Pak EPA and international donor agencies. The assessment has generally been based on the factual site condition in the light of experience gained from similar projects and discussions held with the local communities and knowledgeable people.

4.2 Delineation of Project's Area of Influence

Before proceeding to the environmental analysis of the project, it is imperative to delineate the areas of project influence. In general, the project affected areas have been considered at two levels, viz. primary and secondary. The primary level affected areas are those that are directly impacted by the project, these include areas where major construction activities are going to take place for construction of project structures, establishment of construction camps and colonies, borrow, quarrying and spoil disposal areas, construction of access and haul tracks, etc. In case of dam and hydropower projects the downstream flows are also reduced due to retention and diversion of water. Therefore, the downstream reach up to a certain limit, most likely till another tributary discharges its flow into the concerned Nullah, is also considered as primary affected area.

Besides the directly impacted areas referred to above, the construction-related and subsequently traffic-borne noise and air pollution may influence areas at large distances away from the primary affected areas. The project construction as well as operational activities may have a variety of direct and indirect effects on the physical, biological and human resources of the project area and its environment. Even the direct impacts may be of primary or secondary nature. Strictly speaking, the primary impacts are directly related to the circumstances where land is to be acquired; people are affected in so far as their physical displacement or relocation is involved. Likewise, removal of vegetative cover for construction may also be considered as a primary impact. On the other hand, secondary impacts entail the direct impacts on physical, biological and human resources arising from the pollution caused by noise, vibrations, toxic emissions, spills, dust, or consumption of natural resources, etc. Depending upon the direct and indirect impacts, the area of influence would be of two types, i.e., one taken in consideration of land acquisition and resettlement and the other on the basis of environmental aspects.

4.3 Project Impact Matrix

Table-4.1 exhibits impacts of the project in the form of a matrix. This illustrates the impacts of various components of the project during construction as well as operational phases on various physical, biological and social environmental parameters qualitatively. The evaluation

ranking of effects on various environmental parameters has been depicted with symbols denoted as "O" for insignificant or none, "L" for low, "M" for medium and "H" for high while type of effect is designated as "A" for adverse and "B" for beneficial. Likewise, "NA" denotes for not applicable and "ND" for not determined.

In general, the impact assessment has been made specific to the areas likely to be affected directly by the project components. Noise generated by the construction activity may scare wildlife inhabiting in the forests. Therefore, this aspect has also been considered and an environmental parameter has been included in the matrix indicated as "Wildlife (Scaring/Facilitating)". It has been assessed that the construction activities of the project will not disrupt the natural habitats; however the noise generated by the construction machinery may result in adverse effects on the wildlife but of very low level or insignificant category. On the other hand, creation of an impoundment (reservoir) during the operation of the project will be beneficial for the wildlife through providing a feeding and drinking place.

The preceding paragraphs have provided a generalized overview of the Project Impact Matrix, while detailed account on the effects of the project on various environmental and social parameters, particularly with reference to potential effects of the project is described in the subsequent sections.

A- ENVIRONMENTAL IMPACTS AND MITIGATIONS

4.4 Land Resources

This section explains how the proposed project could potentially affect the land resources through change in land use, soil erosion and contamination, and describes mitigation measures to manage these impacts.

4.4.1 Impact on Land Use and Resources

a) Land Productivity and Use

- It is obvious that acquisition of land for weir, access road or establishing contractor's facilities will change the local land use pattern. The change in land use for the former activity will be permanent while that for latter ones it will be temporary.

- It is envisaged that use of borrow material will be very limited because the majority of the material will be formed at excavation at the weir site. However, it will cause the loss of some of the fertile plough layer and a drop in the elevation thus resulting in the decrease of land productivity.

- Potential conflicts may emerge with landowners regarding the restoration of temporarily acquired areas for establishing contractor's facilities, particularly borrow and spoil disposal areas.

- Borrow pits and other landscape depressions if left open, may prove hazardous to human beings, livestock and wildlife. Moreover rain water pounding in open pits can be a potential health hazard both for human beings and livestock due to mosquito breeding and the pollution caused by stagnation of the water.

b) Soil Erosion and Land Sliding

- Notwithstanding the land sliding problems that aggravated after the earthquake, the cutting of the hillside slopes for project structure will further destabilize the slopes. Most of the hill slopes in the project area are covered with variable thickness of primary or colluviums. Excavation at the toe of the hill for construction of the access road will destabilize the colluviums resting on the upper part of the slopes thus will promote the landslides. Thus if hillside or valley side slopes are left unprotected these will be subject to a natural weathering and become increasingly prone to soil erosion and land sliding.

- Soil erosion may occur in the workshop areas as a result of improper runoff drawn from the equipment washing-yards and improper management of construction activities in hilly areas particularly in the vicinity of natural streams. Soil erosion may also occur at quarry areas, if unmanaged blasting is carried out.

- The reduction in vegetative cover will reduce the binding capacity of the soil and susceptibility to erosion by the force of rainfall, resulting in increased soil erosion and removal of plant nutrients. The loss of vegetative cover can increase propensity for landslides.

- Uncontrolled dumping of waste or excavated material on the valley side slopes will over load and overstress the top of the slope and upon saturation these loose dumps will slide down into the river.

c) Soil Contamination

- Land may be contaminated by the spillage of chemicals like fuels, solvents, oils, paints and other construction chemicals and concrete. This normally happens when these materials are transported in open or loosely capped containers or by careless handling.

- The possible contamination of soil by oils and chemicals at campsites, workshop areas and equipment washing-yards may limit the future use of land.

- It is anticipated that a large quantity of excavated material will need to be disposed off. If this waste material is not properly disposed off, it will contaminate the soil and water resources, especially during the monsoon season.

4.4.2 Mitigation Measures

The mitigation measures, which will be carried out in construction as well as operation stages for land resources are as under:

a) Land Productivity and Use

- Project facilities, viz., construction camp and workshop will be located at a minimum distance of 500 m from wildlife habitats and settlements, etc. This limit will be 1000 m in the case of asphalt batching plant. If there are constraints to meet with these

conditions due to hilly terrain, the contractor will consult the Engineer–in-charge for resolving the matter.

- Prior to the commencement of construction activities, the contractor will submit a layout and location plan of the facilities to the Engineer-in-charge, Local Government and Khyber Pakhtunkhwa-EPA, for its scrutiny and approval.

- As far as possible, waste land i.e. areas not under agricultural, residential or forestation use will be used for borrow material and setting up project facilities.

- Where the use of agricultural land is unavoidable for borrow of earth material, the top 30 cm of the plough layer will be stripped and stockpiled for redressing the land after the required borrow material has been removed. In case deep ditching is carried out, the top 1 m layer of the ditching will stripped and stockpiled. The ditch will initially be filled with scrap material from construction then leveled with the stockpiled topsoil to make it match the rest of the area. It shall be ensured that the scrap does not contain any material that would contaminate soil or water resources.

b) Soil Erosion and Land Sliding

Good engineering practices will help control soil erosion both at construction sites and in peripheral areas, particularly in borrow and dumping areas and a long haul tracks. Soil erosion and landslide remedial measures will be based on geotechnical, geomorphic and hydrological conditions of the project area and these will vary from site to site. However, the following measures will be adopted as per site conditions:

- Depending upon the valley side slopes, retaining walls will be provide for ensuring the integrity of the road embankments against erosion, slippage under gravity, particularly when under-stratum is scoured by the river, or due to saturation from the rain water and plastic flow of the material down the slope and erosion.

- It is presumed that the hillside slopes will be protected up to an appropriate elevation under the contract package for the contractor engaged for project construction.

- For mild valley side slope vegetative cover will be provided to check the erosion.

- The plantation for slope protection will constitute fast growing indigenous trees with deep root system for anchoring the soil material and under growth of bushes and creeping grasses having capability of developing mesh of shallow fibrous roots to protect the slope against pitting from rain water. It may be kept in view that the replacement of cut pine trees may be planted with the same species and not with other broad leaved species.

- Proper monitoring of the soil erosion and landslide prone areas will be carried out during operation phase and soil conservation measures (if needed) will be carried out like provision of physical structures e.g. retaining walls, etc.

c) **Soil Contamination**

The following practices will be adopted to minimize the risk of soil contamination:

- The contractor will be required to train its workforce in the storage and handling of materials like furnace oil, diesel, petrol and chemicals, etc., that can potentially cause soil contamination. The contractor will be required to prepare a training manual and module for all the construction related activities along with the schedule of training program and submit to the supervising consultants for approval.
- Soil contamination by asphalt and other obnoxious material will be minimized by placing all containers in caissons or dumped into pits lined with impervious liners to contamination of soils/groundwater from leachate.
- Solid waste generated during construction and at campsites will be properly treated and safely disposed of only in demarcated waste disposal sites.

4.5 Water Resources

This section explains how the proposed project may affect the water resources use, contamination of water bodies and groundwater, siltation of natural streams and alterations in drainage pattern; the section also describes mitigation measures to manage these impacts.

4.5.1 Impact on Water Resources

The surrounding land's drainage system and water resources will be affected by construction activities as follows:

a) **Depletion of the River Flows**

- Depletion of the river flows when the water is diverted through Power Tunnel will affect the population of villages as well as aquatic ecosystem falling in the river stretch between the Weir and the Powerhouse.
- Most of the population between weir to powerhouse use spring water for daily agricultural requirements. There is no water channel or any other structure exists between this reach which divert Siran River. Further no water requirements has been discussed by the community during scoping sessions and it was confirmed during the transect walk by the field staff. Anyhow considerable ecological flow will also be needed to maintain downstream ecosystem

b) **Use of Local Water Supplies**

- Local water supplies will need to be tapped to meet campsite and construction requirements, thereby competing with local use.
- Local water supplies through the springs may be affected due to implementation of project both in quantity as well as quality.

c) **Contamination of Surface and Ground Water Resources**

- Surface and sub-surface water resources in the selected project area may be contaminated by fuel and chemical spills, or by dumping of waste material and effluents generated by the kitchens and toilets at construction campsites.

- Natural streams and hill torrents will be contaminated with chemicals, oil, lubricants, detergents, etc. through runoff from the construction area, construction camp, workshops and equipment washing-yards.

- Soil erosion may occur at quarry areas, and it may contaminate the surface water resources if unmanaged blasting is carried out.

- If waste material is not properly disposed of, seepage of polluted water during monsoon season will pollute surface as well as groundwater quality.

4.5.2 Mitigation Measures

Measures to be adopted to mitigate the adverse impact on water resources and surface drainage patterns are discussed below:

Mitigation Measure:

a) **Depletion of the River Flows**

- The proponent will make arrangement during for release of water from the Weir to meet the demand of downstream reach of the river. Proponent will ensure the release of water discharge during constructional and operational phase of the project.

- In the absence of a specific Pakistan guideline or recommendations for the amount of water (residual water) to be retained in a watercourse when water is diverted for hydropower purposes, there is three different method considered to evaluate ecological flow:

1. **USA (Montana) Method**
   Percentages of mean flow are specified that provide different quality habitat for fish e.g. 10% for poor quality (survival), 30% for moderate habitat and 60% for excellent habitat. This method is known as Tennant or Montana method. The Siran River reach downstream LS Dam site has low biological productivity. Fishery is not being practiced in the reach. Therefore for survival of natural ecological habitat in this river reach 10% of mean flow may be specified as per this method.

2. **Swiss Standards.**
   The Swiss mountain topography and hydrology is similar to the mountain streams of Northern Pakistan. The minimum residual water flow to be left in a river is determined by a formula. For water bodies with a 500 litres/s discharge for Q^{347} (there Q^{347} means the discharge appearing in the river for more than 347 days of the year, i.e. more than 95% of the time) a residual flow of 280litres/s must be retained

in the water body. For each further discharge of 100 litres/s, above, 500 litres/s an additional 31 litres/s must be left in the water body.

3. **CEMAGREF Model**

For the determination of ecological flow, a formula representing a function of the available mean monthly discharges and the mean annual discharges, was used as presented below,

$$Q_e = \{(0.0651 \times Q_m + 2) / 100\} \times Q_a$$

Where Q_e = Mean monthly ecological flow (m^3/s)

Q_m= Mean monthly flow (m^3/s)

Q_a = Mean annual flow (m^3/s)

The formula was also used for feasibility study for Madian HPP and feasibility study of the Gabral-Kalam HPP and was developed by CEMAGREF which is an Agricultural and Environmental Engineering Research Organization of (Antony) France. The model is also recommended by the International Association of Small Hydropower.

The last one method (CEMAGREF Model) is used to calculate the mean monthly ecological or residual flows from weir to downstream and results are given in the Table-4.2. This also depicted mean monthly flow, from 1969 to 2008.

Discharge of $0.134 m^3/s$ is the recommended mean monthly ecological or residual flow which also covers river water usage for the community as well.

b) Use of Local Water Supplies

- The contractor will explore the alternative water resource so that the existing community water resources are not impacted, moreover existing spring water under the use of community will be exploited by the Contractor for campsite as well as construction purposes.
- Availability of water for campsite facilities and construction purposes will be ensured by the Contractor prior to start of construction activities. As per Local Government Act, the contractor will seek approval from the local government for exploitation of the water resources.
- The Contractor will be required to liaise closely with local communities to ensure that any potential conflicts related to common resource utilization for project purposes are resolved quickly.
- The contractor will prepare guidelines for the workers for minimizing the wastage of water during construction activities and at campsites.

c) **Contamination of Surface and Ground Water Resources**

- Camps will be located at least 500.m away from the nearest local settlement to prevent the contamination of community-owned water resources like springs, hill torrents, etc.

- Construction camps will be established in areas with adequate natural drainage channels in order to facilitate flow of the treated effluents.

- Wastewater effluent from contractors' workshops and equipment washing-yards will be passed through gravel/sand beds to remove oil/grease contaminants before discharging it into natural streams. Similarly, the wastewater effluent from the campsite will be treated before disposal into a stream. According to local laws, the BOD_5 concentration in sewage must be brought down to less than 80 mg/l before being discharged into a natural stream with a capacity to dilute the effluent further by 10 times.

- Borrow pits and natural depressions with pre-laid impervious liners will be used to dispose of obnoxious material and then covered with soil. This will check potential groundwater contamination. Such measures will also be provided at river side disposal of waste material in addition to retaining walls or gabions. Available stone (boulders) from excavated rocks will be used for retaining walls as well as for gabions. It will reduce the quantity of dumping material.

4.6 Ambient Air Quality

This section discusses the impact of the construction and operation on the ambient air quality and noise levels along the area of project influence. It also describes the mitigation measures to manage these impacts.

4.6.1 Impact on Air Quality

a) Dust Smoke and other Pollutants from Plants & Equipments

The emission or dust from the batching plant or construction machinery can be very harmful for the site worker and the local population. The emission/dust could cause skin and respiratory disease e.g. skin rashes, lungs problem etc. Roads and traffic will be affected due to the heavy vehicles movement in the area carrying plants and material. Contractor could select the suitable location provided the following control measures are in place.

b) Smoke from Burning of Waste Material or Burning Firewood

A number of big and small fires in the labour camp can produce smoke and smog which can cut off visibility, reduce traffic ability and cause suffocation along with causing diseases of respiratory tract.

c) Impact on Air Quality of Earth Work Activities

Excavating activities will generate dust and pollute the surrounding area. The emission from the plants use in earth work activities will also degrade the air quality of the site. Exhaust of

noxious gases from movement of heavy machinery will further pollute air which will adversely affect health and vigor of plants.

4.6.2 Mitigation Measures

a) Dust Smoke and other Pollutants from Plants & Equipments

- Air quality should be monitored on regular basis near the plant.
- The plant should be located at least 500m away from any living area.
- Regular spraying of water should be undertaken to minimize the dust pollution.
- All vehicles, machinery, equipment and generators used during construction activities will be kept in good working condition to minimize the exhaust emissions.
- Proper Personal Protective Equipments (PPE) should be issued to the site worker and make sure the worker wears the PPE properly during working on site.

If batching plant is close to the living area. This site can only be use for batching plant if the following conditions are followed:

- The plant has to be **Zero Emission Plant.** This will include using washed aggregate and enclosed cyclone with automatic injection system of material in to the mixing chamber.
- The access roads for the delivery Lorries pass through the living area. These roads/paths should be sprayed with water on regular basis to minimize dust pollution.

b) Smoke from Burning of Waste Material or Burning Firewood

- It is contractor's contractual obligation to use and provide clean and smoke free fuel in the labour camp.
- Cutting and burning trees or shrubs for fuel shall be prohibited.
- Gas cylinders should be used in the labour camp for cooking purposes.

c) Impact on Air Quality of Earth Work Activities

- Regular spraying of water should be undertaken to minimize the dust pollution.
- All vehicles, machinery, equipment and generators used during construction activities will be kept in good working condition to minimize the exhaust emissions.
- The Contractor will regularly spray water on the site traffic routes to minimize the dust pollution.
- Enforce the maximum speed limit to 20km/h for vehicles using embankments and access road.

4.7 Noise

4.7.1 Impact of Noise Pollution

a) Noise Pollution from Construction Activities

Construction activities particularly blasting site near the powerhouse area could generate noise and disturb the natural habitat.

4.7.2 Mitigation Measures

a) Noise Pollution from Construction Activities

- Use of vehicles and machinery of good condition and well tuned engine that will reduce noise hazards according to permissible limits as fixed by Pak-EPA for noise is 85 dB (A) while the WHO noise guidelines prescribed a limit of 55 dB (A), these limits will be considered in operation phase of the project. The WHO guideline values for community noise in specific environment is as shown in Table-4.3 and Table-4.4 provides an indication of relative sound dB (A) levels compared to various activities for reference.

- Monitor noise level on regular basis and maintain the level within the NEQS level.

- Monitor noise level on hourly bases at the start of the work activities for at-least first 2 days of work. The monitoring interval could increase to daily after two days.

- All working activities should be restricted within the allowed day time particularly for blasting.

4.8 Biological Environment

The impact on flora and fauna and corresponding mitigation measures are described in the following paragraphs:

4.8.1 Impacts on Flora and Fauna

a) Flora

Proposed project will impact about 350 trees (about 200 shade trees and 150 fruit trees) and during construction activities the Contractor's workers may damage the vegetation and trees (for use as fire-wood to fulfill the camps requirements).

The cutting of trees will cause degradation of local environment as under.

- It will enhance soil erosion. Without the branches and leaves, to break its fall, heavy storms can quickly wash away the soil from even a gentle slope. Cutting down of trees/shrubs also takes away the roots that would otherwise help in binding the soil.

- During the entire construction period dust lader. polluted air will form a dust film on leaves thus blocking sunshine and stomata consequently hindering photosynthesis processes causing detrimental effect on the plant health.

b) Fauna

i) Mammals and Reptiles

- During the construction phase, there will be some impacts on the mammals and reptiles of the area, due to construction activities involving excavation, blasting, access roads, movement of labour, carriage of goods and machinery to various sites within the area of influence. Mammals, such as jungle cat, jackal, fox, etc. will avoid these areas. Same will be the case with reptiles. Some reptiles may be killed during the earthworks operations. Movements of the mammals and reptiles will be restricted during the construction phase.

- Uncontrolled blasting may damage the existing wildlife of the project area. Food and refuse at the Contractor's camps may attract wildlife that might in turn be hunted by the workers.

- Due to establishment of labour camps, food storage, setting up of kitchens production of sewage and waste water may result in multiplication of rodents like rats, mice and shrew etc. and vectors like mosquitoes, bugs and flies which will have a negative impact.

ii) Birds-Avian Fauna

Birds will try to find shelter and food somewhere else and will tend to move away from the project area due to the activities mentioned above for fear of being hunted/ trapped. Unmanaged blasting activities may harm birds.

iii) Aquatic Fauna

There is no definite record about fish is available, as there is no official from the Fishery Department posted in Jabori Town. There is no commercial fishery in the area. Even traditional fishermen do not exist. However, some fishing activities are carried out for household use and recreational purpose.

4.8.2 Mitigation Measures

a) Flora

It is estimated that against cutting of about 350 trees SHYDO will make a provision of compensatory plantation at the ratio of 1:3. As such, the total compensatory plantation comes to about 1050 trees more ever to minimize the impacts on flora; following measures will be adopted construction and operation stages.

- Campsites, workshop and batching plants will be established on waste/barren land rather than on agriculturally productive land. However, if such type of land is not

available, it will be ensured that minimum clearing of the vegetation is carried out and minimum damage is caused to trees and undergrowth.

- Construction vehicles, machinery and equipment will remain confined within their designated areas of movement.

- The Contractor's staff and labour will be strictly directed not to damage any vegetation such as trees or bushes. They will use the paths and roads for movement and will not be allowed to trespass through farmlands or forested areas.

- Contractor will provide gas cylinders at the camps for cooking purposes and cutting of trees/bushes for fuel will not be allowed.

- Cutting of mother trees, if any, will be avoided, as far as possible, so that the negative effect to the process of natural regeneration of the species is minimized.

- A tree plantation program will be formulated by the SHYDO with the help of local Forest Department of Khyber Pakhtunkhwa and about 1050 trees will be planted. The SHYDO will enter into an agreement with the Forest Department to implement the program under deposit work. As the land along the slopes generally belong to the communities/individual owners, the Forest Department will involve the communities carrying out plantation on the lands. The Department may also involve the communities on participatory basis to construct dry stone masonry check dams to break the length of the slope thus abating the erosion problems.

- Open fires should be banned in the area to avoid hazards of fire in the area, especially in the Chir zone.

(b) Fauna

i) Mammals and Reptiles

- Hunting, poaching and harassing of wild animals will be strictly prohibited and Contractor will be required to warn its labour accordingly.

- Blasting and other noise generating activities will not be carried out during the night.

- Camps will be located at least 500 m away from the nearest wild life area and their source of food as well as water.

- The camps will be properly fenced and gated to check the entry of wild animals in search of eatable goods. Similarly, wastes of the camps will be properly disposed off to prevent it being eating by wild animals, as it may be hazardous to them.

ii) Birds

- Special measures will be adopted to minimize impacts on the wild birds, such as avoiding noise generating activities during the critical periods of breeding.

- Staff working on the project should be given clear orders, not to shoot, snare or trap any bird.

- If possible nests of bird, on trees need to be uprooted, be shifted to other nearby trees.

iii) Aquatic Fauna

- The weir intake structure will be designed and constructed to allow the minimum mean monthly 0.134 m^3/s (month wise detail is given in Table-4.2) of water flow to always be maintained in the Siran River for the maintenance of riparian as well as aquatic ecosystem of downstream.

B. SOCIAL IMPACTS, MITIGATIONS AND RESETTLEMENT

4.9 Social Environment/ Human Resources

This section describes the impact of the proposed Project on local communities, construction workers, indigenous and vulnerable people as well as on structures or sites of cultural and religious significance.

4.9.1 Social Impacts

a) Land Acquisition

Permanent Land Acquisition

➢ The Project is going to consume about 207 kanals of agricultural land, about 55 kanals of forest land and 172 of waste land, i.e. 45.09% of the agriculture, 37.4% waste land and 11.9% of the forest land in the area. By and large this is proprietary land. (Reference Figures-3.23 & 3.24)

Temporary Acquisition of Land

➢ The contractors will require temporary acquisition of land for: Establishment of aggregate quarries, Contractor's camp and other facilities. It is estimated that about 25 kanals of cultivated land is required for established these structures.

b) Impacts on Communication

The surrounding of the Project area's communities will be affected during the construction phase as follows:

- During the construction phase the general mobility of the local residents and their livestock in and around the project area is likely to be hindered. Likewise access to the natural resource may be affected. This particularly applies to the women folk and children.

- Construction activities, particularly excavation and movement of haul truck and machinery may disrupt the existing tracks leading from the valley access road to

settlements. This will limit the accessibility of the local population to the valley access road.

- During construction activities, traffic flow will be disturbed. The Jabori – Shinkiari road being partly be used for access between weir to power house for the movement of construction material, there will be limited scope for providing diversion tracks for the mobility of local and through traffic. This aspect needs to be carefully handled in accordance with site specific conditions.

c) Impacts on Local Community/ Workforce and Community Resources

- Usage of Community's common resources like potable water, fuel wood etc. by Contractor workforce may create conflicts between the community and the Contractor.

- Community will have to face the noise and dust hazards during the construction activities.

- The presence of outside construction workers inevitably causes some degree of social disruption and even active disputes with the local community as a result of social/cultural differences. This particularly relates to the disruption of the privacy of women folk working in the fields or even the yards of their houses, should the house lying at lower elevation than the working sites. Likewise the risk of theft of the community assets by the Contractor workers and vice versa may occur.

- The Contractor will prefer to work during the night hours. The night time working will be having intrinsic problems relating to safety and noise hazards for the communities and the workers.

d) Gender Issues

- The rural women normally are actively participate in other outdoor socio-economic activities such as livestock rearing, bringing of potable water, etc which may also be affected by the project activities.

- 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 local women for working in the field, herding livestock, picking fuel wood, etc.

e) Indigenous and Vulnerable Households

- During the social field survey of the project, no indigenous or vulnerable household group of people was identified. So no impact on these people is envisaged due to the implementation of the project.

f) Safety Hazards

- Occurrence of accidents/incidents during the construction activities, particularly from blasting and excavation activities is a common phenomenon. Safety of general

public residing at the top of the hill where blasting/excavation is to be carried will particularly be at stake. The local people, particularly the children and women, may get injuries or even fatalities.

- Contractor staff while working at steep hilly slopes may slip and get injuries.

g) Relocation of Residential Unit & Public Infrastructure

- The Project will disrupt one residential unit located close to the reservoir area. The total population of the disrupted house is 12. The total covered area of this house is about 7 Marla (1,894 ft^2). Detail of disrupted house has been shown in Table-4.5 and Location in Figure-3.23.

- There is a Water Supplies pipe which supply water from Ghoridakta to Deedal. The diameter of the pipe is 3 inch; this will be submerging in the reservoir.

h) Religious, Cultural and Historical Sites

- No historical or archeological site has been observed along the Project area of influence.

4.9.2 Mitigation Measures

a) Land Acquisition

Permanent Land Acquisition

The land required for the reservoir and other structures will be acquired in accordance with the provisions of the Land Acquisition Act, 1894.

Temporary Land Acquisition

Land required for establishing contractor's facilities including borrowing earth material and dumping of excess spoil will be leased directly from private landowners by the contractor. The provisions of the Land Acquisition Act, 1894 will not be invoked under temporary land acquisition as the acquisition of the land will be on short term basis and will be covered by short-term lease agreements between the landowners and contractors. Rental terms will have to be negotiated to the satisfaction of the landowners concerned. Given that land acquisition conflicts between the contractors and landowners are unlikely. The staff of the SHYDO and supervisory Consultants will monitor the process of restoration and ensure, through the terms of the construction contracts, that landowners are compensated according to the terms of the lease agreements, and the restoration actions agreed upon by the contractors are duly carried out. The photo-documentation of the existing land prior to temporary acquisition will be available which will be beneficial to resolve the restoration conflicts between the landowner and contractor. Similarly, prior to the start of work, Contractor will carry out base line survey for selecting the camp sites, dumping sites, public and community/ private owned utilities, in conformity with the

requirements specified in IEE studies and obtain approval from the Supervisory Consultants.

b) Impacts on Communication

Potential social conflict will be contained by implementing the measures listed below:

- Two new concert bridges, one at weir site of the other at powerhouse site, will be constructed which enhanced mobility between both banks of the river. More ever, the contractor will ensure that the mobility of the local communities, particularly women and children, and their livestock is not hindered by the construction activities.

- Generally the contractor will avoid using the village tracks for hauling the construction material. However, if it is unavoidable, the existing ones will be widened, overlaid with shingle or surface treated to accommodate local as well as contractors traffic.

c) Impacts on Local Community/ Workforce and Community Resources

- The Contractor will be required to maintain close liaison with the local communities to ensure that any potential conflicts related to common resource utilization for the project purposes are resolved quickly.

- In areas where potable water is scarce and where the people use spring water, the contractor will make alternative arrangement in accordance with water requirement for Contractor's camp and construction activities.

- Camps will be located at least 500 m away from the nearest local settlement to avoid the contamination of community-owned water resources.

- Approval from the local administration will be obtained before using the local water resources by the Contactor.

d) Gender Issues

- The Contractor will have to select the specific timings for the construction activities particularly near the settlements, so as to cause least disturbance to the local population particularly women considering their peak movement hours.

- Contractor will take due care of the local community and sensitivity towards local customs and traditions will be encouraged.

- Contractor will warn the staff strictly not to involve in any un-ethical activities and to obey the local norms and cultural restrictions particularly with reference to women.

- During construction activities, if privacy of the nearby households is affected, the Contractor will inform the house owner to make some parda arrangements. Similarly, Contractor will have to take care as much as possible that the construction activities should not affect the privacy particularly with reference to women.

e) Indigenous and Vulnerable Households

- As referred earlier, no indigenous or vulnerable household group of people was identified in or along the project area of influence, so the ADB Policy will not be triggered.

f) Safety Hazards

- Complying with the safety precautions for construction workers as per International Labour Organization (ILO) Convention No. 62, as far as applicable to the project contract.
- The contractor will ensure that blasting is not carried out in the near vicinity of the settlements and village tracks that are very frequently used. Here only excavators will be used.
- Blasting will be carried out during the fixed hours (preferably during the mid-day). The timing will be made known to all the people within 500 m from the blasting site in all directions. People, except those who actually light the fuse shall be evacuated from the area of 200 m from the blasting site in all directions at least 15 minutes before blasting.
- Effective construction controls by the Contractor to avoid inconvenience to the locals due to noise, smoke and fugitive dust. The contractor will frequently sprinkle water at the work areas and haul tracks to avoid generation of fugitive dust. The frequency of sprinkling will be determined by the weather condition. During long spell of hot and dry weather the sprinkling will be done after 2 or 3 hour intervals.
- Haul-trucks carrying concrete, aggregate, sand and earth fill materials will be kept covered with tarpaulin to help contain construction materials being transported between the sites.
- Good relations with the local communities will be promoted by encouraging Contractors to provide opportunities for skilled and unskilled employment to the locals, as well as on-the-job training in construction for young people. Contractor will restrict his permanent staff to mix with the locals to avoid any social problems.
- Local vendors will be provided with regular business by purchasing campsite goods and services from them.
- The Contractor will warn the workers not to involve in any theft activities and if anyone would involve in such type of activities, he will have to pay heavy penalty and would be handed over to police. Similarly, at the time of employing, Contractor has to take care that the workers should be of good repute. The Contractor camp will be properly fenced and main gate will be locked at night with a security guard to check the theft issues from community side.
- Contractor will take care of the local community and sensitivity towards the local customs and traditions, particularly in the context of privacy of women folk.

In case of night time working the Contractor will adopt the following measures:

- It is desirable that the night-time working may be avoided at places where settlements are very close to the construction sites.
- If the above is unavoidable, the use of heavy machinery generating noise should be avoided only the manual works or light machinery may be deployed.
- No blasting will be carried out during the night time.
- The Contractor will provide adequate light at the site and display florescent sign boards at appropriate places for warning to the communities and drivers.
- Take safety precautions for the workers and the local communities.
- The Contractor will keep first aid boxes at the site and make availability of vehicle for transporting the injured people to the hospital. This arrangement will also be made even during the day time working.
- The Contractor will share the plan and schedule of night time working with the Supervision Consultants for approval.
- Training of workers in construction safety procedures, environmental awareness, equipping all construction workers with safety gadgets including safety boots, helmets, gloves, and protective masks, and monitoring their proper and sustained usage.
- Contractor will ensure the provision of medicines, first aid kits, vehicle, etc. at the campsite and working place.
- Warning to local communities prior to blasting and to enhance blasting safety the contractor will use protective devices, including wire containment, displaying warning signs along the work site, blowing sirens, etc.
- Prior to blasting thorough inspection will be conducted.
- Safety lookouts will be built to prevent people and vehicles from passing at the time of blasting.
- Cordon off the work areas where necessary.
- The storage of all solid waste shall be practiced so as to prevent the attraction, harborage or breeding of insects or rodents, and to eliminate conditions harmful to public health or which create safety hazards, odors, unsightliness, or public nuisances.

g) Relocation of Private/Public Infrastructure

- Houses will be compensated on replacement cost basis; that is given in Table-4.5 and proposed location for relocation is given in Figure-3.23.

- The Water Supply pipe which will be relocated to a suitable place will cost approximately Rs: 200,000.

h) Religious, Cultural and Historical Sites

- As referred earlier, no relocation of religious structures is involved, so no mitigation is required except that contractor will follow the prayer timing particularly at prayer of Juma and the workforce will observe the sanctity of religious properties.

- There are no archaeological sites located within the Project area of influence and no impacts on archaeological sites are envisaged. However, the Contractor will be required to instruct the construction crews and site supervisors in archaeological site recognition, conservation procedures, and temporary site protection.

4.10 Risks of Dam Failure

There are two natural forces that may be catastrophic for the hydraulic structures of the Project. These include heavy floods and seismic activity. In spite of the fact that provision has been made for both in the design of the weir, mathematical model studies are required for confirmation of the design parameters. These may be carried out during the detailed design stage of the Project. According to guidelines of the US Army Corps of Engineer, the Project falls in intermediate category of dams with respect to the height of the weir as well as the storage capacity (Reference Table-4.6).

The storage capacity of the Jabori HPP is about 0.213 mcm and the weir height is about 8 m. Therefore, it falls in the Intermediate Category. According to US Army Corps of Engineer, the Hazard category of the weir would be "Low" since there is no population within the reach of the flood that would be at risk under dam failure. Additionally, there is no economic structure of any value that is likely to get damaged as a result of weir failure flood. Therefore, the weir needs to be designed as a Low Hazard and intermediate size classification. From Table-4.7, it follows that the structure has to be safe against flood ranging from 100 year frequency to 50% of Probable Maximum Flood (PMF).

TABLES

Table 4.1
PROJECT IMPACT MATRIX

Sr. No.	ENVIRONMENTAL COMPONENTS / PROJECT COMPONENTS	PHYSICAL ENVIRONMENT										BIOLOGICAL ENVIRONMENT											SOCIAL ENVIRONMENT									
		Agricultural Lands	Soils (Erosion/Stability)	Housing/Infrastructures	Energy/Mineral Resources	Surface Water Quantity	Surface Water Quality	Groundwater Quantity	Groundwater Quality	Air Quality	Noise	Aquatic Ecosystem	Wetland Ecosystem	Terrestrial Ecosystem	Endangered Species	Miggatory Species.	Beneficial Plants	Beneficial Animals	Pest Plants	Wildlife (Scaring/Facilitating)	Pest Animals	Disease Vectors	Public Health	Resource/Land Use	Communication System	Employment	At-Risk Population/Safety	Population disruption	Community Stability	Cultural & Religious Values	Tourism And Recreation	Living Standard
A	**Construction Phase**																														
1	Weir	O	MA	O	O	O	MA	O	O	LA	LA	LA	O	O	O	O	O	O	O	LA	O	O	O	O	O	MB	O	O	O	O	O	MB
2	Intake	O	MA	O	O	O	LA	O	O	LA	LA	LA	O	O	O	O	O	O	O	MA	O	O	O	O	MA	MB	MA	O	O	O	O	MB
3	Power Tunnel	O	HA	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	MA	O	O	O	O	O	MB	HA	O	O	O	O	MB
4	Power House	O	MA	O	LA	O	MA	O	O	LA	MA	LA	O	O	O	O	O	O	O	LA	O	O	O	O	LA	MB	MA	O	O	O	O	MB
5	Disposal of Spoil Material	O	HA	O	MA	O	MA	O	O	LA	LA	O	O	MA	O	O	MA	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
6	Construction Camp/Workshop	LA	LA	LA	LA	O	MA	O	O	O	LA	LA	O	LA	O	O	LA	O	O	O	O	O	O	LA	O	O	O	O	O	O	O	O
7	Borrow Area/Quarries	MA	HA	O	LA	O	LA	O	O	MA	MA	O	O	LA	O	O	LA	O	O	MA	O	O	MA	LA	O	MB	MA	O	O	O	O	MB
B	**Operation Phase**																														
1	Reservoir	MA	O	MA	MA	O	O	MB	O	O	O	HB	HB	MB	O	MB	O	O	O	O	O	LA	O	LA	O	O	MA	LA	HA	O	HB	MB
2	Project Operation	O	O	O	HB	HB	O	O	O	O	O	HB	HB	MB	O	MB	O	O	O	O	O	LA	HB	O	O	MB	O	O	O	O	HB	MB

NA : Not Applicable
ND : Not Determinable
HA : High Adverse
MA : Medium Adverse
LA : Low Adverse
O : None or Insignificant
LB : Low Beneficial
MB : Medium Beneficial
HB : High Beneficial

Table- 4.2

Estimated Mean Monthly Flows-1969 to 2008 (m^3/sec)

Months	Mean Monthly Flow	Recommended Mean Monthly Ecological/ Residual Flow
Jan	4.39	0.129
Feb	5.39	0.133
Mar	7.04	0.139
Apr	7.54	0.141
May	6.37	0.136
Jun	5.29	0.132
Jul	6.70	0.138
Agu	7.08	0.139
Sep	5.30	0.132
Oct	4.51	0.130
Nov	4.02	0.128
Dec	4.11	0.128
Mean	**5.65**	**0.134**

Table-4.3

WHO Guideline Values for Community Noise in Specific Environments

Specific Environment	L eq* (dB)	L max,** (dB)
Outdoor living area	55	-
School class rooms and pre-schools (indoors)	35	-
School, playground (outdoors)	55	-
Hospital, ward rooms (indoors)	30	40
Hospital, treatment rooms (indoors)	1	-
Industrial, commercial, shopping and traffic areas (indoors and outdoors)	70	110

*Level equilibrium

* *Maximum level

Table-4.4

Relative Sound Levels

Sound Level dB(A)	Activity
40 – 50	Rural Area
55	Quiet background conversation
60	General office
72	Passenger car @ 60 km/hr at 7 meters distance
85	Heavy diesel lorry @ 40 km/hr at 7 meters distance
90	Hazard to hearing from continuous exposure
95	Pneumatic drill (un-silenced) at 7 meter distance

Table-4.5

Detail of Residential Unit

Name of Affected Person (Head of Household)	Number of Persons	Nature of Construction	Covered area (Sq.ft)	Year of construction	Estimated cost at present*
M.Yousaf s/o Alam Din	12	Kacha Pacca	1,894	2008	929,954

*Excluded 15% CAS but includes land rates

Table-4.6

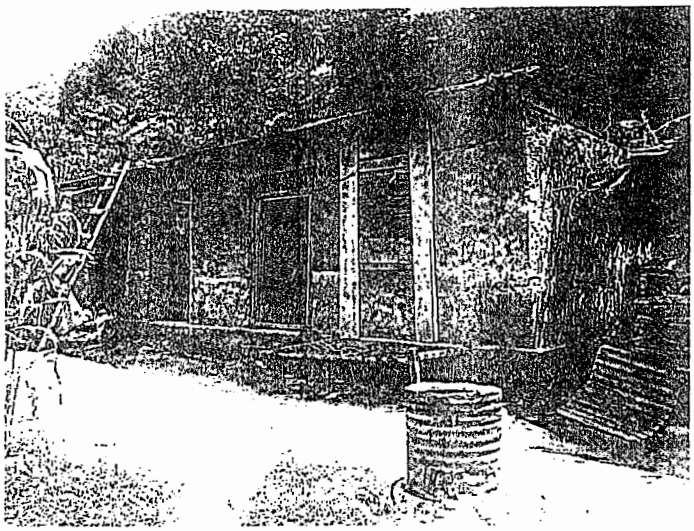
Size Classification of Dam

Category	Reservoir Capacity (hm^3)	Height of the Dam (m)
Small	From 0.62 to 1.23	From 7.6 to 12.2
Intermediate	From 1.23 to 61.5	From 12.2 to 30.5
Large	≥61.5	≥30.5

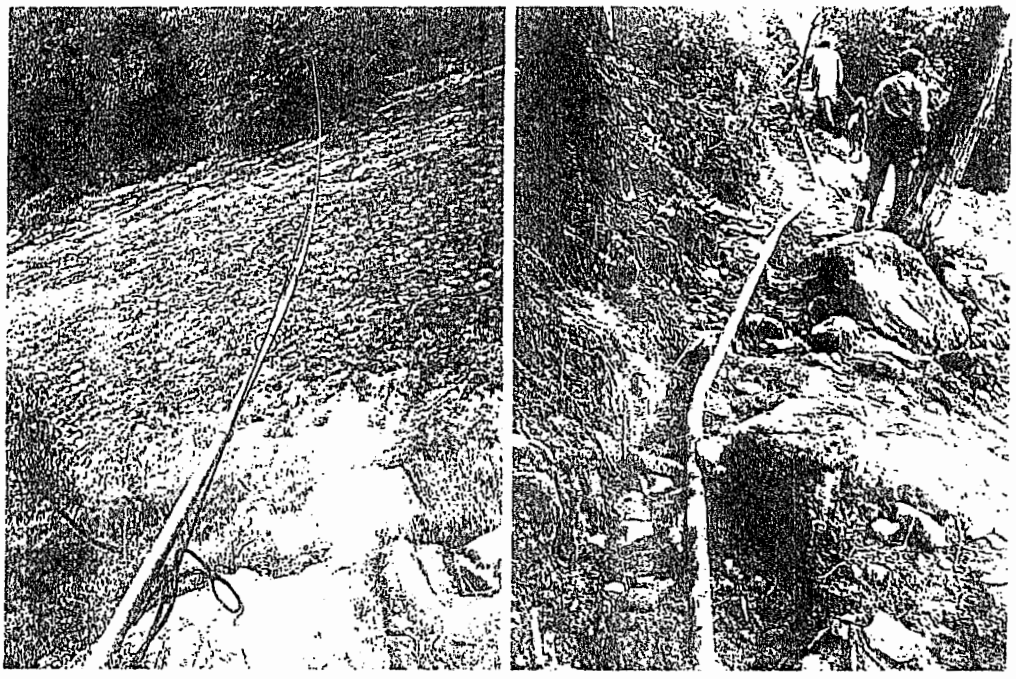
Table-4.7

Recommended Safety Standard

Hazards	Dam Size	Flood Safety Standards
Low	Small	50-years to 100-years flood
	Intermediate	100-years flood to 50% of the PMF
	Large	50 % to 100 % of the PMF
Significant	Small	100-years to 50% of the PMF
	Intermediate	50 % to 100 % of the PMF
	Large	PMF
High	Small	50 % to 100 % of the PMF
	Intermediate	PMF
	Large	PMF



Photograph: 4.1 Shows the Type of Construction



Photograph 4.2: Water Supply Pipe

CHAPTER - 5

PROJECT ALTERNATIVE CONSIDERED

5.1 General

This chapter deals with the need of power in the country and discusses with alternative sources available. This also provides brief information about the government's policy for power generation and position of the present project with respect to the policy. Emphasizing the need of this project in meeting the power demand of country, the chapter analyzed various optional sources of power generation including various hydropower projects in pipeline. In this context, the following options have been considered.

- No Action
- Alternative Resources of Power Generation, their exploitation status in the country and Alternative Hydropower Generation Resources
- Project Design Alternative

5.2 No Action

Pakistan is facing critical shortfall of electric energy since long, particularly during the last few years. It has been estimated that during the last five years the annual power demand has been increasing by 4.8% that is likely to increase by 8 to 10% by the end of this decade. Existing installed generation capacity of the country is 17,772 MW. Out of these 17,772 Megawatts, the Water and Power Development Authority (WAPDA) of Pakistan owns 9,884 MW, another 5,417 are owned by private, Independent Power Producers (IPPs), the Karachi Electric Supply Corporation (KESC) capacitates 1,756 MWs while the rest is the installed capacity of nuclear and other cogenerating industries. Thermal plants using oil, natural gas, and coal account for about 68% of this capacity, with hydroelectricity making up 29.4% and nuclear plants 2.6%. Hydroelectric generation which is about 30% of the national total generation is generally constrained somewhat due to the multipurpose nature of most of the facilities. Irrigation demands normally control the seasonal operation of reservoirs and the resulting distribution of energy production. Currently WAPDA is facing a shortfall of about 5,000 MW during peak hours, which may increase up to 5,529 MW by year 2010. This demands enhancement of installed capacity by 2,000 MW per year.

With this scenario, Pakistan is forced to exploit every source of power generation including hydro, oil, gas, coal, nuclear, wind, solar etc. Even realizing constraints in the public sector investment and to take up the task on fast track, the Government of Pakistan framed a policy in 1994 to attract private investors for power generation by using thermal resources. This policy was revised in 2002 to include hydropower in private sector, which previously fell under the jurisdiction of WAPDA but now SHYDO is also following the same policy to increase hydroelectric generation in Khyber Pakhtunkhwa involving private sector to build and operate powerhouse.

As a result of Power Policy of 1994, a number of thermal power project have been installed in the country. These include Uch Power Plant (550 MW), Hubco Power Plant (1300 MW), and Liberty Power Plant (235 MW) besides privatization of WAPDA' Kot Addu Power Plant (1500 MW). Besides, during this period three power generation projects, namely Ghazi-Barotha Hydropower Project (1,450 MW), Chashma Hydropower Project (184 MW) and Chashma Nuclear Power Plant (325 MW) were implemented in public sector. Similarly, despite lately enhancement in the power generation capacity, there is still a wide gap between power generation and peak hour demand of power supply.

To cater for this gap of power supply and also to meet the future power demand, Pakistan is in need of exploitation of all resources of power generation. Therefore, the option of "No Action" can not be adopted. This option will not only affect the domestic sector but also hamper the development of industrial, commercial and agriculture sectors of Pakistan.

5.3 Alternative Sources of Power Generation

The available resources of power generation in Pakistan are hydro, natural gas, coal, to some extent oil, wind in the coastal regions, nuclear and solar. Of these, hydro resources are of the prime importance for Pakistan. It is not only due to the fact that hydropower is the cheapest power generation source but also because the country is endowed with ample hydro resources for power generation up to 40,000 MW, out of which only about 7,000 MW has been exploited so far, which forms about 30% of the total power generation capacity of the country while the remaining about 70% is thermal from oil, gas, coal and nuclear in the descending order. Two decades back, the power generation capacity was almost in the reverse order, hydropower contributing up to 70% and thermal about 30%. As a result of this, the power generation cost has increased tremendously. This is because of the fact that indigenous oil production is very low, the operation of oil-fired power plants are dependent on rather expensive imported oil. Natural gas resources of Pakistan are currently facing shortfall. Therefore, its further utilization for electric power generation will affect its domestic and industrial use unless it is imported at high cost. The poor economy does not allow the import of fossil fuels, particularly oil, on a large scale. Too much reliance on imported oil is critical from energy security point of view.

Apart from this, a large fraction of the population lives in remote areas and is still waiting to be connected to the national electricity grid. To help these remote communities in particular, and to overcome energy shortages in general, Pakistan needs to develop its indigenous energy resources like hydropower, solar and wind. More than 1000 km long coastline in south and some places in northern mountainous areas provide an excellent resource of wind energy. This vast potential can be exploited to produce electricity on both community and wind farm scales.

In spite of the fact that Pakistan has recently discovered large reserves of coal in Thar Desert in Sind Province, its development and exploitation for electric power generation would take long time. The use of wind and solar energy for electric power generation is still at a preliminary stage in Pakistan. Pakistan lacks technology in these sectors, thus much reliance has to be made on technical and logistic assistance of the developed countries. Recently, the very first wind energy project has been launched in Thatta District of Sindh

with power generation capacity of 45 MW to act as a pilot project. Still there is long way to exploit the full wind resources of the coastal area of Pakistan.

As far as use of solar energy for electric power is concerned, Pakistan's effort in this sector is almost negligible. This is because solar photovoltaic systems are prohibitively expensive in terms of installation costs. Power from them is also available intermittently; only when energy from the sun is available, unless large scale storage batteries are also installed. This will further escalate the installation cost.

In the light of this, the only option left with Pakistan is the exploitation of vastly available renewable and cheap resource of hydro-energy. WAPDA has prepared a plan for exploitation of this energy source under "Vision 2025". As a follow up, a number of projects have been undertaken both in public and private sectors. Some of these are at the implementation stage while others are in different stage of planning. The former category includes Khan Khwar (72 MW), Allai Khwar (121 MW), Duber Khwar (130 MW), Jinnah (96 MW) and Neelum-Jehlum (969 MW). The latter projects include Basha-Diameer (4500 MW), Dassu (5000 MW), Bunji (5200 MW), Golen Gol (106 MW), Palas Valley/Spat Gah Cascade Complex (about 2500 MW) and many more small hydel projects in Gilgit-Baltistan, Azad-Jammu and Kashmir and Khyber Pakhtunkhwa.

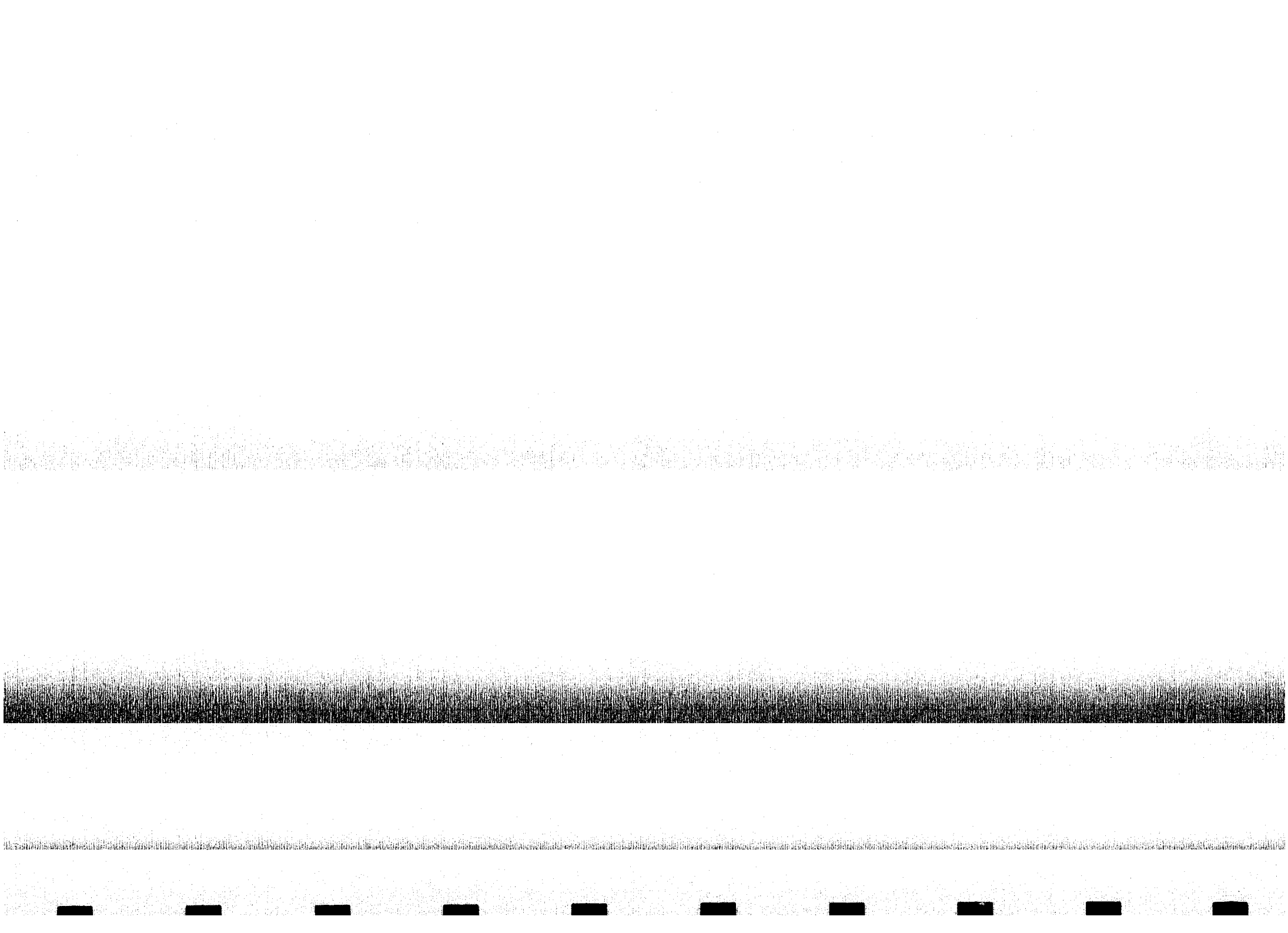
5.4 Project Location Alternatives

As referred in previous sections, the project will be located in a very narrow valley; therefore there is very limited scope of alternative consideration for the layout of the major project components.

The alignment of the tunnel will be determined by the fixation of the locations of weir axis and powerhouse. As this structure will be underground, the environmental hazards will be limited to the quantum of the excavated material that would need to be disposed off. Depending upon the locations of the two terminal structures, the length of tunnel will slightly vary resulting in change in the quantity of spoil material.

CHAPTER

ENVIRONMENTAL MANAGEMENT & MONITORING PLAN



CHAPTER - 6

ENVIRONMENTAL MANAGEMENT & MONITORING PLAN

6.1 Environmental Management and Monitoring Plan (EMM_tP)

The environmental management plan and its institutional requirements have been described in tabular form at Table-6.1. The table identifies the effects of the construction and operation of different project components on various environmental parameters. It also spells out mitigation/enhancement actions. The table also defines the responsibilities of various actors, viz. Proponent, Contractor and the Engineer in the implementation and monitoring of the mitigation actions.

6.2 Objectives of Environmental Management and Monitoring Plan (EMM_tP)

The EMM_tP will help SHYDO to address the adverse environmental impact of the project, enhance project benefits and introduce standards of good environmental practice. The primary objectives of the EMM_tP are to:

1. Define the responsibilities of project proponents, contractors and other role players, and effectively communicate environmental issues among them.

2. Facilitate the implementation of the mitigation measures identified in the IEE by providing the details of each project impact.

3. Define a monitoring mechanism and identify monitoring parameters to ensure that all mitigation measures are completely and effectively implemented.

6.3 Environmental and Social Issues

The social and environmental issues associated with this project were discussed in detail in Chapter 4 and 7 and include:

1. Permanent and temporary acquisition of land for project structures, access road and colonies of project operation and maintenance staff.

2. Appropriately locating temporary construction camps, site office, depots, workshops and concrete and asphalt batching plants.

3. Since excavation for project structures, tunneling and cutting hills for power channel will result in generation of large quantity of excavated spoil, disposal of which will be a matter of great concern.

4. Regulating the procurement of borrow material, soil erosion and land sliding during construction as well as at operation stage.

5. Enhancing and maintaining tree plantation in the project environ particularly on slopes for their stabilization as a compensatory action for loss of vegetation by the project.

6. Ensuring safety of construction crew and local communities during construction and operation.

6.4 Institutional Arrangements for Implementation of EMM_tP

Supervision and implementation of the EMM_tP will be undertaken by SHYDO management in conjunction with the proposed implementation specialists or supervisory consultant.

SHYDO will also obtain approvals from Khyber Pakhtunkhwa-EPA and then monitor the project and forward monitoring reports on a regular basis to the Provincial EPA as per the requirements of the Federal EPA regulations. This IEE and the EMM_tP can form the basis of a submission for environmental approval from the Khyber Pakhtunkhwa-EPA.

SHYDO will be responsible for ensuring that conditions are included in project construction contract documents. It will also ensure that during the construction phase, environmental mitigation measures, as per the EMM_tP, are effective and are implemented. The EMM_tP implementation will be coordinated with Government Agencies such as Forest, Fisheries and Wildlife Departments, for such activities as securing removal permits for trees.

As SHYDO does not yet have the expertise and capacity required for implementing the IEE and Abbreviated Resettlement Plan, it will have to depend on additional external technical assistance and will therefore hire the following additional expertise.

Purposed part time Implementation or Supervisory Consultants[1] (Environmental and Resettlement Specialists) who will be hired directly by SHYDO, to provide technical assistance in implementation of the Environmental Management & Monitoring Plan and Abbreviated Resettlement Plan. Another part-time Consultant (External Monitoring) to conduct the external monitoring and evaluation of the implementation of the EMM_tP and resettlement activities for the project.

6.5 Environmental Monitoring Plan

This section provides a monitoring plan that identifies the roles and responsibilities of project staff involved in environmental monitoring, and lists the parameters that will be used in the monitoring process. The main objectives of construction phase monitoring plans will be to:

- Monitor the actual project impact on physical, biological and socio-economic indicators. This will indicate the adequacy of the IEE in identifying and mitigating the project adverse effects.
- Recommend mitigation measures for any unforeseen impact or where the impact level exceeds than that anticipated in the IEE.
- Ensure compliance with legal and community obligations including safety on construction sites.

[1] TORs will be decided later with M/s of SHYDO while cost is reflected in chapter 11 of Main Report, Volume I.

- Monitor the rehabilitation of borrow areas and the restoration of the construction campsite as described in the EMMtP.

- Ensure the safe disposal of excess construction materials.

The main objectives of monitoring during the operation phase will be to:

- Appraise the adequacy of the IEE with respect to the project's predicted long-term impacts on the area of influence physical, biological and socioeconomic environment.

- Evaluate the effectiveness of the mitigation measures proposed in the EMMtP, and recommend improvements in the EMMtP, if required.

- Monitor the survival rate of compensatory plantations carried out for loss of vegetation by the project.

- SHYDO will ensure two types of monitoring during the execution of the project. (i) Compliance Monitoring - to ensure that proposed measures in the EMMtP are adhered to, and (ii) Effects Monitoring - to establish baseline values for environmental parameters such as air quality, water quality and noise levels. Given the circumstances of the project, independent environmental monitoring consultant already engaged for the ongoing project shall be asked to conduct the monitoring program.

For social monitoring SHYDO will select independent monitoring agency to verify the efficacy and ensure the transparency of land acquisition, compensation and resettlement process carried out by SHYDO. The agency engaged for independent monitoring will report their findings on a quarterly basis directly to the Project Coordinator, Deputy Director, federal D/Environment and the Resettlement and Social Committee. In order to meet the above objectives the following parameters need to be monitored:

- Water Quality / Quantity

- Air and Noise quality,

- Soil Conservation, and

- Sanitation and Waste Disposal

TABLES

Table-6.1

Environmental Management Plan

Resources	Impacts	Stage of Project	Description	Receptors	Mitigation	Responsibilities		Cost(Rs.)*
						Implementation	Supervision	
A. Land Resources	1. Land Acquisition	Pre – Construction	It is estimated that the project will involve acquisition of about 207 kanals of agricultural land, 172 of waste land and about 55 kanals of forest land. While temporary land acquisition involves 25 kanals of agricultural land .By and large this is the proprietary land.	Land Owner/ Local Peoples	Cash compensation for acquired land at replacement value. For temporary land acquisition, rental terms will have to be negotiated to the satisfaction of the landowners concerned. Tentatively Rs. 50,000/kanal is estimated.	Deputy Director (DD) in charge of the land acquisition and resettlement operations / Land Revenue Department (LAC)	Monitoring Consultant / SHYDO	64,660,000
	2. Land Productivity and Use	Construction	Borrow or excavated material will cause the loss of some of the fertile plough layer thus resulting in the decrease of land productivity.	Land owner	The top 30 cm of the plough layer will be stripped and stockpiled for redressing the land after the required borrow material has been removed. In case deep ditching is carried out, the top 1 m layer of the ditching will stripped and stockpiled.	Contractor	Monitoring Consultant / SHYDO	-
	3. Soil Erosion and Land Sliding	Construction	If hillside or valley side slopes are left unprotected these will be subject to a natural weathering and become increasingly prone to soil erosion and land sliding. Soil erosion may also occur at quarry areas, if unmanaged blasting is carried out. The reduction in vegetative cover will reduce the binding capacity of soil and	Local Communities	Good engineering practices will help control soil erosion both at construction sites and in peripheral areas, particularly in borrow and dumping areas and a long haul tracks. The plantation, for slope protection, with deep root system for anchoring the soil material and growth of bushes and creeping grasses having capability to protect the slope against pitting from rain water.	Contractor	Supervision Consultant / SHYDO	-

Resources	Impacts	Stage of Project	Description	Receptors	Mitigation	Responsibilities		Cost(Rs.)*
						Implementation	Supervision	
			enhanced erosion.					
	4. Soil Contamination	Construction	Land may be contaminated by the spillage of materials like fuels, solvents, oils, paints and other construction chemicals and concrete.	Construction sites & Workshops	The contractor will be required to train its workforce in storage and handling of materials like furnace oil, diesel, petrol and chemicals, etc., that can potentially cause soil contamination.	Contractor	Supervision Consultant / SHYDO	-
B. Water Resources	1. Depletion of the Water	Construction Operation & Maintenance	There is no water channel or any other structure exists between this reach which divert Siran River.	Aquatic Ecosystem	Flow of 0.134 m^3/ s is the recommended mean monthly ecological or residual flow.	Contractor	Supervision Consultant / SHYDO	-
	2. Use of Local Water Supplies	Construction	Local water supplies through the springs may be affected due to implementation of project, both in quantity as well as quality.	Local Communities	As per Local Government Act, the contractor will seek approval from the local government for exploitation of the water resources.	Contractor	Local Government / SHYDO	-
	3. Contamination of Surface and Ground Water Resources	Construction	If waste material is not properly disposed of, seepage of polluted water during monsoon season will pollute surface as well as groundwater quality.	Local Peoples, Domestic Fauna	Wastewater effluent from contractors' workshops and equipment washing-yards will be passed through gravel/sand beds to remove oil/grease contaminants before discharging it into natural streams. Similarly, the wastewater effluent from the campsite will be treated before disposal into a stream. According to local laws, the BOD_5 concentration in sewage must be brought down to less than 80 mg/l before being discharged into a natural stream with a capacity to dilute the effluent further by 10 times.	Contractor	Supervision Consultant, SHYDO	-
C .Ambient air Quality	1.Dust Smoke and other Pollutants from Plants &	Construction	The emission or dust from the batching plant or construction machinery can be very harmful for the site	All Biotic receptor	Regular spraying of water should be undertaken to minimize the dust pollution	Contractor	Monitoring Consultant / SHYDO	-

Resources	Impacts	Stage of Project	Description	Receptors	Mitigation	Responsibilities		Cost(Rs.)*
						Implementation	Supervision	
	Equipments		worker and the local population.		All vehicles, machinery, equipment and generators used during construction activities will be kept in good working condition to minimize the exhaust emissions. Proper PPE should be issued to the site worker and make sure the worker wears the PPE properly during working on site. Cutting and burning trees or shrubs for fuel shall be prohibited.			
	2.Smoke from Burning of Waste Material or Burning Firewood	Construction	Smoke from burning of waste material or firewood	Nearby communities	Cutting and burning trees or shrubs for fuel shall be prohibited. Gas Cylinders should be used in the labour camp for cooking purposes.	Contractor	Monitoring Consultant / SHYDO	-
D. Noise	1. Noise pollution	Construction	Construction activities particularly blasting site near the powerhouse area could generate noise and disturb the natural habitat.	Adjacent communities and domestic Fauna	All working activities should be restricted within the day time particularly blasting. Follow Pak-EPA and WHO guideline values for community noise in specific environment.	Contractor	Monitoring Consultant / SHYDO	-
	1. Powerhouse generator	Operation & Maintenance	Powerhouse generator could generate noise and disturb the natural habitat.	Nearby community	Follow Pak-EPA and WHO guideline values for community noise in specific environment.	SHYDO	EPA.	-
E. Biological Environment	1.Impact on Flora	Construction	Proposed project will impact about 350 trees and during construction and operational activities which includes Contractor's workers may damage the vegetation and trees	Flora and owner of trees	It is estimated that against cutting of about 350 trees SHYDO will make a provision of compensatory plantation at the ratio of 1:3 with the help of local forest department. As such, the total compensatory plantation comes to about 1050 trees to	Contractor	Forest Department / SHYDO	432,500

Resources	Impacts	Stage of Project	Description	Receptors	Mitigation	Responsibilities		Cost(Rs.)*
						Implementation	Supervision	
					minimize the impacts on flora. Relevant contract clauses will be included to control cutting of trees/vegetation.			
	2.Impacts on Fauna	Pre – construction	There will be impacts on the mammals and reptiles of the project area as well as along the area of project influence during the constructional activities, viz. excavation, blasting, access roads, movement of labor, carriage of goods and machinery to various sites. Unmanaged blasting activities may harm birds.	Domestic Fauna	Blasting and other noise generating activities will not be carried out during the night. Hunting, poaching and harassing of wild animals will be strictly prohibited and Contractor will be required to warn its labour accordingly.	Contractor	Supervision Consultant / SHYDO	-
		Construction	Birds will migrate from the project area due to the activities mentioned above for fear of being hunted/ trapped.	Avian Fauna	Staff working on the project should be given clear orders, not to shoot, snare or trap any bird. If possible nests of bird, on trees need to be uprooted, be shifted to other nearby trees.	Contractor	Supervision Consultant / SHYDO	-
		Construction	There is no definite record about fish is available however diversion will impact on aquatic ecosystem.	Downstream Ecosystem	The weir intake structure will be designed and constructed to allow the minimum mean monthly flow of 0.134 m^3/s, to always be maintained in the Siran River for the maintenance of riparian as well as aquatic ecosystem of downstream.	Contractor	Supervision Consultant / SHYDO	-
F. Social Environment	1. Impacts on Local Communities/ Work force	Pre – Construction	Effect on general mobility. Accessibility of the local population to the valley	Local people	The contractor will ensure that the mobility of the local communities, particularly women and children and their livestock is not hindered by the construction activities. Two new bridges will be constructed in order to access	Contractor	Supervision Consultant / SHYDO	Cost included in the cost estimates chapter.

Resources	Impacts	Stage of Project	Description	Receptors	Mitigation	Responsibilities		Cost(Rs.)*
						Implementation	Supervision	
			access road.		traffic to weir and power house site. The contractor will provide crossing points at the project structure specially power channel area at appropriate places.			
		Construction	Community will have to face the noise and dust hazards.	Local Communities	The contractor will ensure that blasting is not carried out in the near vicinity of the settlements and village tracks that are very frequently used. Here only excavators will be used. Effective construction controls by the Contractor to avoid inconvenience to the locals due to noise, smoke and fugitive dust. The contractor will frequently sprinkle water at the work areas and haul tracks to avoid generation of fugitive dust. The frequency of sprinkling will be determined by the weather condition. During long spell of hot and dry weather the sprinkling will be done after 2 or 3 hour intervals.	Contractor	Supervision Consultant / SHYDO	-
		Pre – Construction & Construction	The presence of outside construction workers inevitably causes some degree of social disruption.	All social Components	The Contractor will be required to maintain close liaison with the local communities to ensure that any potential conflicts related to common resource utilization for the project purposes are resolved quickly.	Contractor	Supervision Consultant / SHYDO	-
		Construction	The night time working will be having intrinsic problems relating to safety and noise hazards for the communities.	Social or Biological Components	It is desirable that the night-time working may be avoided at places where settlements are very close to the construction sites. The Contractor will share the plan and schedule of night time	Contractor	Supervision Consultant / SHYDO	-

Resources	Impacts	Stage of Project	Description	Receptors	Mitigation	Responsibilities		Cost(Rs.)*
						Implementation	Supervision	
					working with the Supervision Consultants for approval.			
	2.Gender Issues	Construction	The rural women normally are actively participate in other outdoor socio-economic activities such as livestock rearing, bringing of potable water, etc which may also be affected by the project activities. The induction of outside labor may create social and gender issues due to the unawareness of local customs and norms	Gender part of Community	The Contractor will have to select the specific timings for the construction activities particularly near the settlements, so as to cause least disturbance to the local population particularly women considering their peak movement hours. Contractor will warn the staff strictly not to involve in any un-ethical activities and to obey the local norms and cultural restrictions particularly with reference to women.	Contractor	Supervision Consultant / SHYDO	-
	3.Indigenous and Vulnerable Households	N/A	no indigenous or vulnerable household group of people was identified	N/A	N/A	N/A	N/A	-
	4.Safety Hazards	Construction	Occurrence of accidents/incidents during the construction activities.	Construction Crew	Complying with the safety precautions for construction workers as per International Labour Organization (ILO) Convention No. 62, as far as applicable to the project contract.	Contractor	Supervision Consultant / SHYDO	-
	5.Relocation of Private Houses/ Community Infrastructure	Pre – Construction	The acquisition of land will cause disruption to a house. There is a water supply pipe which is likely to submerge in the reservoir.	N/A	Houses will be compensated on replacement cost basis. Use good engineering practices for the relocation of water supply pipe to a suitable place.	Deputy Director (DD) in charge of the land acquisition and resettlement operations, Land Revenue Department (LAC)	Supervision Consultant / SHYDO	929,954 200,000
	6.Religious, Cultural and Historical Sites	N/A	No historical or archeological site has been observed within the project area of influence.	N/A	N/A	N/A	N/A	-

* Cost with breakdown is depicted in table 9.1 of chapter 9 of this Volume II – A.

Table-6.2

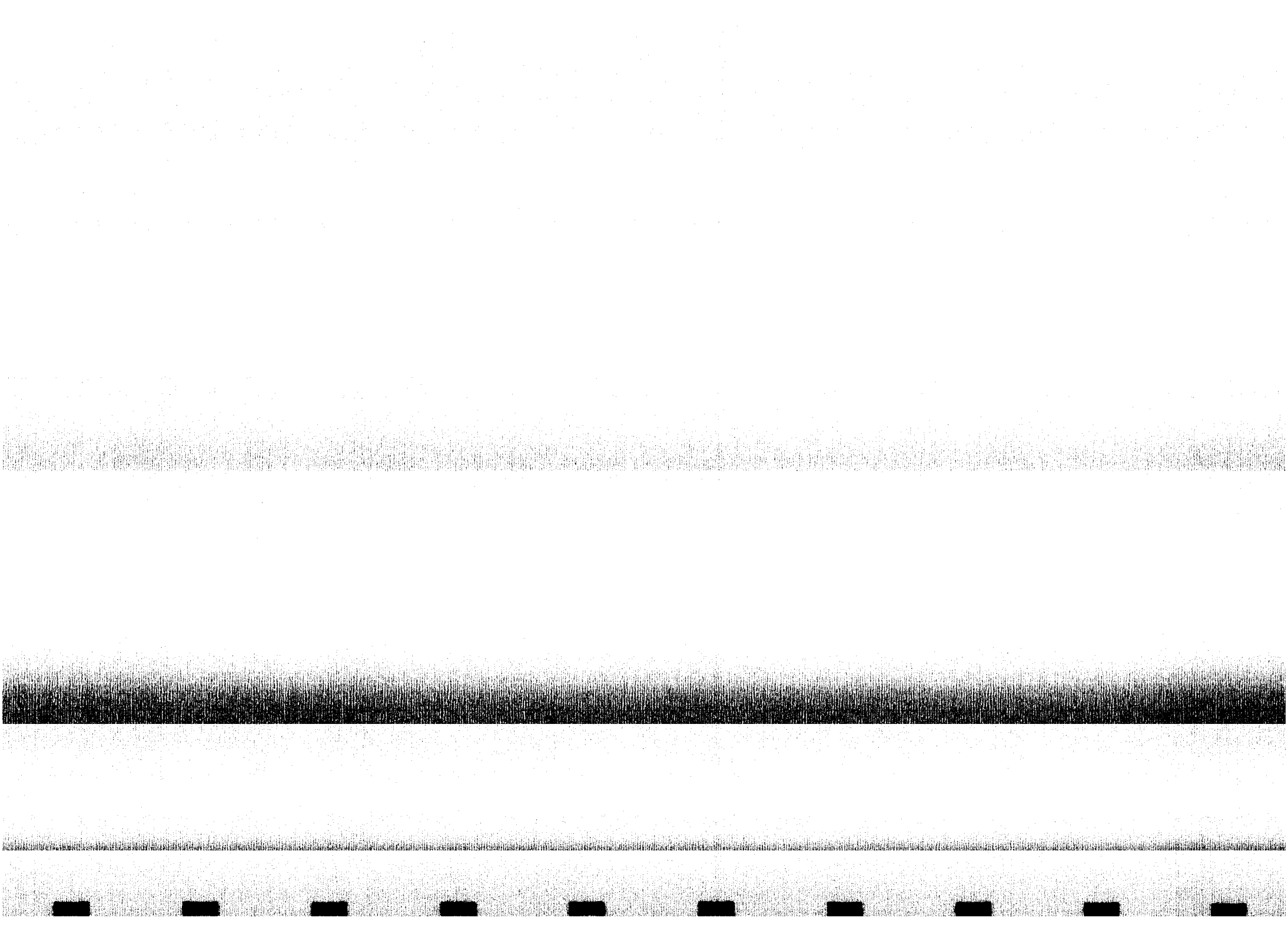
Environmental Monitoring Plan

Sr. No.	Items	Parameters	Frequency	Location	Responsibilities		Cost (Rs.)*
					Implementation	Supervision	
				For Construction Phase (32 months)			
1.	Surface Water	as per NEQS of PAK- EPA	Once every in three months	Before and after treatment from septic tank.	Contractor	Part Time Monitoring Consultant hired by SHYDO /EPA.	660,000
2.	Drinking Water	as per NEQS of PAK- EPA	Once every in three months	Labour camps and colonies.	Contractor	Part Time Monitoring Consultant hired by SHYDO /EPA.	550,000
3.	Noise	Equivalent noise level as per NEQS of PAK- EPA	Bi - annually	At major construction sites	Contractor	Part Time Monitoring Consultant hired by SHYDO /EPA.	18,000
4.	Air quality	as per NEQS of PAK- EPA	Bi - annually	At 40m radius of Batching Plant (determine the dominate air direction and carry out monitoring at downstream of air flow)	Contractor	Part Time Monitoring Consultant hired by SHYDO /EPA.	180,000
5.	Soil	Oil and grease	As per occurrence of spills	Two selected locations in contractors' equipment yards as identified by the supervision consultant	Contractor	Part Time Monitoring Consultant hired by SHYDO /EPA.	67,500
				For Operation/Maintenance Phase (for one Year)			
1.	Surface Water	as per NEQS of PAK- EPA	Once every in three months	Before and after treatment from septic tank.	SHYDO	EPA.	240,000
2.	Drinking Water	as per NEQS of PAK- EPA	Once every in three months	Labour camps and colonies.	SHYDO	EPA.	200,000
3.	Noise	Equivalent noise level as per NEQS of PAK- EPA	Bi - annually	At major construction sites	SHYDO	EPA.	6,000
4.	Air quality	as per NEQS of PAK- EPA	Bi - annually	At 40m radius of Power house area (determine the dominate air direction and carry out monitoring at downstream of air flow)	SHYDO	EPA.	60,000

Note: *Cost with breakdown is depicted in table 9.1 of chapter 9 of this Volume II – A.

CHAPTER

PUBLIC CONSULTATION PROCESS



CHAPTER – 7

PUBLIC CONSULTATION PROCESS

7.1 Public Consultation

The Environmental Protection Act makes the participation of the local communities mandatory in the planning and design of a development project. Scoping session is a process that ensures participation of the communities, knowledgeable people of the project area and other stakeholders of the project. The objectives of this process were to:

1. Share information with stakeholders on proposed project and expected impact on the physical, biological, and socio-economic environment of the project's area of influence.

2. Understand stakeholders' concerns relating to environmental hazards and social disruption and recording their suggestions in respect of mitigation actions and facilitations.

3. Understand the concerns of the female members of the affected population.

4. Address specific issues relating to:

- Disruption of settlements, earning of people who get benefits from the land, disruption of public infrastructure, Flora and Fauna etc.

- Depletion of river flow for part of the year in the stretch between weir and powerhouse when the flows will be diverted through the Power Tunnel.

- Social concerns of the population settled on the high benches near both the portals of the Power Tunnel and Powerhouse that is not directly disrupted by the project.

7.2 Major Development Issue Discussed During Scoping Sessions

Project area is connected with the Karakoram Highway (KKH) through a road, which is under construction. Residents demanded the completion of this road as well as roads to the settlements, bridges, educational facilities and employment opportunities. The most pressing problem perceived by the respondents is lack of health facilities within the project area. Project would bring physical infrastructure, educational, health and other facilities to the area and improve the services thereby improving the living standards of the community.

7.3 Perception of Respondents about the Project

Representatives of households were asked about their understanding regarding: positive and negative impacts of the project, upon employment opportunities, mobility of the villagers, income generation activities, living standard, availability of electricity, agricultural activities, deforestation and about drinking water. A large number of respondents considered that the project will have positive impact and expressed their views that the

project will provide good opportunities in all the fields. The perceptions on various impacts of the project are depicted in the Table-7.1

7.4 Main Concern of the Stakeholders

Main concerns raised by the stakeholders are provided following paragraphs:

7.4.1 Construction Phase

- Contractor should not use the local resources without permission of the community.
- Contactor should employ the local people, as they know the local norms and customs.
- Affected people should provide the job opportunities during construction phase on preference basis.
- Contractor labour should be careful about local customs.
- Mobility of local women should not be hindered due to construction activities.
- Construction activities should not hinder the daily activities of the locals.
- Contractor should keep their machinery within the project area.
- Contactor should make proper arrangements to control the noise and air pollution.
- Contractor should not dispose off their camps waste in the community area and it should be properly disposed off.
- Contactor should not cut the tree nearby the project area for their consumption for food cooking in camps. He should arrange alternative sources like gas cylinders, etc for cooking purposes.

7.4.2 Operation Phase

- Project should provide the job opportunities to the local community on regular basis.
- Local community would be face water scarcity due to diverting the water to power tunnel there should be an arrangement for release some compensation water for community uses.
- Project should provide gas, telephone, and water supply facilities to the local community.
- Arrangements should be made to control the noise and air pollution.
- A process of community consultation should be continued even at operational stage of the project.

7.5 Addressing of Stakeholders' Concerns

Following measures will be adopted to address the stakeholders' concerns.

7.5.1 Construction Phase

- Preference will be given to the local people for employment during construction activates.
- Contractor will make arrangements for utilization of resources with the consultation of community.
- Contractor will ensure the availability of gas cylinders for cooking in camps.
- Wastes of the construction camp will be disposed off properly.
- Camp site will be at least 500 m away from nearby settlements.
- Contractor will comply all the local norms and customs.
- Waste of construction camps will not be disposed off into the community area.
- Proper working timings will be adopted to minimize the hindrance to the local community mobility particularly woman.

7.5.2 Operation Phase

- Local population will be provided the job opportunities particular to project affected peoples.
- Efforts will be made to provide the utility services in the nearby localities which are under influence of the Project.
- Release of water from weir made compulsory as per social or ecological requirements.
- Proper measures to control the noise and air pollution will be adopted by the Project.
- Community consultation process will be continued even at operation stage.

Consultation with local community and their concerns, grievances and demands are described in tabular form in Table-7.2 and list of attendance is given in Table-7.3.

TABLES

Table- 7.1

Perception of Respondents on Project Impacts

Categories	Increase (%)	Decrease (%)	No Affect (%)
Employment Opportunities	100	0	0
Income Generation Activities	93.8	1.0	5.2
Unemployment	2.1	89.7	8.2
Living Standard	94.8	0.0	5.2
Facilities / Amenities	93.8	2.1	4.1
Electrification	90.7	3.1	6.2
Agriculture	59.8	27.8	12.4
Housing	69.1	23.7	7.2
Forestation	53.6	28.9	17.5
Deforestation	32.0	25.8	42.3

Table 7.2

Record of Scoping Sessions

Sr. No.	Date	Venue	Participants	Concerns	Action/Response
1	30.4.2009	Meeting with local Jirga (weir site)	35	• Team introduction, Project briefing, discuss Security issues and social values of the area. • Affected villages should be converted into model villages by model village schemes. • As main source of income is agriculture in our village, which is being affected by the reservoir. An alternate source of income should be managed. • Resettlement Action Plan must be disclosed before switching the construction.	• All possible efforts will peruse. • The project will provide unskilled jobs during the construction phase and limited number of job in operational phase as well. • As there is only one residential structure being affected or relocation aspect is negligible so abbreviated resettlement plan is envisages rather than RAP.
2.	1.5.2009	Meeting with people of upper Bella. (weir site)	12	• The river water is used for washing clothes by women, watering livestock and bathing during summer. Almost all the households keep livestock. So when the water will be diverted into the Power Tunnel, there will be no water in the river main stream. The Project should make substitute arrangement. • Majority of households in the village have septic tanks and soakage pits. Some household dispose off wastewater into their fields. So there is no chance of pollution of river water from the wastewater. • Fishing is very rare in the village, and is only recreational not commercial.	• The Proponent will make arrangement during operation of the project for release of water from weir to meet the demand of downstream reach of the river. • N/A
3	3.5.2009	Meeting with Nazim UC and other people of Granthali Village at Nazim's house. (power house site)	20	• The village Sacha Kalan, Deedal, Giyar Sachan, Upper bela, Kalawan and Lower bela along the banks of river use water for washing clothes, watering livestock and bathing. Therefore, one gate at the dam may be kept open for regular flow in the river. This is because the water from springs does not meet the requirement, particular when they are dried during summer.	• 0.134 m^3/ s are the recommended mean monthly ecological or residual flow .The project has adopted this figure for energy calculation of the project.

Sr. No.	Date	Venue	Participants	Concerns	Action/Response
4	3.5.2009	Meeting with local people of Granthali and Kundi Sheri near power house site	12	◦ Suggested that water may be made available from the project for irrigation purposes.	◦ Agreed
5	15.8.2009	At shop of Bhogar Mang.	7	◦ Description of the project. ◦ As land of our villages is being affected by this project, and we are sacrificed, therefore they were showing fears of getting no compensation.	◦ Fair and early compensation given to the actual affectees.
6	17.8.2009	At house of Namberdar.	15	◦ All the labor should be hired from affected villages. ◦ Free electricity should be provided to affected villages. ◦ The rate of land is 10 hundred thousand per Kanal.	◦ The project will provide unskilled jobs during the construction phase and limited number of job in operational phase as well. ◦ This will be negotiating later with SHYDO M/s. ◦ Land Compensation will depend on current market rates.
7	18.8.2009	Meeting with coordinator of road construction at Jabori	8	◦ Local labor should be hired when start construction. ◦ All the people were in support of this project except some ones. ◦ Parks play grounds and other recreational spot should be established. ◦ It should be tried to save our houses ◦ We accept this project only on agricultural land.	◦ All possible efforts will peruse. ◦ Only one house is affected. ◦ All possible efforts will peruse.
8	19.8.2009	Meeting with people of Kundisheri proposed location of power house staff colony	25	◦ Project description and perception. All the people were in support of this project except some ones. ◦ Besides our house and land, water pipe is also being affected. An alternate source of water should be arranged.	◦ This pipe will be relocated and if required alternative source of water would be arranged. ◦ Only one house is affected.

Sr. No.	Date	Venue	Participants	Concerns	Action/Response
				• It should be tried to save our houses. • We accept this project only on agricultural land.	• All possible efforts will peruse.
9	19.8.2009	Meeting with people of Kundisheri at proposed road construction sits	15	• Project description and briefing. • An alternate source of income should be managed. • We are not ready to provide any data relating to our houses, because we will not allow including residential land for reservoir. • It should be tried to save our houses. •	• For Job placement, preference will be given to the affectees of the project. • All possible efforts will peruse.

Table-7.3

List of Attendance

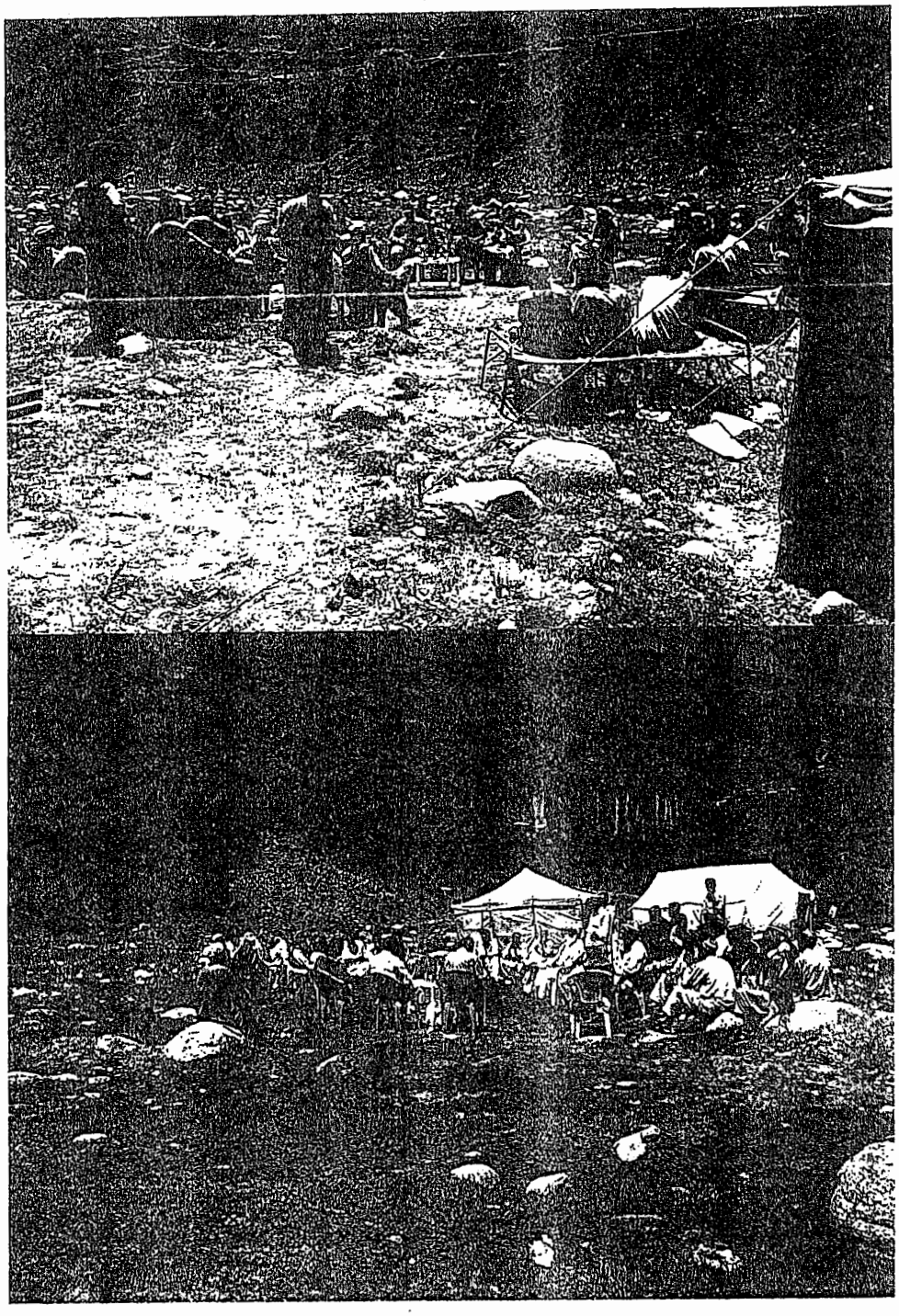
Sr.no.	Name of Respondent	Father of Respondent	Name of Tribe / Clan	Village Name	Union Council Name
1	Niaz Ahmad	Muhammad Sultan Khan	Swati	Deedal	Sacha Kalan
2	Aziz ur Rehman	Hakim Din	Gujjar	Deedal	Sacha Kalan
3	Ma Wali	Raj Wali	Tanoli	Giyar Sacha	Sacha Kalan
4	Abdul Qayum	Muhammad Hajat Khan	Swati	Giyar Sacha	Sacha Kalan
5	Muhammad Sultan	Azad Khan	Swati	Giyar Sacha	Sacha Kalan
6	Muzamil Ayub	Muhammad Ayub Khan	Yousaf-Zai	Giyar Sacha	Sacha Kalan
7	Daud Khan	Arsla Khan	Swati	Giyar Sacha	Sacha Kalan
8	Abdul Shakoor	Muhammad Sultan Khan	Swati	Deedal	Sacha Kalan
9	Shaukat Khan	Khushal Khan	Swati	Giyar Sacha	Sacha Kalan
10	M. Haroon	Malik Khan	Swati	Giyar Sacha	Sacha Kalan
11	Muhammad Riaz	Muhammad Ishaq Khan	Swati	Giyar Sacha	Sacha Kalan
12	Abdul Rasheed	Ahmed	Awan	Granthali	Bughalmang
13	Arif	Abdul Staar Khan	Swati	Kund	Sacha Kalan
14	M. Ayyaz Khan	M. Sultan Khan	Swati	Deedal	Sacha Kalan
15	Nazir Ahmed	Roshan Khan	Swati	Deedal	Sacha Kalan
16	M. Naeem	Abdul Latif	Swati	Deedal	Sacha Kalan
17	Abdur Rasheed	Ajoon Khan	Swati	Deedal	Sacha Kalan
18	M. Asif	Ajoon	Swati	Deedal	Sacha Kalan
19	Zulfiqar	M. Sultan Khan	Swati	Deedal	Sacha Kalan
20	Toseef	Abdul Latif Khan	Swati	Deedal	Sacha Kalan
21	Fayyaz Ahmed	Sultan Khan	Swati	Deedal	Sacha Kalan
22	Mother Saif ur Rehman	Abdul Hameed (Late)	Swati	Deedal	Sacha Kalan
23	M. Zubair	Miskeen	Awan	Giyar Sacha	Sacha Kalan
24	A. Qayyum	Miskeen	Awan	Giyar Sacha	Sacha Kalan
25	M. Sabir	Miskeen	Awan	Giyar Sacha	Sacha Kalan
26	M. Younis	Miskeen	Awan	Giyar Sacha	Sacha Kalan
27	M. Anwar	Ajoon Khan	Swati	Deedal	Sacha Kalan
28	Ghazanfar Ali	Abdul Latif Khan	Swati	Deedal	Sacha Kalan
29	M. Iqbal	Musa Khan	Tanoli	Lower Bela	Sacha Kalan
30	Sultan Muhammad	Gohar Aman	Swati	Kund	Sacha Kalan
31	Muhammad Ashfaq	Muhammad Rafiq	Quraish	Giyar Sacha	Sacha Kalan

Sr.no.	Name of Respondent	Father of Respondent	Name of Tribe / Clan	Village Name	Union Council Name
32	Jahangir Khan	Hajit Khan	Swati	Giyar Sacha	Sacha Kalan
33	Nawab Khan	Bram	Swati	Deedal	Sacha Kalan
34	Muhammad Riaz	Abdul Qayyum Khan	Swati	Giyar Sacha	Sacha Kalan
35	Muhammad Rafiq	Mutkeem	Quraish	Giyar Sacha	Sacha Kalan
36	Abdul Baser	Ghulam Jaan	Awan	Giyar Sacha	Sacha Kalan
37	Zia-ur-Rehman	Ghulam Jaan	Awan	Giyar Sacha	Sacha Kalan
38	Asif Irfan	Muhammad Irfan	Swati	Giyar Sacha	Sacha Kalan
39	Rafaqut Ali	Khushal Khan	Swati	Giyar Sacha	Sacha Kalan
40	Alam Zaib	Muhammad Younas	Swati	Giyar Sacha	Sacha Kalan
41	Muhammad Saleem	Mir Afzal Khan	Swati	Kund	Sacha Kalan
42	Muhammad Irfan	Hajit Khan	Swati	Giyar Sacha	Sacha Kalan
43	Shahzada Qaiser Freedon	Muhammad Irfan Khan	Swati	Giyar Sacha	Sacha Kalan
44	Nazakat Ali	Khushal Khan	Swati	Giyar Sacha	Sacha Kalan
45	Muhammad Nazir	Malik Aman	Swati	Giyar Sacha	Sacha Kalan
46	Aurang Zaib	Jahan Zaib	Swati	Giyar Sacha	Sacha Kalan
47	Shahzada Qaiser Freedon	Muhammad Irfan Khan	Swati	Giyar Sacha	Sacha Kalan
48	Muhammad Nisar	Ahmad Khan	Swati	Giyar Sacha	Sacha Kalan
49	Muhammad Ayyaz	Aurang Zaib	Swati	Giyar Sacha	Sacha Kalan
50	Sardar	Ahmad Khan	Swati	Giyar Sacha	Sacha Kalan
51	Zauq Akhtar	Muhammad Irfan	Swati	Giyar Sacha	Sacha Kalan
52	Ameer Muhammad	Muhammad Aslam Khan	Swati	Giyar Sacha	Sacha Kalan
53	Manzoor Ahmad	Arsla Khan	Swati	Giyar Sacha	Sacha Kalan
54	Ahmad Nawaz	Aurang Zaib	Swati	Giyar Sacha	Sacha Kalan
55	Niaz Ahmad	Aurang Zaib	Swati	Giyar Sacha	Sacha Kalan
56	Liaqut Ali	Khushal Khan	Swati	Giyar Sacha	Sacha Kalan
57	Raja Iqbal Khan	Muhammad Younis Khan	Swati	Giyar Sacha	Sacha Kalan
58	Muhammad Ashraf	Ajoon Khan	Swati	Giyar Sacha	Sacha Kalan
59	Muhammad Bashir	Malik Khan	Swati	Giyar Sacha	Giyar Sacha
60	Farnaaz Bibi	Muhammad Sabir	Swati	Giyar Sacha	Sacha Kalan
61	Abdul Qadus	Khushal Khan	Swati	Giyar Sacha	Sacha Kalan
62	Bibi Gulzar	Ahmad Khan	Swati	Giyar Sacha	Sacha Kalan
63	Khanbaaz	Suba	Gujjar	Giyar Sacha	Sacha Kalan
64	Mahboob	Suleman	Awan	Giyar Sacha	Sacha Kalan
65	Muhammad Husain	Suba	Gujjar	Giyar Sacha	Sacha Kalan
66	Maskeen	Kala	Awan	Giyar Sacha	Sacha Kalan

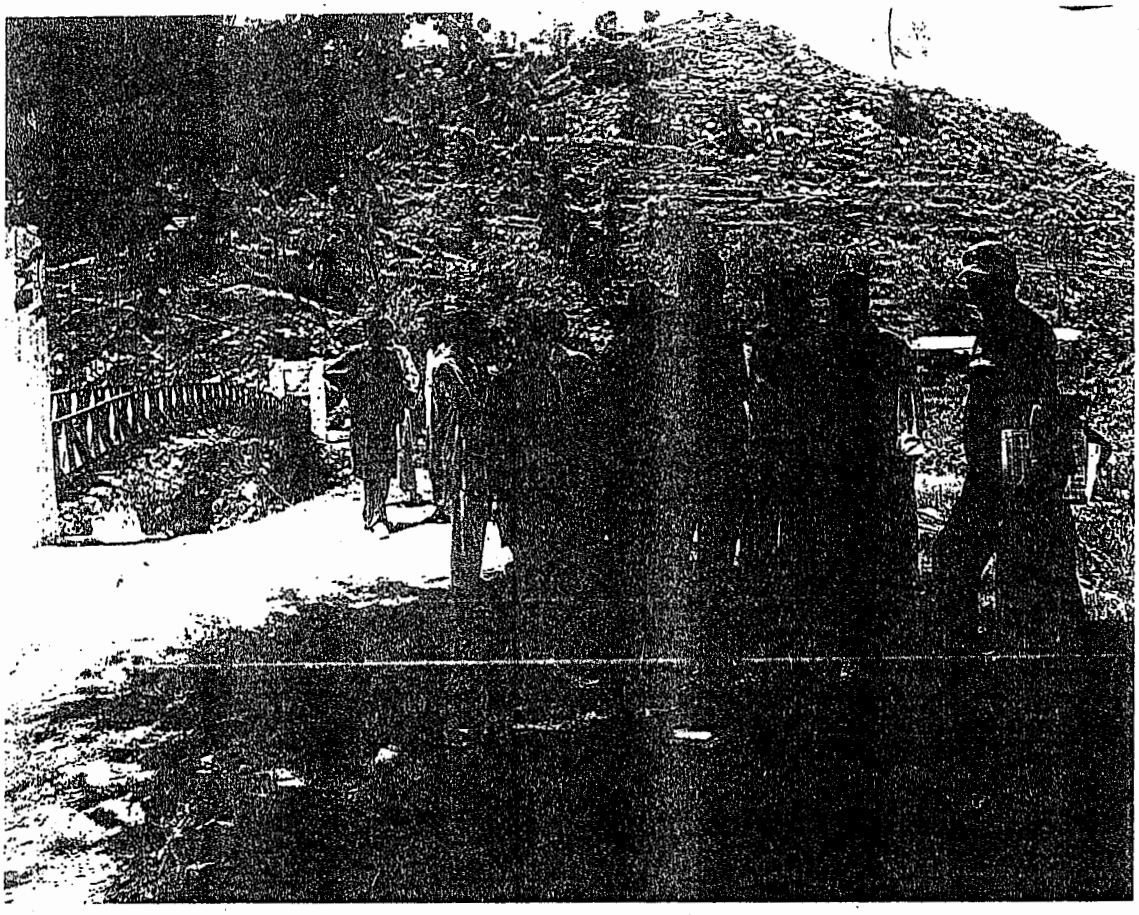
Sr.no.	Name of Respondent	Father of Respondent	Name of Tribe / Clan	Village Name	Union Council Name
67	Ghulam Khan	Makhan Khan	Awan	Giyar Sacha	Sacha Kalan
68	Hamayun	Maskeen	Awan	Giyar Sacha	Sacha Kalan
69	Muhammad Ayub	Sakandar	Tanoli	Giyar Sacha	Sacha Kalan
70	Muhammad Younas	Meer Wali	Tanoli	Giyar Sacha	Sacha Kalan
71	Ajmal	Muhamamd Aslam Khan	Swati	Giyar Sacha	Sacha Kalan
72	Muhammad Arif	Muhammad Khalil	Tanoli	Giyar Sacha	Sacha Kalan
73	Muhammad Zaman	Khanizman	Tanoli	Giyar Sacha	Sacha Kalan
74	Kala	Nawab	Awan	Giyar Sacha	Sacha Kalan
75	Muhammad Bnaras Khan	Muhammad Younas Khan	Swati	Giyar Sacha	Sacha Kalan
76	Zafeer Khan	Muhammad Haroon	Tanoli	Giyar Sacha	Sacha Kalan
77	Muhammad Khalil	Faiz Ali	Tanoli	Giyar Sacha	Sacha Kalan
78	Abdulkhanan	Kaldar Khan	Swati	Granthali	Bhogarmang
79	Adeel Hussain	Gulam Mustafa	Swati	Granthali	Bhogarmang
80	Ahamad Nawaz	Yaqoob Khan	Swati	Granthali	Bhogarmang
81	Gul Nawaz Khan	Gulam Farooq	Swati	Granthali	Bhogarmang
82	M.Nawaz	Khushal Khan	Swati	Granthali	Bhogarmang
83	Tariqu Jamil	Mir Afzal Khan	Swati	Granthali	Bhogarmang
84	Farooq khan	Bahram khan	Swati	Granthali	Bhogarmang
85	M.Nasar	Hajii Anwer	Swati	Granthali	Bhogarmang
86	Aurangzeb	Hajii Allah Dad	Swati	Granthali	Bhogarmang
87	Wajjid Ali	M.Sabir	Swati	Granthali	Bhogarmang
88	M.Arshad	M,Younas	Swati	Granthali	Bhogarmang
89	Nadeem	Abdulqaum	Swati	Granthali	Bhogarmang
90	Ali Afsar	M.khushal Khan	Swati	Granthali	Bhogarmang
91	Khalil-ur-Rahman	M.Khan	Swati	Granthali	Bhogarmang
92	Adil Hussain	Gulam Mustafa	Swati	Granthali	Bhogarmang
93	Ali Akbar	Manzoor Ali	Swati	Granthali	Bhogarmang
94	Abdulkhanan Khan	khalik Khan	Swati	Granthali	Bhogarmang
95	Imtiaz khan	M.Khan	Swati	Granthali	Bhogarmang
96	Taj Muhammad	Khushal Khan	Swati	Granthali	Bhogarmang
97	Aleem Khan	M.Noor Khan	Swati	Granthali	Bhogarmang

PHOTOGRAPHS

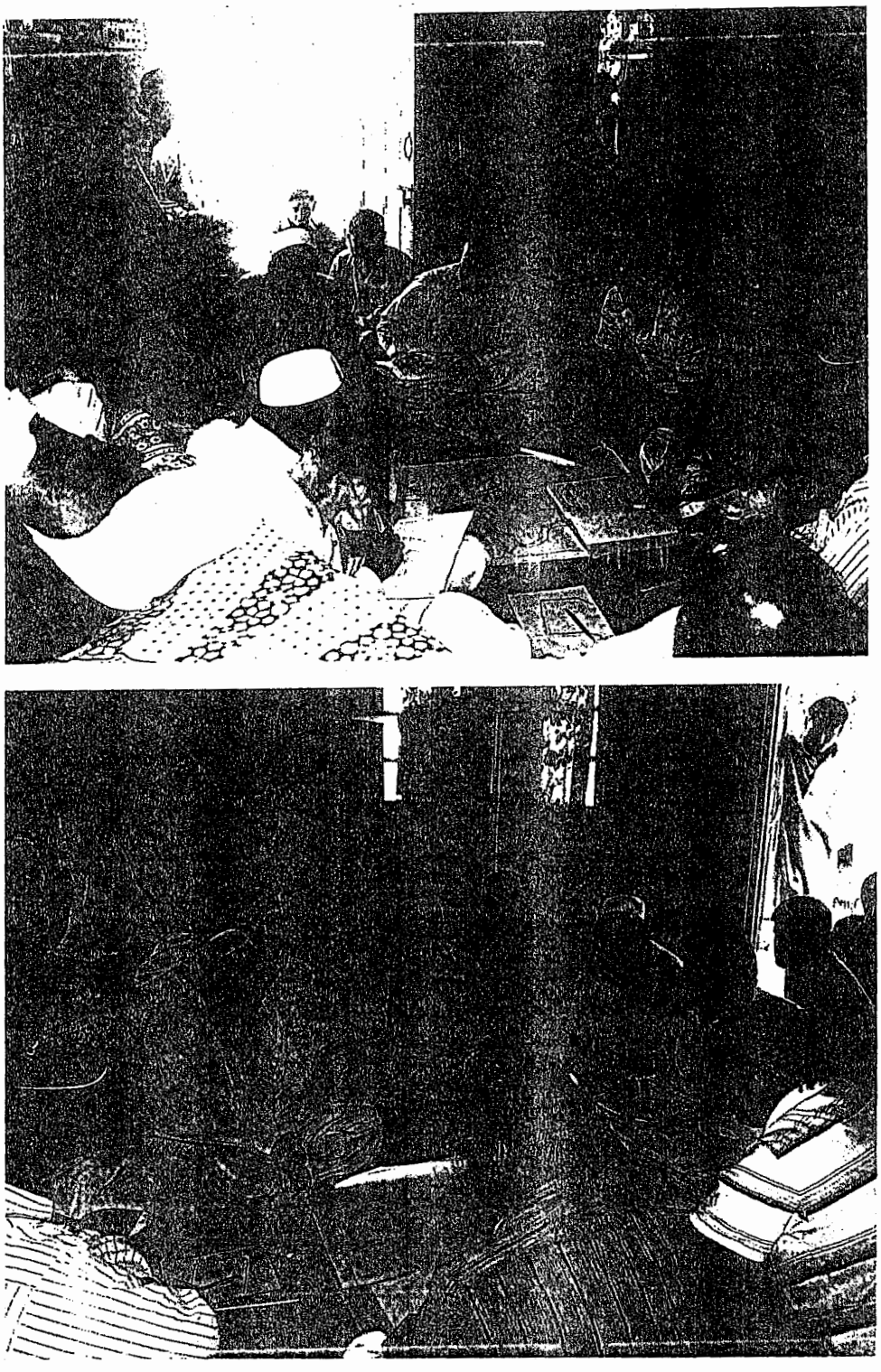
7.3 Scoping Sessions and Public Consultation in Photographs from 7.1 to 7.9.



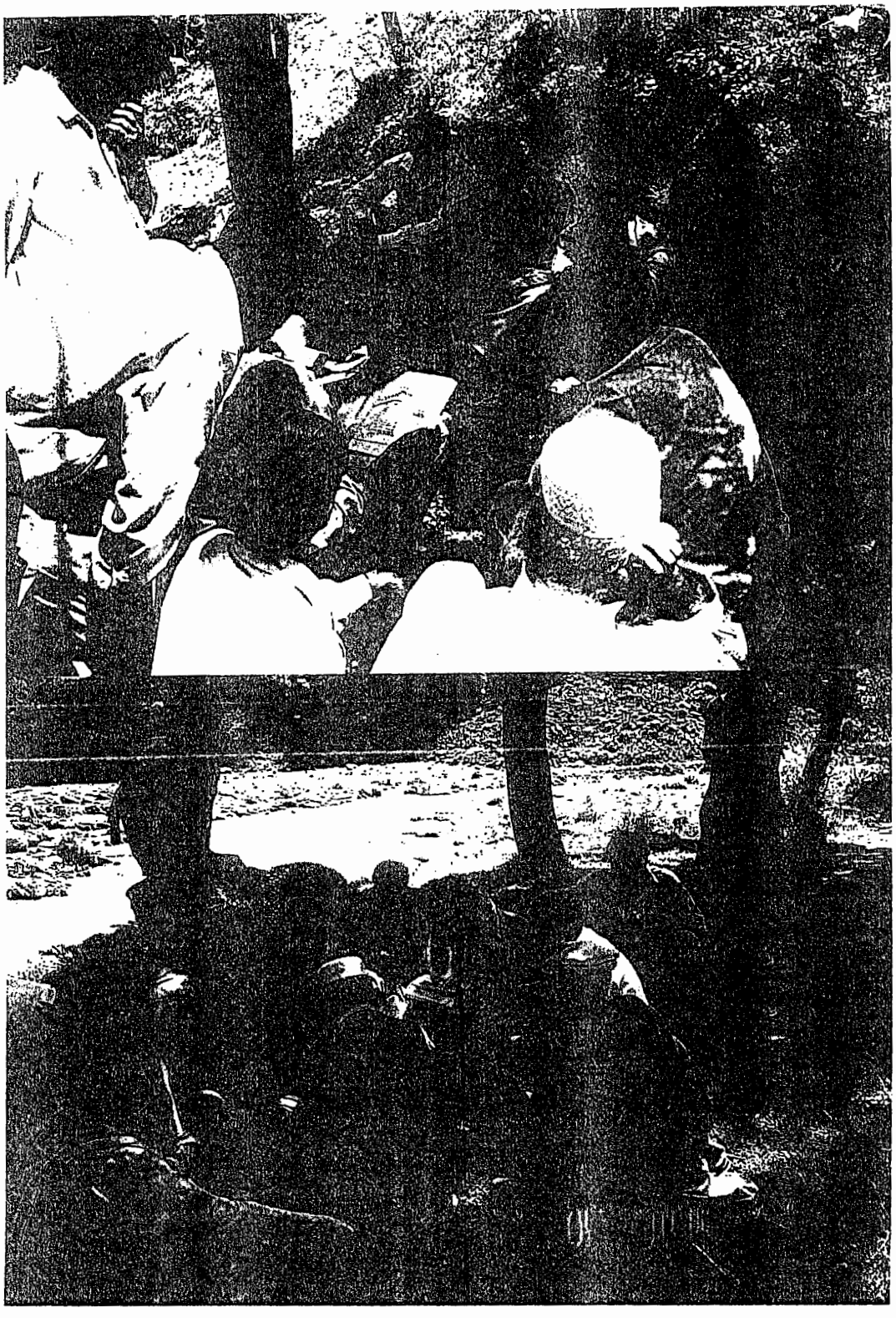
Photograph: 7.1 Meeting with local Jirga at proposed weir site.



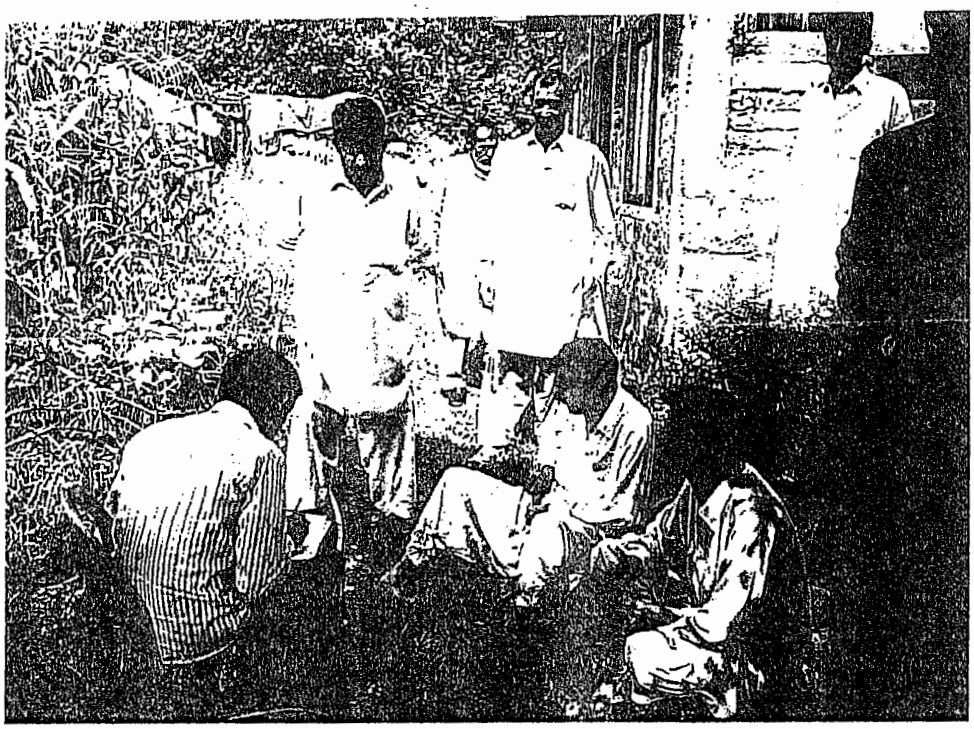
Photograph: 7.2 Meeting with people of Upper Bella



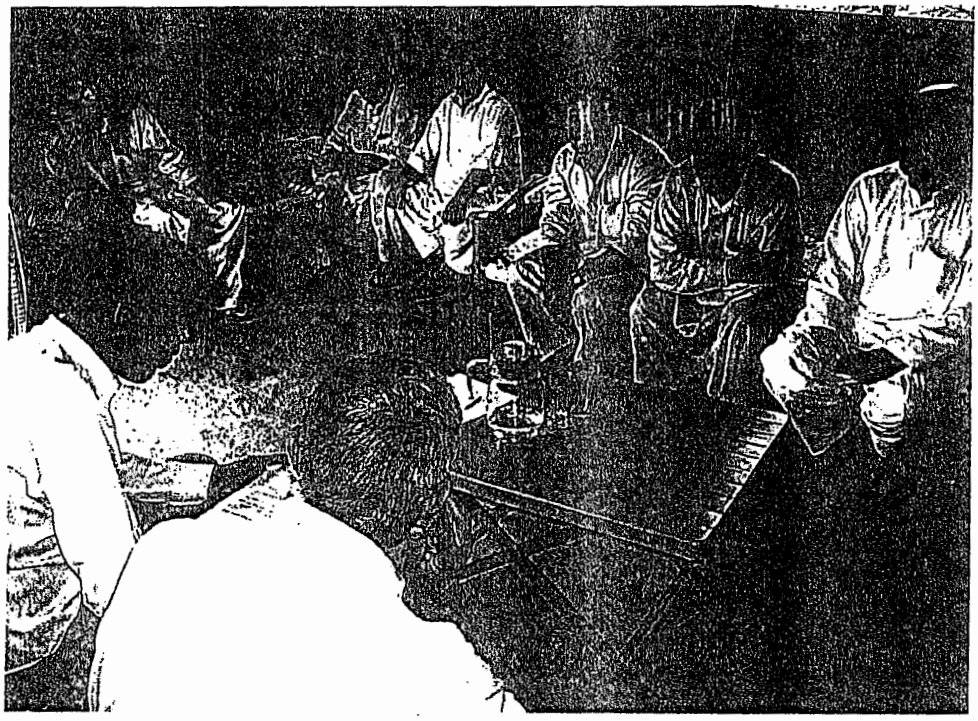
Photograph: 7.3 Meeting with Nazim UC and other people of Granthali Village at Nazim's house.



Photograph: 7.4 Meeting with people of Giyar Sachan, Deedal and upper Bella Village at Wire site.

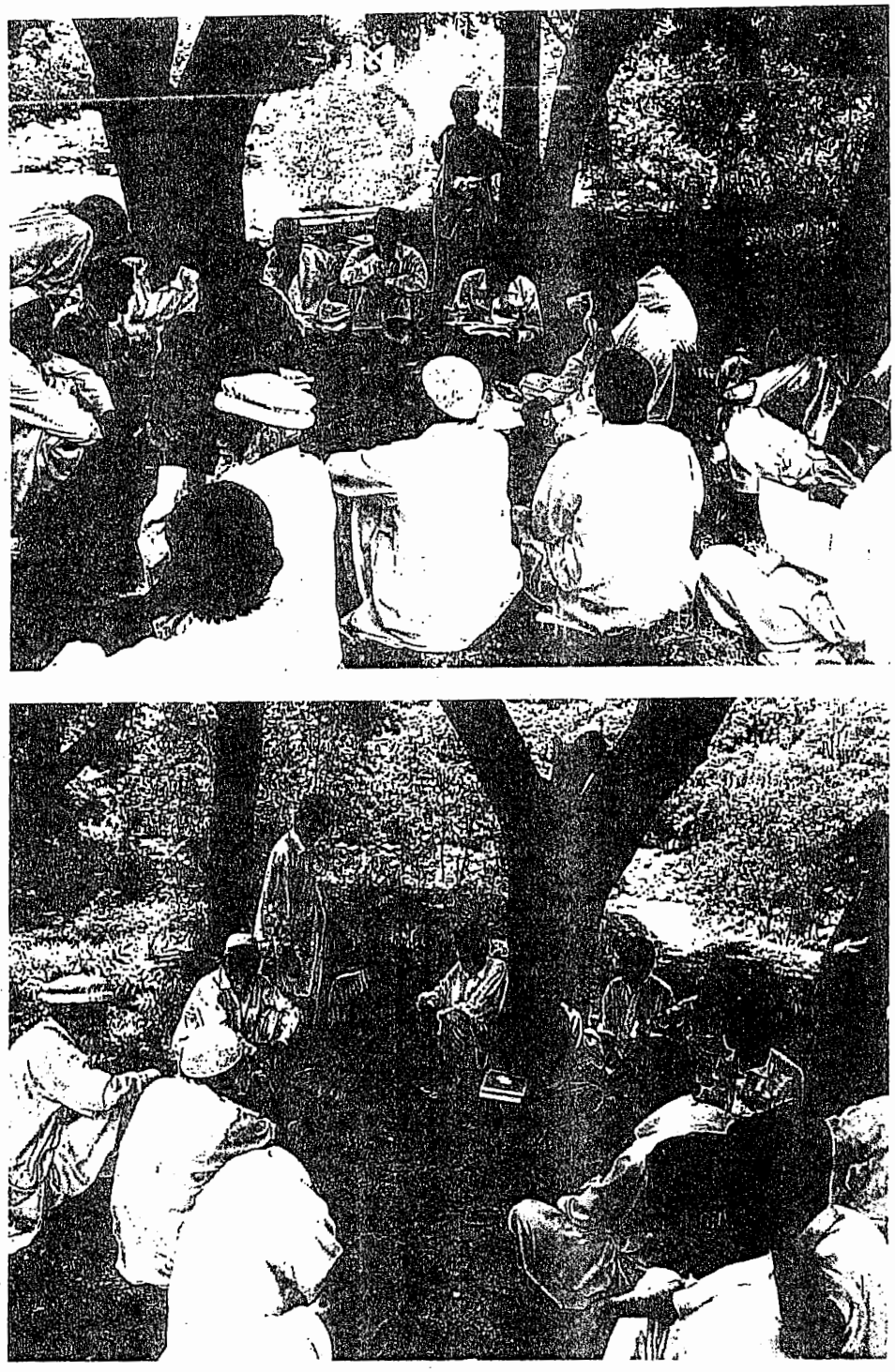


Photograph: 7.5 Meeting at shop of Bhogarmang.



Photograph: 7.6 Meeting with local coordinator of road construction at Jabori.

Photograph: 7.7 Meeting with the people of Power House at house of Namberdar.

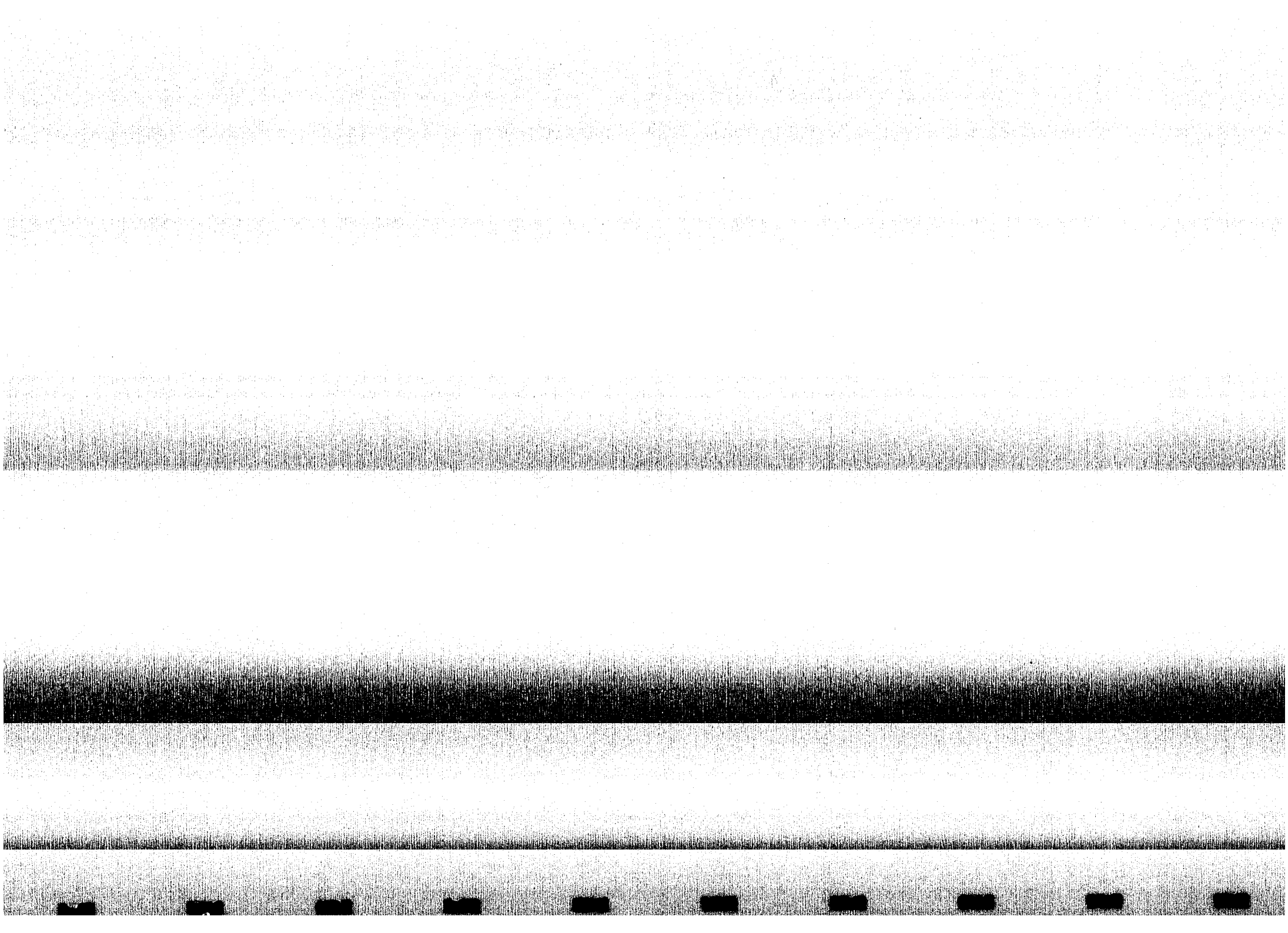


Photograph: 7.8 Meeting with people of Kundi Sheri at proposed residencies area.

Photograph: 7.9 Meeting with people of Kundi Sheri at proposed road construction site.

ABBREVIA

ETTL



CHAPTER – 8

ABBREVIATED RESETTLEMENT PLAN

8.1 Introduction

In Pakistan, a number of laws give and protect the proprietary rights. Also, laws have been promulgated at different occasions for purposes like urban and rural development, and for establishment of the authorities to implement their programmes that include acquisition of private properties for development. The Land Acquisition Act, 1894 (LAA) has been the most commonly used law for acquisition of land and other properties for development projects. Although it lays down detailed procedures for the acquisition of private properties for public purposes and their compensation, the LAA or any other law of the land, does not cover resettlement and rehabilitation of persons in a manner perceived today.

National Resettlement Policy has, therefore, been formulated to not only cover the affected persons (APs) in existing systems but also to ensure an equitable and uniform treatment of resettlement issues all over Pakistan. This Policy will apply to all development projects involving adverse social impacts, including land acquisition, loss of assets, income, business etc. It has addressed to those areas, which are not looked after in LAA and will be applicable wherever the people, families or communities are affected by any public sector or private development project, even when there is no displacement. The Policy also aims to compensate for the loss of income to those who suffer due to loss of communal property including common assets, productive assets, structures, other fixed assets, income and employment, loss of community networks and services, pasture, water rights and public infrastructure like mosques, shrines, schools, graveyards etc.

In case of resettlement, subsequent to the Policy and Ordinance, the most important reference and reporting documents are the Resettlement Plan and Abbreviated Resettlement Plan.

8.1.1 Resettlement Plan (RP)

In accordance with established resettlement policy, if the impact of the project is severe such that more than 200[1] people (40 - 50 families) are displaced by the Project, its component or sub-project, a comprehensive Resettlement Action Plan (RP) for each component or subproject will be prepared in accordance with the provisions of National Resettlement Policy as well as ADB Resettlement Policy.

8.1.2 Abbreviated Resettlement Plan (ARP)

In case the impact of the project is marginal or minor, and such that less than 200 persons (about 40-50 families) are affected and/or displaced, or where the impacts with minor

[1] Draft Resettlement Policy and Ordinance were prepared in 2002 which is not yet approved by the Government of Pakistan. ADB Resettlement Policy, 1995; and, ADB Handbook on Involuntary Resettlement: A Guide to Good Practice, 1998.

displacement, an Abbreviated Resettlement Plan instead of comprehensive Resettlement Action Plan, may suffice.

8.2 Justification for Abbreviated Resettlement Plan

The environmental assessment study of Jabori Hydropower Project indicates that only one family comprising 12 members will be displaced in addition to minor effects on other families due land taking, thus an Abbreviated Resettlement Plan (ARP) is suggested for the Project. This is based on the socioeconomic profile of project area as depicted in chapter 3 of Volume II-A.

8.3 Main Objective of Abbreviated Resettlement Plan

This ARP is designed to address all the limited impacts of the project. It provides an analysis of the impacts identifies the nature and types of losses and establishes an entitlement matrix as a guide to payments of compensation and resettlement benefits. It also contains a budget, institutional arrangement for implementing the ARP, implementation framework and monitoring arrangements. This has been described in the following sections of the chapter.

8.4 Potential Effects of the Project

The area to be consumed by the Project structures, i.e. reservoir, channel, sand trap, power house, and camps & colony and approach/access roads is given in Table-8.1

The Project is going to affect lands of about 52 families i.e. villages Sacha Khurd (5 No.), Deedal (14 No.), Giyar Sachan (2 No.), Upper bela (3 No.), Lower bela (8 No.), Kalawan (1 No), Granthali (12) and Kundi Sehri (7).Out of these, only 1 family will be losing residential land, while the rest of 51 families will lose part of their cultivated or other land types.

A total of 45 households or families (230 persons), are non settler[2] category of the Jabori village, will be affected by permanent land acquisition and 1 family (12 persons) who lose their house as well as their land fall in resident owner category of Jabori village. Among them 7 household (40 persons), of resident owner category, will also be affected by temporary land acquisition for the project implementation. Table-8.2 & 8.3 depicts detailed about project impacts on permanent land acquisition and project impacts on temporary land acquisition.

The entire affected persons are losing agricultural land, waste land and forest land. These affected persons have an average land holding size of 5 – 18 kanal, while land owners of weir site are non-settlers and the land owners of power house site are resident owners. The detail of land holding and affected trees in respect to their owners is given in Table-8.4 and Table-8.5. All the households losing lands are legal titleholders. There are no squatter households who will be affected. The total loss of trees in the project area is 350 as per the survey.

[2] Non settler refers to people whose residence is other than their impacted land.

There is no vulnerable group[3] and no indigenous category of people that exists in the project area so ADB policy is not triggered in this respect.

8.5 Policy and Legal Framework

8.5.1 Land Acquisition Act (1894) and Practice in Khyber Pakhtunkhwa

The Government of Pakistan and the four Provincial Governments, including the Khyber Pakhtunkhwa, use the Land Acquisition Act of 1894 (the Act), with amendments, as the core legal document for acquiring private land for public purposes. The process of land acquisition is initiated by serving a preliminary notice under Section 4 of the Act by the District Revenue Officer (DRO), acting as the Land Acquisition Collector (LAC), expressing the government's intention to "enter upon" the identified private lands for surveying and soil-testing for a specified public purpose. The next activity is carried out under Section 5, which involves marking and measurement of the land and assessment of compensation. The final declaration for possession of the selected portions/strips of the lands is issued under Section 6 of the Act. Under this Act, only persons officially registered with the Revenue Department as owners with the Land Revenue Department or who possess formal lease agreements are considered "eligible" for land compensation.

As per the provisions of the Act, cash compensation is assessed (Section 5) on the basis of the latest five to three years average registered land sale transfer rates, and is paid to the landowners for their lands being acquired. However, there have been instances in the recent past of taking average rates of the past one year, and even taking the current rates. For land acquisition for this project, however, the current open-market rates / replacement value will be applied, as per the ADB Resettlement Policy, and the process of land acquisition will be shortened by replacing formal LAA methods with direct negotiations with the landowners and their village elders.

8.5.2 ADB Policy on "Involuntary Resettlement"

The "Involuntary Resettlement Policy" of ADB addresses losses of land, resources, and means of livelihood or social support systems which people suffer as a result of ADB projects or project components. The "Involuntary Resettlement Policy" takes into consideration social and economic impacts that are permanent or temporary and are:

- Caused by acquisition of land and other fixed assets,
- By change in the use of land, or
- Restrictions imposed on land as a result of an ADB operation.

An "affected person" (AP) is one who experiences such impacts.

---

[3] The groups of population are considered socially vulnerable comprises of (a) those that are below the poverty line (BPL); (b) those who belong to scheduled castes (SC), scheduled tribes (ST); (c) female headed household (FHH); (d) elderly (above 65 year) and (e) disable persons

8.5.3 Main Differences between the Pakistan's LAA 1894 and ADB Resettlement Policy Guidelines

The following Table-8.6 shows the main differences between the Pakistani Land Acquisition Act (1894) and the ADB Resettlement Policy and Guidelines.

8.6 Identification of Compensation Parameters

Affected people and communities will be fully compensated for their respective losses. The following compensation parameters will be utilized:

- Ideally the 'land for land' option should be adopted but as no government land exists in the area this option cannot be applied.
- Cash compensation to be provided for land is to be based on current market /replacement value to landowners (including women), plus 15% Compulsory Acquisition Surcharge (CAS), as provided in the Pakistani Land Acquisition Act (LAA).
- Cash compensation for loss of crops is based on market value of mature crops. If sown or standing crops are damaged or uprooted, the eligible persons will be compensated in cash for the loss of un-harvested crops, at the mature crop value to be assessed on the basis of the local current market rates, regardless of the title or tenurial status.
- Compensation for loss of fruit-trees is based on the value of fruit for up to 10 years, to be assessed at current market prices, regardless of the title or tenurial status.

8.7 Entitlement and Eligibility

The ADB Resettlement Policy/Guidelines require compensation for the lost assets at replacement costs to both titled and non-titled landholders and resettlement assistance for lost income and livelihoods. Table-8.7 provides a matrix of entitlements for various types of losses and affected persons.

8.7.1 Compensation for Loss of Land, Standing Crops and Trees

Cash compensation to be provided for agricultural land is to be based on current market /replacement value to title holders or traditional land rights plus 15% Compulsory Acquisition Surcharge (CAS), as provided in the LAA. Tentative unit price of Agriculture Land is Rs.200, 000/Kanal, for Waste Land is Rs.80, 000/Kanal and for Forest Land Rs. 150,000/Kanal.

For temporary land acquisition, cultivated land is leased out at Rs.50, 000 per kanal which also includes productive value of land.

Compensation for fruit trees (for up to 10 years) to be assessed at the rate of current market prices. Estimated rate for shade trees are 1,000 Rs. /tree and for fruit trees are 1,200 Rs. /tree.

8.7.2 Restoration of Damaged Community Infrastructure and Installations

The community infrastructure that may become damaged or deteriorate as a consequence of the operation related to the project construction works will be restored to at least their prior standards totally at the project cost, especially: Drinking water pipe will be relocated and improved as a goodwill gesture towards the community. It is estimated that cost for relocation for water supply pipe per foot is 400.

Two new concert bridge will be constructed, one at weir site and the other one at powerhouse site. These will increase mobility between both banks of the river.

8.7.3 Relocation and Income Restoration Strategy

The Project will disrupt one house falling in the reservoir area. The total population of the disrupted house is 12. The total covered area of this house is about 7 Marla (1,894 ft^2). Loss of residential structure: shifting allowance will be paid to the household and affected people will be allowed to salvage materials from their demolished structures. Residential structure will be compensated on replacement cost basis, estimated rate for per square feet is Rs.491 and location for resettlement is shown in Figure-3.1.

As no income generating businesses will be affected by the project, no additional income restoration needs were mentioned by the affected people during the consultation meetings. On site job opportunities however, will be offered to the community during the construction work and affected households will be given preference in employment opportunities.

8.8 Resettlement Cost Estimates

The total estimated cost for land acquisition and resettlement for the proposed Jabori Hydropower Project is estimated at PRs.65.78 million. Estimated resettlement cost with per unit price is described in Table-8.8.

8.9 Institutional Responsibilities and Monitoring Arrangements

8.9.1 Institutional Arrangements

SHYDO will be the executing agency (EA) for this Project. A Project Directorate, headed by a Project Director (PD), will be established in SHYDO Regional Office in Peshawar, which will be responsible for the overall execution of the Project. The PD will recruit and appoint local NGO/s as required for resettlement activities. The EA will depute an Executive Engineer level officer as the Deputy Director (DD) in charge of the land acquisition and resettlement operations, who will report to the Project Director. He/she will work in close coordination with the respective field-based offices and Project NGO/s on the day to day activities of the resettlement plan implementation.

The DD through the field offices, District Land Acquisition Collector/s (LACs) in Khyber Pakhtunkhwa and Project NGO will execute and monitor the progress of the work. He will ensure coordination between the relevant departments, NGO, the Grievance Redress Committee (GRC) and the Project's affected people (APs). In addition, the Project Directorate will establish environment and social assessment units that will also be

responsible for periodic internal monitoring and evaluation of the project activities, including abbreviated resettlement plan implementation.

8.9.2 Land Acquisition Organization

The land acquisition collectors are formally responsible for acquiring the identified land/s from the respective landowners and paying the due compensation money to the affected landowners according to procedures laid down in Land Acquisition Act, 1894 and the Entitlement Matrix (Table-8.7). Once acquired and the compensation paid to the affected persons, land acquisition collectors will hand over possession of the acquired lands to SHYDO for utilization in the project implementation.

Thus, as far as the land acquisition part of the abbreviated resettlement plan is concerned, there exists a well organized system and time-tested process in Pakistan. However, with respect to other resettlement-related activities, the government officials lack the necessary know-how, as there exists so far no formal resettlement policy.

Accordingly, SHYDO has no institutional mechanisms for resettlement planning, implementation and monitoring & evaluation within the present organizational set-up. Thus, the project will have to depend mainly on external technical assistance for implementing the resettlement-related activities, side by side with their internal institutional capacity building in their Department for future self-sufficiency. This will be done by hiring the following additional expertise:

a) A Resettlement Specialist is being proposed in the team of Project Supervision Consultants to provide technical assistance in resettlement planning, implementation and internal monitoring and evaluation;

b) A Local Panel of Experts is being proposed to conduct periodic monitoring and evaluation of implementation of the ARP activities.

8.9.3 Grievances Redress Committees (GRC)

Various provisions under the Land Acquisition Act (1894) enable aggrieved "Affected Persons" (APs) at different stages of the land acquisition process to represent their cases to the Land Acquisition Collector (LAC) or even refer to the court of law for redressal and seek higher rate of compensation. However, the major grievances that might require mitigations include:

a) APs not enlisted;

b) Losses not identified correctly;

c) Compensation/assistance inadequate or not as per entitlement matrix;

d) Dispute about ownership;

e) Delay in disbursement of compensation/assistance; and

f) Improper distribution of compensation/assistance in case of joint ownership.

Thus, the main objective of the grievance redressal procedure will be to provide a mechanism to mediate conflict and cut down on lengthy litigation, which often delays such projects. It will also provide people who might have objections or concerns about their assistance, a public forum to raise their objections and through conflict resolution, address these issues adequately.

The project will establish a Grievance Redressal Committee for each contract, headed by the District Land Acquisition Collector in Khyber Pakhtunkhwa with two or three local councilors including at least one women councilor, local NGO/CBO and officials of SHYDO. The DD or his nominee, a field-based Assistant Engineer will be the member-secretary of the committee and shall act as the Project's Grievance Officer. GRC will meet at least once a month and the decision of GRC would be final. The Committee shall deliver its decision within four to six (4-6) weeks of registration of the case. The functions of the Grievance Redressal Committee shall be to:

a) Provide support to APs on problems arising out of their land/property acquisition;

b) Record the grievance of the APs, categorize and prioritize the grievances that need to be resolved by the Committee; and

c) Report to the aggrieved parties about the developments regarding their grievances and the decision of the Project authorities.

8.9.4 General Implementation Schedule

The land acquisition is a complex and lengthy process in Pakistan; it is expected to formalize the acquisition quickly due to priority given to the project by the government. Generally, the process of land acquisition in Pakistan takes about a year. The SHYDO should adopt the implementation schedule given in Table-8.9 to ensure the quick land acquisition process.

8.9.5 Monitoring and Evaluation

The SHYDO through EA will be responsible for internal monitoring of the resettlement through their field office. The Resettlement Specialist will provide necessary technical assistance in implementation and monitoring the temporary land acquisition. He will ensure the coordination between the relevant departments, the Grievance Redress Committee and the project's affected people.

In addition, a part-time Monitoring Consultant will be responsible for independent external monitoring. He will evaluate the satisfaction of the affected people regarding their compensation for their temporarily affected land. Towards the end of the project both internal and external monitors will make sure that the farmland will be restored properly and handed over to the original owners. Both consultants will submit a final report to SHYDO/ADB.

8.9.6 Indicators for Monitoring and Evaluation

The following will be considered as the basis for indicators in monitoring and evaluation of the project:

- Socio-economic conditions of the APs in the post-resettlement period
- Communications and reactions from APs on entitlements, compensation and options
- Alternative developments and relocation timetables etc.
- Changes in housing and income levels
- Valuation of property
- Grievance procedures
- Disbursement of compensation, and
- Level of satisfaction of APs in the post resettlement period

8.10 Environmental Impacts of Resettlement Plan

The project will have limited environmental impacts with the mitigation proposed in the chapter 4 of this volume II-A, IEE.

TABLES

Table-8.1

Land Required by the Project Structures

Project Structures	Cultivated land		Waste land		Forest /Grazing land		Total	
	Land (kanal)	%	Land (kanal)	%	Land (kanal)	%	Land (kanal)	%
Reservoir and Channel	104	44.8	169.4	98.5	30	54.5	303.4	66.1
Sand Trap	0	0.0	0.6	0.3	0	0.0	0.6	0.1
Access Road	1	0.4	2	1.2	0	0.0	3	0.7
Camps and Colony	25	10.8	0	0.0	0	0.0	25	5.4
Power House etc.	102	44.0	0	0.0	25	45.5	127	27.7
TOTAL LAND REQUIRED	232		172		55		459	

Table-8.2

Project Impacts on Permanent Land Acquisition in Jabori Town

Type of Impact	Residence of Affected People	No. of HH	No. of APs	Displacement
Loss of land	Settlement Sacha Khurd*	5	28	No displacement only land is affected
	Settlement Deedal*	14	80	No displacement only land is affected
	Settlement Giyar Sachan*	2	10	No displacement only land is affected
	Settlement Upper bela*	3	18	No displacement only land is affected
	Settlement Granthali	13	58	No displacement only land is affected
	Settlement Lower bela*	8	36	No displacement only land is affected
Loss of Residential Unit	Village Jabori	1	12	One Displacement as well as land is affected
Loss of trees	Settlement Sacha Khurd*	-	-	24 trees affected in Settlement Sacha Khurd
	Settlement Deedal*	-	-	34 trees affected in Settlement Deedal
	Settlement Giyar Sachan*	-	-	02 trees affected in Settlement Giyar Sachan
	Settlement Upper bela*	-	-	01 trees affected in Settlement Upper bela
	Settlement Lower bela*	-	-	22 trees affected in Settlement Lower bela
	Village Granthali	-	-	244 trees are affected in Granthali
Water Supply Pipe	Ghori-da-kta to Deedal	-	-	Relocating of Water Supply Pipe
Total		46	242	

* Owners residence is in this locality while affected land is in project Area (Jabori.)

Table-8.3
Project Impacts on Temporary Land Acquisition

Type of Impact	Location	No. of HH	No. of APs	Displacement
Loss of land	Village Kundi Sehri	7	40	No displacement only land is affected
Loss of trees	Village Kundi Sehri	-	-	No trees affected in Village Kundi Sehri
Total		7	40	

Table-8.4
Detail of Affected Land

Sr.No	Identification				Tribe	Detail of Affected Land			
	Project Site	Name of Settlement	Name of Respondent	Name of Father of Respondent		Agricultural Land	Residential Land	Forest Land	Waste Land
1	Jabori Weir	Sacha Khurd	M. Tariq	M. Ashraf	Awan	4	0	0	5
2	Jabori Weir	Sacha Khurd	Sultan	Gohar Aman	Awan	5	0	0	5
3	Jabori Weir	Sacha Khurd	M. Riaz	Abdul Qayyum	Awan	4	0	0	6
4	Jabori Weir	Sacha Khurd	M. Saleem	Meer Afzal Khan	Awan	3	0	0	5
5	Jabori Weir	Sacha Khurd	M. Nazir	M. Roshan Khan	Awan	2	0	0	4
6	Jabori Weir	Dedal	M. Sultan Khan	M. Aslam Khan	Swati	3	0	0	5
7	Jabori Weir	Dedal	Zulfiqar Ali Khan	M. Sultan Khan	Swati	5	0	0	4
8	Jabori Weir	Dedal	Ayaz Khan	M. Sultan Khan	Swati	3	0	0	5
9	Jabori Weir	Dedal	Niaz Ahmad	M. Sultan Khan	Swati	3	0	0	4
10	Jabori Weir	Dedal	Fayyaz Ahmad	M. Sultan Khan	Swati	4	0	0	5
11	Jabori Weir	Dedal	Abdul Shakoor	M. Sultan Khan	Swati	2	0	0	4
12	Jabori Weir	Dedal	M. Anwer	M. Ajoon Khan	Swati	3	0	0	5
13	Jabori Weir	Dedal	M. Asif	M. Ajoon Khan	Swati	3	0	0	5
14	Jabori Weir	Dedal	H. Abdur Rasheed	M. Ajoon Khan	Swati	2	0	0	4
15	Jabori Weir	Dedal	Arif	Abdul Sttar Khan	Swati	3	0	0	5
16	Jabori Weir	Dedal	Abdul Hameed	Abdul Hameed	Swati	3	0	0	5
17	Jabori Weir	Dedal	Ghazanfar Ali	Abdul Latif	Swati	7	0	0	7
18	Jabori Weir	Dedal	M. Naeem	Abdul Latif	Swati	5	0	0	6
19	Jabori Weir	Dedal	Touseef	Abdul Latif	Swati	5	0	0	6
20	Jabori Weir	Upperbela	Manzoor	Arsla Khan	Awan	4	0	0	7
21	Jabori Weir	Upperbela	Foedad	Maroof	Awan	2	0	0	4
22	Jabori Weir	Upperbela	Aurang Zaib	Youniz Khan	Awan	2	0	0	4
23	Jabori Weir	Lowerbela	M. Zaman	Khen-e-Zaman	Awan	6	0	0	5
24	Jabori Weir	Upperbela	Shouket Ali	Khushkhal Khan	Awan	4	0	0	6
25	Jabori Weir	Lowerbela	Ajmal	M. Aslam Khan	Awan	6	0	0	6
26	Jabori Weir	Lowerbela	Iqbal	Musa Khan	Tanoli	8	0	0	5
27	Jabori Weir	Lowerbela	Jahnzaib	Roshan Khan	Tanoli	8	0	0	6
28	Jabori Weir	Lowerbela	Muzamil Ayub	M. Ayub Khan	Tanoli	8	0	0	6
29	Jabori Weir	Lowerbela	S. Qasir Firdoon	M. Irfan	Tanoli	4	0	0	7
30	Jabori Weir	Lowerbela	Daud	Arsla Khan	Tanoli	5	0	0	6

Sr.No	Identification				Tribe	Detail of Affected Land			
	Project Site	Name of Settlement	Name of Respondent	Name of Father of Respondent		Agricultural Land	Residential Land	Forest Land	Waste Land
31	Jabori Weir	Lowerbela	Rafaqat Ali	Khushal Khan	Tanoli	6	0	0	7
32	Jabori Weir	Lowerbela	Abdul Qayyum	Hajat Khan	Tanoli	5	0	0	8
33	Jabori Weir	Lowerbela	M.Yousaf	Alam Din	Tanoli	2.5	0.5	0	0
34	Power house	Granthali	M.Farooq Khan	Behram Khan	Swati	5	0	20	0
35	Power house	Granthali	M.Ayza	Kushal Khan	Swati	8	0	0	0
36	Power house	Granthali	Ahamad nawaz	Yaqoob Khan	Swati	5	0	0	0
37	Power house /access road	Granthali	M.Gulnawaz Khan	Gulam Farooq	Swati	10	0	0	0
38	Power house	Granthali	Taj Muhammad	Khushal Khan	Swati	10	0	0	0
39	Power house	Granthali	Nazia Jaha	Baharam Khan	Swati	0	0	2	0
40	Power house	Granthali	Abdul khanan	Kaldar Khan	Swati	5	0	0	0
41	Power house	Granthali	Adil Hussain	Gulam Mustafa	Swati	5	0	0	0
42	Power house	Granthali	M.Nasir	Haji Anwer	Swati	5	0	0	0
43	Power house	Granthali	Ali Afsar	Khushal Khan	Swati	5	0	5	0
44	Power house	Granthali	Khalil-ur-Rahman	M.Khan	Swati	4	0	8	0
45	Power house	Granthali	Aurang Zaib	Haji Allah Data	Swati	8	0	10	0
46	Ressidence PH	Granthali	Najum Nisa	Musa Khan	Swati	5	0	0	0
47	Ressidence PH	Granthali	Sabir Khan	Ilyass Khan	Swati	5	0	0	0
48	Ressidence PH	Granthali	kalid Khan	Miandad Khan	Swati	5	0	0	0
49	Ressidence PH	Granthali	Rasham jaha	Irfan Khan	Swati	4	0	0	0
50	Ressidence PH	Granthali	Bashir Khan	M.Ashraf Khan	Swati	5	0	0	0
51	Ressidence PH	Granthali	Mustaq Khan	Naseem Khan	Swati	4	0	0	0
52	Ressidence PH	Granthali	Sadaqat Khan	Roshan Khan	Swati	5	0	0	0
Total						242.5	0.5	45	172

Table-8.5
Details of Affected Trees

Sr. No	Identification			Detail of Affected Trees
	Project Site	Name of Settlement	Name of Respondent	
1	Jabori Weir	Sacha Khurd	Sultan Muhammad	3
2	Jabori Weir	Sacha Khurd	M. Riaz	9
3	Jabori Weir	Sacha Khurd	M. Saleem	10
4	Jabori Weir	Sacha Khurd	M. Nazir	2
5	Jabori Weir	Deedal	M. Sultan Khan	11
6	Jabori Weir	Deedal	Zulfiqar Ali Khan	3
7	Jabori Weir	Deedal	Niaz Ahmad	2
8	Jabori Weir	Deedal	Fayyaz Ahmad	4
9	Jabori Weir	Deedal	Abdul Shakoor	2
10	Jabori Weir	Deedal	M. Anwer	4
11	Jabori Weir	Deedal	M. Asif	2
12	Jabori Weir	Deedal	H. Abdur Rasheed	2
13	Jabori Weir	Deedal	Arif	8
14	Jabori Weir	Deedal	Abdul Hameed	10
15	Jabori Weir	Deedal	Ghazanfar Ali	3
16	Jabori Weir	Deedal	M. Naeem	2
17	Jabori Weir	Deedal	Touseef	3
18	Jabori Weir	Upper bela	Manzoor	2
19	Jabori Weir	Upper bela	Foedad	3
20	Jabori Weir	Upper bela	Aurang Zaib	5
21	Jabori Weir	Lower bela	M. Zaman	1
22	Jabori Weir	Upper bela	Shouket Ali	1
23	Jabori Weir	Lower bela	Ajmal	5
24	Jabori Weir	Lower bela	Iqbal	7
25	Jabori Weir	Lower bela	Jahnzaib	3
26	Jabori Weir	Lower bela	Muzamil Ayub	2
27	Jabori Weir	Lower bela	Daud	5
28	Jabori Weir	Lower bela	Rafaqat Ali	6
29	Jabori Weir	Lower bela	Abdul Qayyum	8
30	Jabori Weir	Lower bela	M.Yousaf	4
31	Power house	Granthali	M.Farooq Khan	20
32	Power house	Granthali	M.Ayza	21
33	Power house	Granthali	Ahamad nawaz	35
34	Power house	Granthali	Taj Muhammad	7
35	Power house	Granthali	Nazia Jaha	13
36	Power house	Granthali	Abdul khanan	19
37	Power house	Granthali	Adil Hussain	5
38	Power house	Granthali	M.Nasir	12
39	Power house	Granthali	Ali Afsar	25
40	Power house	Granthali	Khalil-ur-Rahman	37
41	Power house	Granthali	Aurang Zaib	20
42	Residence PH	Granthali	Rasham jaha	4
Total				350

Table-8.6
Main Differences between LAA and ADB Involuntary Resettlement Guidelines

Pakistan's Land Acquisition Act 1894	ADB Involuntary Resettlement Guidelines
• Compensation only for landowners with titles and/ or customary rights	• Compensation for titleholders and non-titleholders of land alike
• Compensation for crop damage to registered landowners and leaseholders	• Compensation for crop damage to all sharecroppers and tenants whether they are registered or not.
• Compensation assessed on the basis of registered land mutation papers	• Compensation assessed on the basis of replacement value of the affected assets
• Land Acquisition Collector is the pre-litigation final authority to decide disputes and address complaints regarding quantification and assessment of compensation for the affected assets	• Disputes, complaints and other grievances are resolved through community participation in the form of a Grievance Redress Committee and community based organizations.
• The decisions regarding land acquisition and compensations are to be published in the official Gazette and notified in convenient places so that the people affected become aware of the same	• All information related to the quantification of land acquisition and other affected assets, entitlements, amounts of compensation and financial assistance must be disclosed to the affected persons/ communities prior to taking possession of the land.

Table-8.7
Resettlement Entitlement Matrix

Type of Loss	Definition of AP's	Entitlement	Entitled
1.Loss of land by owners	(i) Titled owners, and (ii) APs with traditional land rights.	Provision of equivalent land within the same village If land is unavailable compensation at market/ replacement value.	Cash compensation based on current market value (plus 15% Compulsory Acquisition Surcharge)
2.Temporary loss of land by individual landowner/s	(i) Titled owners, and (ii) APs with traditional land rights.	Notice to harvest standing crops Restoration Cash Compensation for loss of income potential	Cash compensation at market value for the equivalent of two seasons (4 months of crop income)
3. Loss of trees and standing crops.	Owners & beneficiaries of land.	Notice to harvest standing crop Compensation at market value	Compensation for sown or standing crops at market value as for mature crops Fruit bearing trees will be compensated at current market value after fruit for 10 years determined by the Forest Department,
4.Relocation of house	(i) Titled owners, and (ii) APs with traditional land rights.	Provision of equivalent land within the same village	Cash compensation based on current market value (plus 15% Compulsory Acquisition Surcharge) Shifting allowance for assistance in relocation
5.Drinking water pipe	Community Structure	Relocation, protection and Improvement	Water supply pipe will be relocated and improved.
6.Any unanticipated impact	Any unanticipated consequence of the project will be documented and mitigated.		

Table-8.8
Estimated Resettlement Cost

Item No.	Item	Category	Unit	Quantity	Average rate (Rs.)/unit	Estimated Amount (Rs.)
Estimated Cost of Resettlement						
1	**Permanent Land Acquisition***	Cultivated Land	Kanal	207	200,000	41,400,000
		Waste Land	Kanal	172	80,000	13,760,000
		Forest/ Grazing Land	Kanal	55	150,000	8,250,000
2	**Temporary Land Acquisition****	Cultivated Land	Kanal	25	50,000	1,250,000
3	**Structure*****	Residential Unit	ft^2	1,894	491	929,954
4	**Relocating**	Water Supply Pipe	ft	500	400	200,000
5	**Bridge**	At Giyar Scha	Cost included in the weir		-	0
		At Granthali Village	A new bridge will be constructed in order to access traffic to power house site.		-	0
					Total	**65,789,954**

* Excluding compulsory acquisition surcharge (CAS at 15%)

**Includes rate of crop value produced on land for one year (for 3 year 1,250,000 x 3)

***Includes land rate

Table- 8.9
General Time Frame for Land Acquisition

Step	LA Process	Agency Responsible	Timeline
1	LA Proposal to Revenue Department; with brief description of the Project – scope of land acquisition, location.	EA (SHYDO)	Week 1-2
2	Publication of Notice expressing the intend to acquire the land under Section 4 of LAA	Revenue Department (Respective District LAC)	Week 3-4
3	Field survey, inventory of assets affected	Revenue Department	Week 5-20
4	Declaration under Section 6 notification	Revenue Department	Week 21-22
5	Dispute/Objections (Grievance Redressal)	Aggrieved parties	Week 25-26
6	Compensation assessment & award preparation	Revenue Department	Week 23-24
7	Possession of land, marking, clearance	Revenue Department	Week 23-52
8	Disbursement of compensation cheques	Revenue Department	Week 23-52
Land acquisition to be completed in a total of 52 weeks (One Year)			

CHAPTER - 10

CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

Jabori Hydropower Project is falling in the IEE category according to the provision of Pak-EPA regulation (SRO 339 (I)/2000) which states that an IEE is required for Hydroelectric project generating less than 50 MW. Complete regulations are described in Appendix I. The Jabori Hydropower Project is of 6.5 MW, capacity and estimated capital cost is Rs. 1,660.86 million.

In spite of the fact that the project activities at some components have adverse effects of medium to high level in certain environmental areas, as depicted in Table 4.1 the overall environmental impact rating is low adverse. The benefits of the project operation and the compensation package proposed in the report outweigh the adverse effects of the project.

Construction of Jabori Hydropower Project will bring the following impacts in the area;

Negative Impacts

- The Project is going to consume about 232 kanals of agricultural land and 55 kanals of forest land.
- The impact on vegetation is not high. About 200 shade trees and 150 fruit trees have to be cut and owners compensated.
- Resettlement impact is very low because only 1 residential unit is falling in project area so only one family needs resettlement.
- There is water supply pipe which supplies water from Ghoridakta to Deedal. It is liable to submergence in the reservoir, and therefore would be relocated higher up.
- The construction activities will affect the air quality and cause noise related hazards, which will be of concern, especially at the Powerhouse where some settlements are close to the construction site.
- Depletion of the river flows when the water is diverted through Power Tunnel will affect the population of villages falling in the river stretch between the Weir and the Powerhouse.

Positive Impacts

- Hydropower is a clean and renewable source of energy and avoids contributions to pollution loads, hence, it is environment friendly
- Creation of an impoundment of relatively shallow depth will be helpful for development of fishery.

- The construction of the project will open job opportunities for the local people. This will help in raising their living standard.
- The provision of electricity in the area will bring prosperity and improve the living standards of the local people.
- The creation of reservoir will open the area for tourism which will again be economically beneficial for the local communities.
- The project will provide in-house power supply and help in developing the capability for exploiting more hydropower resources.
- The reservoir may also improve the groundwater condition, if not of the surrounding areas, at least in the downstream reaches of the river.
- No historical or archeological site has been observed along the area of influence.
- Two new concert bridges, one at weir site of the other at powerhouse site, will be constructed which enhanced mobility between both banks of the river.
- During the social field survey of the project, no indigenous or vulnerable household group of people was identified. So no impact on these people is envisaged due to the implementation of the project.

10.2 Recommendations

During construction, setting up speed limits, in close consultation with the local stakeholders, is recommended. The movement of vehicles carrying construction material should be restricted during daytime to reduce traffic load and inconvenience to the local people.

Maintenance of heavy machinery and vehicles should be of good order and engines well-tuned to avoid smoke emissions, oil leakages and other chemicals which may result in contamination of land and water.

The villages of the nearby project do not have any proper drainage and sewerage systems which contaminate the nearby Nullah water. It is necessary to provides proper drainage and sewerage system to the villages.

The proprietary land should be compensated in cash in accordance with the market rates currently prevailing or according to the abbreviated resettlement plan. The average market rates for agricultural land is Rs. 200,000 per kanal, residential land is Rs. 250,000 per kanal, forest land is Rs. 150,000 per kanal and waste land is Rs. 80,000 per kanal, plus 15% Compulsory Acquisition Surcharge.

The health and hygiene practices are primitive. Awareness projects should be conducted.

The project area should be rehabilitated after the completion of project. There should be proper disposal of residual muck material.

There should be trained staff at the project site for the environmental management and monitoring.

The existing utilities should be rehabilitated before construction, to avoid any inconvenience to the resident of the project area and provide them with alternative arrangement during the construction period.

The proponent should make arrangements in the operation of the project for release of 0.314 cumec water from the Weir for downstream reach of the river for the residual flow.

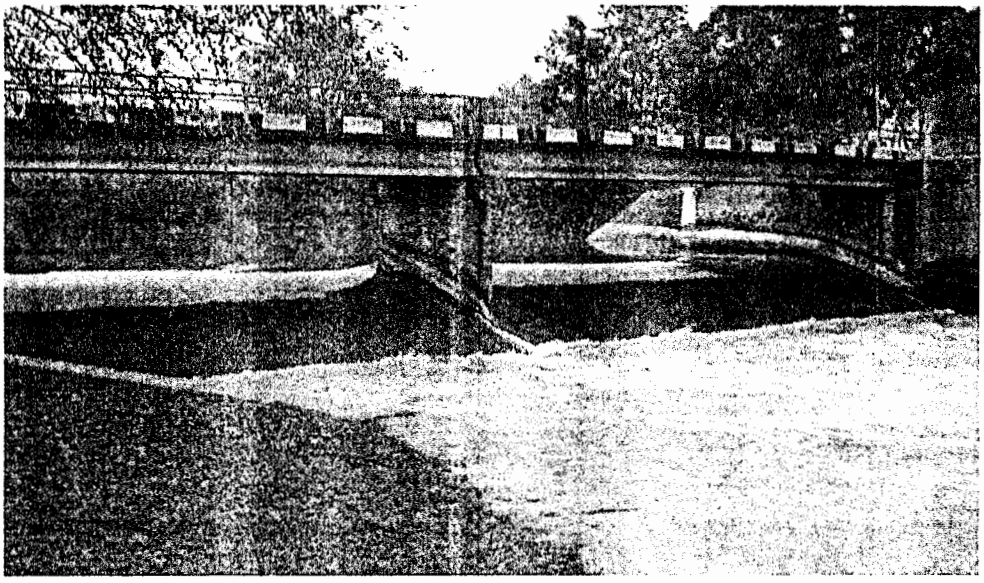
It is concluded that the project activities at certain sites will have adverse effects of medium to high level, however, the overall environmental impact rating is "low adverse". The project adequately meets the prescribed environmental standards.

Report No. PPI-189.1-Final/17

INTERCONNECTION STUDY

For

10.2 MW Jabori Hydropower Plant
District Manshera, KPK



Final Report
(March 2017)

Power Planners International Ltd.

Registered in England & Wales No. 6363482

UK Office:
3-Sylvester Road,
Sudbury Town, Middlesex,
HA0 3AQ, UK
Phone & Fax:+44-(0)208-9223219

Pakistan Office:
64-F/1, Wapda Town,
Lahore 54770, Pakistan
Phone: +92-42-5182835;
Fax: + 92-42-5183166

Email: info@powerplannersint.com
www.powerplannersint.com

Executive Summary

- The Final Report of Interconnection of the 10.2 MW Jabori Hydro Power Plant in PESCO grid system is submitted herewith.
- The study objective, approach and methodology have been described and the plant's data received from the client is validated.
- The PESCO system data as available with PPI for other studies have been used.
- The interconnection study of Jabori HPP to evacuate its maximum power of 10.2 MW is envisaged and studied in detail for Jabori Hydro power project.
- Keeping in view the comments raised on draft report, following scheme of interconnection of Hydro Power Plant with Batal 132kV to evacuate its maximum power of 10.2 MW is envisaged and studied in detail:
  - Direct 132 kV double transmission line of 20 km length using Lynx conductor to be laid from 132 kV Bus Bar of Jabori HPP till Batal 132/11 kV substation.

The proposed scheme will require the following equipment at switch yard of Jabori HPP:

- Two breaker panels of 11 kV for connecting two Generating Units
- Two 132 kV breaker/line bays need to be added for the double circuit from Jabori to Battal Grid Station

- Keeping in view the COD of Jabori HPP, July 2018, Load flow studies have been carried out for the peak load conditions of September 2018 for the proposed scheme considered under normal and N-1 conditions.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 10.2 MW of the plant under normal condition.
- The short circuit analysis has been carried out to calculate maximum fault levels at Jabori HPP at 132 kV and 11 kV and the surrounding substations in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from Jabori HPP.
- The maximum short circuit levels of Jabori HPP 11 kV have been evaluated for the peak case of 2018 to evaluate the maximum fault currents on Jabori HPP and the 132 kV Substations in its vicinity. The maximum short circuit level of the Jabori HPP 11 kV is 14.10 kA and 8.29 kA for 3-phase and 1-phase faults in the year 2018. Therefore industry standard switchgear of the short circuit rating of 25 kA at 11kV and 40 kA would

Executive Summary

- The Final Report of Interconnection of the 10.2 MW Jabori Hydro Power Plant in PESCO grid system is submitted herewith.
- The study objective, approach and methodology have been described and the plant's data received from the client is validated.
- The PESCO system data as available with PPI for other studies have been used.
- The interconnection study of Jabori HPP to evacuate its maximum power of 10.2 MW is envisaged and studied in detail for Jabori Hydro power project.
- Keeping in view the comments raised on draft report, following scheme of interconnection of Hydro Power Plant with Batal 132kV to evacuate its maximum power of 10.2 MW is envisaged and studied in detail:
  - Direct 132 kV double transmission line of 20 km length using Lynx conductor to be laid from 132 kV Bus Bar of Jabori HPP till Batal 132/11 kV substation.

The proposed scheme will require the following equipment at switch yard of Jabori HPP:

- Two breaker panels of 11 kV for connecting two Generating Units
- Two 132 kV breaker/line bays need to be added for the double circuit from Jabori to Battal Grid Station

- Keeping in view the COD of Jabori HPP, July 2018, Load flow studies have been carried out for the peak load conditions of September 2018 for the proposed scheme considered under normal and N-1 conditions.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 10.2 MW of the plant under normal condition.
- The short circuit analysis has been carried out to calculate maximum fault levels at Jabori HPP at 132 kV and 11 kV and the surrounding substations in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from Jabori HPP.
- The maximum short circuit levels of Jabori HPP 11 kV have been evaluated for the peak case of 2018 to evaluate the maximum fault currents on Jabori HPP and the 132 kV Substations in its vicinity. The maximum short circuit level of the Jabori HPP 11 kV is 14.10 kA and 8.29 kA for 3-phase and 1-phase faults in the year 2018. Therefore industry standard switchgear of the short circuit rating of 25 kA at 11kV and 40 kA would

be fine to be installed at 132 kV switch room of Jabori HPP as per PESCO/NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 11 kV bus bar of Jabori HPP substation followed by the final trip of 11 kV circuits emanating from this substation, has been performed for fault clearing within 5 cycles (100 ms). The system is found strong enough to stay stable and recovered with fast damping. Moreover, the critical clearing time was found out to be **0.2 sec.**
- The proposed scheme of interconnection has no technical constraints or problems, it meets all the criteria of stability under steady state load flow, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Report Contents

Appendices

1. Introduction

1.1. BACKGROUND

The project is on Siran river near Jabori village, District Mansehra situated in the concession area of Peshawar Electricity Supply Company (PESCO). Mansehra District is located at 34°-12' to 35°-10' N latitude and 72°-42' to 74°-12' E longitudes, 150 km to the east of the Peshawar and 90 km to the north of Islamabad. The project area is located almost in the central part of Mansehra District. The location of Jabori-HPP is shown in Appendix-A. The net output planned to be generated from the site is about 10.2 MW of electrical power. The project is expected to start commercial operation by the mid of year 2018. The electricity generated from this project would be supplied to the national grid of PESCO 132/11 kV Batal.

1.2. OBJECTIVES

The overall objective of the Study is to develop an interconnection scheme between Jabori Hydropower Project and PESCO network, for stable and reliable evacuation of 10.2 MW of electrical power generated from this plant. The specific objectives are:

1. To develop schemes of interconnections at 132 kV of which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system through load-flow analysis.
3. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 11 kV and 132 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at Jabori HPP.
4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping after 3-phase faults on the system.

1.3. PLANNING CRITERIA

The planning criteria required to be fulfilled by the proposed interconnection is as follows:

Steady State:

Voltage	± 5 %, Normal Operating Conditions
Frequency	50 Hz, Continuous, ± 1% variation steady state
	± 5% variation Short Time
	49.5 - 50.5 Hz, Short Time
Power Factor	0.85 Lagging; 0.9 Leading

Dynamic/Transient:

The system should revert to normal condition after dying out of transients without losing synchronism with good damping.

- For 132 kV and above, the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).

- For 11 kV the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 180 ms (9 cycles).

2. Assumptions of Data

Generator Data

The electrical parameters of the generators at Jabori HPP as provided by the client are as follows:

Jabori HPP data

Generator data:

Number of Generating Units	= 2
Installed Capacity of generating units	= 5.215 MW
Lump sum maximum generating capacity	= 2 x 5.215 =10.43 MW
Net Output of the Plant	= 10.2 MW
Power factor	= 0.85 lagging, 0.9 leading
Lump sum MVA capacity	= 2 x 6.315 MVA (at PF 0.85) = 12.63 MVA
Rated Voltage	= 11 kV

Generator Step-up Transformer Data:

Transformer Rating	= 13/15 MVA
Voltage Ratio	= 132/11kV
GSU Percent Impedance	= 9 % at rated MVA

For dynamic stability analysis, we have assumed the following parameters:

Inertia Constant H (turbine + generator)	= 1.758 (MWs/MVA)

2.1. NETWORK DATA

The 11 kV and 132 kV networks available for interconnection to Jabori Hydro Power Plant are as shown in Appendix-B.

The NTDC/PESCO system data of National Grid have been assumed in the study as already available with PPI.

3. Study Approach and Methodology

3.1. UNDERSTANDING OF THE PROBLEM

Jabori 10.2 MW HPP is going to be a low head hydropower project embedded in the distribution network of PESCO. Jabori HPP is in the vicinity of Battal Grid Station which is connected with Mansehra via Oghi Grid stations.

From Mansehra a Single circuit of 132 kV feed the loads of Oghi and Battal grid stations. In the event of contingency of this single circuit causes the issues of reliability.

3.2. APPROACH TO THE PROBLEM

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for the year 2018, which is after the commissioning of Jabori HPP in July 2018, comprising all 500kV, 220kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly in PESCO.
- Month of September 2018 has been selected for the study of the base case because it is high water season and we can judge the maximum impact of the plant on the network in these conditions.
- Interconnection schemes without any physical constraints, like right of way or availability of space in the terminal substations, have been identified and confirmed by PESCO via letter No. CE (Dev.)/4657-58 dated 30-12-2015
- Performed technical system studies for peak load conditions to confirm technical feasibility of the interconnection schemes. The proposed scheme has been subjected to standard analysis like load flow, short circuit, and transient stability study to check the strength of the machines and the interconnection scheme under disturbed conditions.
- Determine the relevant equipment for the proposed technically feasible scheme.

4. Development of Schemes of Interconnection

4.1 THE EXISTING AND ONGOING NETWORK

The nearest existing PESCO interconnection facilities at the time of commissioning of Jabori Hydro Power Project would be Batal 132/11 kV Substation

The existing 132 kV network available around the 132/11 kV grid station is shown in Sketch-I & II in Appendix-B.

4.2 THE SCHEME OF INTERCONNECTION OF JABORI HPP

Given the nearest interconnection facility is the 132/11 kV substation for Jabori HPP following scheme of interconnection of Hydro Power Plant with Batal 132kV is envisaged and studied in detail:

- Direct double 132 kV transmission line of 20 km length using Lynx conductor to be laid from 132 kV Bus Bar of Jabori HPP till Batal 132/11 kV substation.

The proposed scheme will require the following equipment at switch yard of Jabori HPP:

- Two breaker panels of 11 kV for connecting two Generating Units
- Two 132 kV breaker/line bays need to be added for the single circuit from Jabori to Battal Grid Station

5 Detailed Load Flow Studies

A base case has been developed for the peak load of September 2018, which is the high water season and will allow us to judge the maximum impact of Jabori HPP on the PESCO network, using the network data supplied/authorized by PESCO/NTDC.

5.1 BASE CASE 2018: WITHOUT JABORI HPP

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit comprises 132 kV network feeding Batal 132/11 kV Substation and its surrounding substations.

The load flow results for the normal case show that the power flows on all the circuits are within their normal rating. We find that there are no capacity constraints in terms of power flow or voltage ratings in the 11 kV or 132 kV network available in the vicinity of Jabori HPP for its connectivity under normal conditions.

5.2 PEAK LOAD CASE 2018: WITH JABORI HYDRO POWER PLANT

The base cases have been developed for the peak conditions of September 2018 using the network data of NTDC and PESCO available with PPI. The peak loads of the year 2018 for PESCO have been modeled as per the latest PMS Demand forecast as provided by NTDC.
Detailed load flow studies have been carried out for September 2018. The results of load flows with Jabori HPP under normal and N-1 conditions have been plotted in Exhibit 1.0 in Appendix-C.

Exhibit 1.1 Jabori to Batal 132kV Single Circuit Out

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % of the nominal. We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.
The grids in the vicinity of study plant are radial ends therefore does not support N-1 contingency criteria.

5.3 CONCLUSION OF LOAD FLOW ANALYSIS

From the analysis discussed above, we conclude that both the proposed interconnection scheme is adequate to evacuate the 10.2 MW export of power from Jabori HPP under normal conditions.

6 Short Circuit Analysis

6.1 METHODOLOGY AND ASSUMPTIONS

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies. The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2018 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

The assumptions about the generator and the transformers data are the same as mentioned in Ch.2 of this report.

6.2 FAULT CURRENT CALCULATIONS WITHOUT JABORI HPP

In order to assess the short circuit strength of the network of 132 kV and 11 kV without Jabori HPP for the grid of PESCO/NTDC in the vicinity of the site of the plant, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will not only give us the idea of the fault levels of Batal 132kV and other grid stations in the vicinity without Jabori HPP but would also help us determine how much the contribution of fault current from Jabori HPP later on may add to the existing levels.

The results are attached in Appendix – D.

The short circuit levels have been represented graphically on the bus bars of 132 kV and 11 kV which are shown in the Exhibit 2.0 attached in Appendix-D.

The fault currents in the Exhibit are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault current is shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-D for the 132 kV and 11 kV bus bars of our interest i.e. the substations connecting in the 132 kV and 11 kV circuits lying close to Jabori HPP. The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1.

Table 6.1
Maximum Short Circuit Levels without Jabori HPP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Batal 132kV	4.02	4.55
Thakot 132kV	1.91	1.97
Oghi 132kV	10.61	9.73
Manshera - New 132kV	18.16	18.35
Manshera132kV	14.13	13.98
Balakot 132kV	11.93	10.58
Patrind 132kV	11.87	11.57
Muzaffarabad-11 132kV	8.93	4.67
Muzaffarabad 132kV	7.29	6.82
Hattian 132kV	3.21	2.67

6.3 MAXIMUM FAULT CURRENT CALCULATIONS WITH JABORI HPP 2018

The fault currents have been calculated for the electrical interconnection of proposed scheme for the 2018 scenario. Fault types applied are three phase and single-phase at the 11 kV bus bar of Jabori HPP itself and other bus bars of the 132 kV and 11 kV substations in the electrical vicinity of Jabori HPP. The graphic results are shown in Exhibit 2.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV and 11 kV bus bars of the network in the electrical vicinity of Jabori HPP and the 11 kV bus bars of Jabori HPP are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2

Table 6.2

Maximum Short Circuit Levels with Jabori HPP- 2018

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Jabori HPP 11kV	14.10	8.29
Jabori 132kV	3.60	3.74
Batal 132kV	4.23	4.89
Thakot 132kV	1.96	2.02
Oghi 132kV	10.90	9.93
Manshera - New 132kV	18.47	18.60
Manshera132kV	14.33	14.13
Balakot 132kV	12.09	10.68
Patrind 132kV	12.03	11.70
Muzaffarabad-11 132kV	9.03	4.70
Muzaffarabad 132kV	7.36	6.88
Hattian 132kV	3.23	2.69

Comparison of Tables 6.1 and 6.2 show slight increase in short circuit levels for three-phase and single – phase faults due to connection of Jabori HPP on the 11 kV bus bars in its vicinity; and some rise on the 132 kV substation of Batal 132kV, and other substations in plant's vicinity. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed on these substations.

The short circuit level at Jabori HPP 11 kV bus bar is 14.10 kA and 8.29 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 25 kA would be fine to be installed at the 11 kV substation of Jabori HPP. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

6.4 CONCLUSION OF SHORT CIRCUIT ANALYSIS

The short circuit analysis results show that for the proposed scheme of interconnection of Jabori-HPP, we don't find any violations of short circuit ratings of the already installed equipment on the 132 kV and 11 kV equipment of substations in the vicinity of Jabori-HPP Feeder due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The short circuit level at Jabori-HPP Feeder 11 kV bus bar is 14.10 kA and 8.29 kA for 3-phase and 1-phase faults respectively for 2018. Therefore industry standard switchgear of the short circuit rating of 25 kA would be fine to be installed at 11 kV substation of Jabori-HPP Feeder taking care of any future generation additions in its electrical vicinity.

7 Dynamic Stability Analysis

7.1 ASSUMPTIONS & METHODOLOGY

7.1.1 Dynamic Models

The assumptions about the generator and its parameters are the same as mentioned in Ch.2 of this report.

We have employed the generic dynamic models available in the PSS/E model library for dynamic modeling of the generator, exciter and the governor as follows;

Generator	GENSAL
Excitation System	EXST1
Speed Governing System	HYGOV
Inertia Constant	H = 1.758 (MWs/MVA)

7.1.2 System Conditions

We have used the system conditions of September 2018, which represents the high water season. Most of the hydel generators in PESCO power system in the vicinity of Jabori HPP such as Patrind and Jagran would be running nearly at their full output.

We have carried out the Dynamic Stability analysis for Jabori HPP with the proposed interconnection scheme. All the power plants of WAPDA /NTDC from Tarbela to Hub have been dynamically represented in the simulation model.

7.1.3 Presentation of Results

The plotted results of the simulation runs are placed in Appendix-E. Each simulation is run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish that the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for nine seconds. Usually all the transients due to non-linearity die out within 2-3 seconds after disturbance is cleared from the system.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbances in the system. Normally we apply 3 phase fault on the bus bar of the power plant, followed by tripping of a circuit emanating from that bus, and trip one of the generators of the plant and / or trip one of the inter-bus transformers if there are two voltage levels in the switching station of the plant. Also we apply 3-phase fault at bus bars at far end of the interconnection of the plant and trip circuit or

transformer as the case may be. The fault clearing time of 11 kV breakers has been assumed 9 cycles as the switchgear of the medium voltages are slow.

7.2 DYNAMIC STABILITY SIMULATIONS' RESULTS

7.2.1 Three-Phase Fault at 132 kV Jabori: Trip Jabori to Batal Single Circuit

We applied three-phase fault on Jabori 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of single circuit between Jabori and Batal 132kV. We monitored different parameters for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 11 kV bus bar of Jabori HPP, and 132 kV substations of Jabori, Batal, Oghi, Manshera New and Manshera are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Generators of Jabori HPP

The pre-fault output of a single generator at Jabori HPP was 5.215 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Speed and mechanical power of Generators at Jabori HPP

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 1.5 MW/MVAR Flow on Jabori to Batal 132kV Single Circuit

Followed by clearing of fault, the trip of Jabori to Batal 132kV Single Circuit caused the output of 10.2 MW to flow on the other single circuit. We plotted the flows of MW and MVAR on this circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Jabori HPP, Patrind, Jagran, Malakand, and Jaban PH are plotted relative to machines at Tarbela. The results show that the rotor angle of Jabori recovers its normal condition after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.2.2 Single-Phase Fault at 132 kV Jabori: Trip Jabori to Batal Single Circuit (Stuck Breaker)

We applied single-phase fault on Jabori 132 kV bus bar, cleared fault in 9 cycles (100 ms) followed by trip of single circuit between Jabori and Batal 132kV. We monitored different parameters for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 11 kV bus bar of Jabori HPP, and 132 kV substations of Jabori, Batal, Oghi, Manshera New and Manshera are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generators of Jabori HPP

The pre-fault output of a single generator at Jabori HPP was 5.215 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Speed and mechanical power of Generators at Jabori HPP

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 2.5 MW/MVAR Flow on Jabori to Batal 132kV Single Circuit

Followed by clearing of fault, the trip of Jabori to Batal 132kV Single Circuit caused the output of 10.2 MW to flow on the other single circuit. We plotted the flows of MW and MVAR on this circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Jabori HPP, Patrind, Jagran, Malakand, and Jaban PH are plotted relative to machines at Tarbela. The results show that the rotor angle of Jabori recovers its normal condition after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.2.3 Three-Phase Fault at 11 kV Jabori HPP: Trip of Single 5.215 MW Generating Unit

We applied three-phase fault on Jabori HPP 11 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of Single 5.215 MW generating unit of Jabori HPP. We monitored different parameters for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 11 kV bus bar of Jabori HPP, and 132 kV substations of Jabori, Batal, Oghi, Manshera New and Manshera are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Generators of Jabori HPP

The pre-fault output of a single generator at Jabori HPP was 5.215 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Speed and mechanical power of Generators at Jabori HPP

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 1.5 MW/MVAR Flow on Jabori 132/11 kV Single Transformer

Followed by clearing of fault, the trip of the Single 5.215 MW generating unit of Jabori HPP caused the output of 10.2 MW to fall at 5.215 MW. We plotted the flows of MW and MVAR

on the single Jabori 132/11 kV transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Jabori HPP, Patrind, Jagran, Malakand, and Jaban PH are plotted relative to machines at Tarbela. The results show that the rotor angle of Jabori recovers its normal condition after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.2.4 Single-Phase Fault at 11 kV Jabori HPP: Trip of Single 5.215 MW Generating Unit (Stuck Breaker)

We applied single-phase fault on Jabori HPP 11 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of Single 5.215 MW generating unit of Jabori HPP. We monitored different parameters for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 11 kV bus bar of Jabori HPP, and 132 kV substations of Jabori, Batal, Oghi, Manshera New and Manshera are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generators of Jabori HPP

The pre-fault output of a generator at Jabori HPP was 5.215 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Speed and mechanical power of Generators at Jabori HPP

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 2.5 MW/MVAR Flow on Jabori 132/11 kV Single Transformer

Followed by clearing of fault, the trip of the Single 5.215 MW generating unit of Jabori HPP caused the output of 10.2 MW to fall at 5.215 MW. We plotted the flows of MW and MVAR

on the single Jabori 132/11 kV transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Jabori HPP, Patrind, Jagran, Malakand, and Jaban PH are plotted relative to machines at Tarbela. The results show that the rotor angle of Jabori recovers its normal condition after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.4 Critical Clearing Time Calculation (Tcc)

Critical Clearing Time is calculated in order to determine the characteristics of the protection equipment used in the station. For this purpose, faults for different durations were applied to check for how long the system can bear a fault without losing its stability.

The system was stable up till 10 cycles of fault duration. When 11 cycle fault was applied, system lost its stability and didn't recover back. These plots are attached in Appendix – F. Hence the critical clearing time was found out to be:

$$\mathbf{Tcc = 10/50}$$

$$\mathbf{= 0.2\ sec}$$

7.2 CONCLUSION OF DYNAMIC STABILITY ANALYSIS

The results of dynamic stability show that the system is very strong and stable for the proposed schemes for the severest possible faults of 11 kV systems near Jabori-HPP Feeder. Therefore there is no problem of dynamic stability for interconnection of Jabori- HPP Feeder; it fulfills all the criteria of dynamic stability.

8 Conclusions

- The study objective, approach and methodology have been described and the plant's data received from the client is validated.
- The PESCO system data as available with PPI for other studies have been used.
- The interconnection study of Jabori HPP to evacuate its maximum power of 10.2 MW is envisaged and studied in detail for Jabori Hydro power project.
- Keeping in view the comments raised on draft report, following scheme of interconnection of Hydro Power Plant with Batal 132kV to evacuate its maximum power of 10.2 MW is envisaged and studied in detail:
  - Direct 132 kV double transmission line of 20 km length using Lynx conductor to be laid from 132 kV Bus Bar of Jabori HPP till Batal 132/11 kV substation.

The proposed scheme will require the following equipment at switch yard of Jabori HPP:

- Two breaker panels of 11 kV for connecting two Generating Units
- Two 132 kV breaker/line bays need to be added for the double circuit from Jabori to Battal Grid Station

- Keeping in view the COD of Jabori HPP, July 2018, Load flow studies have been carried out for the peak load conditions of September 2018 for the proposed scheme considered under normal and N-1 conditions.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 10.2 MW of the plant under normal condition
- The short circuit analysis has been carried out to calculate maximum fault levels at Jabori HPP at 132 kV and 11 kV and the surrounding substations in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from Jabori HPP.
- The maximum short circuit levels of Jabori HPP 11 kV have been evaluated for the peak case of 2018 to evaluate the maximum fault currents on Jabori HPP and the 132 kV Substations in its vicinity. The maximum short circuit level of the Jabori HPP 11 kV is 14.10 kA and 8.29 kA for 3-phase and 1-phase faults in the year 2018. Therefore industry standard switchgear of the short circuit rating of 25 kA at 11kV and 40 kA would be fine to be installed at 132 kV switch room of Jabori HPP as per PESCO/NTDC

requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 11 kV bus bar of Jabori HPP substation followed by the final trip of 11 kV circuits emanating from this substation, has been performed for fault clearing within 5 cycles (100 ms). The system is found strong enough to stay stable and recovered with fast damping. Moreover, the critical clearing time was found out to be **0.2 sec.**
- The proposed scheme of interconnection has no technical constraints or problems, it meets all the criteria of stability under steady state load flow, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.